SPECIFICATIONS

PUB 408/2020
(Initial Edition,
effective April 10, 2020)

pennsylvania
DEPARTMENT OF TRANSPORTATION

Commonwealth of Pennsylvania
DEPARTMENT OF TRANSPORTATION
Publication 408/2020
SPECIFICATIONS

PREFACE

Contents:
Publication 408/2020 contains current Construction Specifications for PennDOT projects. Publication 408/2020 is located on the PennDOT website at www.penndot.gov, select "Forms, Publications, and Maps". Updated semiannually, each new Change will contain all previous Edition/Change(s) in their entirety, with changed pages integrated. The changed pages for each new Change are also located on the PennDOT website.

Standard Special Provisions (SSPs) and Master Construction Items that apply to Publication 408/2020:
SSPs and Master Items are maintained in PennDOT's Engineering and Construction Management System (ECMS) and accessible on the PennDOT website to both PennDOT Business Partners and Public Users. This is the only access provided to these documents and lists to all users. Public Users should go to the ECMS website, login as a Guest, and then navigate to "Construction Projects" > "Resources". "Resources" provides access to both Master Items and SSPs. Business Partners can login before selecting "Construction Projects" > "Resources" if they want access to other more complete ECMS data and information applying to PennDOT projects and schedules.

Use of Dimension Values:
Publication 408/2020 is a single set of Construction Specifications that contains measurements in English values. Metric values may be shown for informational purposes and/or generally accepted industry use. Dual values will not be indicated on design drawings, renderings, or in details and instructions that are project specific. Similarly, there will not be a mixing of values in formulating calculations or in presentation. In addition, to provide clarification, each project bid proposal will contain a Special Provision that will specify the dimension value to be used.

Changes and their Effective Dates:
Publication 408/2020 will be available only as an online document. Hardcopy versions will not be made available. Each semiannual change will be updated with new pages incorporated into the document and a separate Change Packet and Transmittal Letter will indicate the most recent changes and will contain a list of the current changes and an Index of Changes listing all changes to date. The full specifics of each Change can be found within the Section to this Publication entitled: ***Change Letters and Indices to Publication 408/2020***. Effective date(s) are:

- Pub 408/2020, Initial Edition (Pub 408/2020-IE) – projects let after April 10, 2020.
- Pub 408/2020, Change No. 1 (Pub 408/2020-1) – projects let after October 2, 2020.
- Pub 408/2020, Change No. 2 (Pub 408/2020-2) – projects let after April 9, 2021.
- Pub 408/2020, Change No. 3 (Pub 408/2020-3) – projects let after October 8, 2021.
- Pub 408/2020, Change No. 4 (Pub 408/2020-4) – projects let after April 1, 2022.
- Pub 408/2020, Change No. 5 (Pub 408/2020-5) – projects let after October 7, 2022.
- Pub 408/2020, Change No. 6 (Pub 408/2020-6) – projects let after April 14, 2023.
- Pub 408/2020, Change No. 7 (Pub 408/2020-7) – projects let after October 6, 2023.

SECTION 100 – GENERAL PROVISIONS

Section		Page From	Page To
101	ABBREVIATIONS AND DEFINITIONS OF TERMS	101 – 1	101 – 9
102	BIDDING REQUIREMENTS AND CONDITIONS	102 – 1	102 – 6
103	AWARD AND EXECUTION OF CONTRACT	103 – 1	103 – 3
104	SCOPE OF WORK	104 – 1	104 – 4
105	CONTROL OF WORK	105 – 1	105 – 10
106	CONTROL OF MATERIAL	106 – 1	106 – 17
107	LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC	107 – 1	107 – 14
108	PERFORMANCE AND PROGRESS	108 – 1	108 – 13
109	MEASUREMENT OF QUANTITIES	109 – 1	109 – 2
110	PAYMENT	110 – 1	110 – 35
111	DELAY CLAIMS	111 – 1	111 – 2
112	PROJECT RECORDS	112 – 1	112 – 2

SECTION 200 – EARTHWORK

Section		Page From	Page To
201	CLEARING AND GRUBBING	201 – 1	201 – 2
202	TOTAL DEMOLITION OR PARTIAL DEMOLITION OF BUILDINGS AND OTHER STRUCTURES	202 – 1	202 – 4
203	CLASS 1, CLASS 1A, CLASS 1B, AND CLASS 1C EXCAVATION	203 – 1	203 – 3
204	CLASS 2, CLASS 3, CLASS 4, AND EXISTING DITCH CLEANING EXCAVATION	204 – 1	204 – 2
205	BORROW EXCAVATION	205 – 1	205 – 2
206	PLACEMENT AND COMPACTION OF EMBANKMENT AND FILL	206 – 1	206 – 7
207	BLASTING FOR ROCK CUT SLOPE EXCAVATION	207 – 1	207 – 10
208	SPECIAL ROLLING	208 – 1	208 – 3
210	SUBGRADE	210 – 1	210 – 2
212	GEOTEXTILES	212 – 1	212 – 2
213	TEMPORARY PROJECT AIR POLLUTION CONTROL	213 – 1	213 – 1
214	SEALING ABANDONED WATER WELLS AND SPRINGS	214 – 1	214 – 1
219	GEOFOAM LIGHTWEIGHT FILL	219 – 1	219 – 6
220	FLOWABLE BACKFILL	220 – 1	220 – 4
221	EXTENSIBLE REINFORCEMENT FOR MSE WALLS	221 – 1	221 – 2
222	GEOCELL LOAD DISTRIBUTION MAT	222 – 1	222 – 2
223	GEOSYNTHETIC REINFORCED SOIL SLOPE(GRS)	223 – 1	223 – 7

SECTION 300 – BASE COURSES

Section		Page From	Page To
301	PLAIN CEMENT CONCRETE BASE COURSE	301 – 1	301 – 2
303	CEMENT TREATED PERMEABLE BASE COURSE	303 – 1	303 – 2
310	CRUSHED AGGREGATE BASE COURSE	310 – 1	310 – 3
312	CRUSHED AGGREGATE BASE COURSE, TYPE DG	312 – 1	312 – 4

SECTION 300 – BASE COURSES

Section		Page From	Page To
313	SUPERPAVE ASPHALT MIXTURE DESIGN, STANDARD CONSTRUCTION, BASE COURSE	313 – 1	313 – 1
316	FLEXIBLE BASE REPLACEMENT	316 – 1	316 – 1
323	ROLLER COMPACTED CONCRETE BASE COURSE	323 – 1	323 – 1
341	COLD RECYCLED ASPHALT BASE COURSE, COLD-IN-PLACE	341 – 1	341 – 2
342	COLD RECYCLED ASPHALT BASE COURSE, CENTRAL PLANT MIX	342 – 1	342 – 2
344	FULL DEPTH RECLAMATION	344 – 1	344 – 6
350	SUBBASE	350 – 1	350 – 2
360	ASPHALT TREATED PERMEABLE BASE COURSE	360 – 1	360 – 4

SECTION 400 – FLEXIBLE PAVEMENTS

Section		Page From	Page To
404	EVALUATION OF ASPHALT PAVEMENT RIDE QUALITY AND PAYMENT OF INCENTIVE	404 – 1	404 – 4
405	EVALUATION OF ASPHALT PAVEMENT LONGITUDINAL JOINT DENSITY AND PAYMENT OF INCENTIVE/DISINCENTIVE	405 – 1	405 – 3
410	SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCION OF PLANT-MIXED HMA FINE-GRADED COURSES	410 – 1	410 – 1
412	SUPERPAVE MIXTRUE DESIGN, CONSTRUCTION OF PLANT-MIXED 6.3 MM THIN ASPHALT OVERLAY COURSES	412 – 1	412 –12
413	SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED ASPHALT COURSES WITH PERCENT WITHIN LIMITS AND LTS TESTING (PWL-LTS)	413 – 1	413 – 29
419	STONE MATRIX ASPHALT MIXTURE DESIGN, RPS CONSTRUCTION OF PLANT-MIXED WEARING COURSES	419 – 1	419 – 15
420	PERVIOUS ASPHALT PAVEMENT SYSTEM	420 – 1	420 – 5
450	MANUAL ASPHALT PATCHING	450 – 1	450 – 2
460	ASPHALT TACK COAT	460 – 1	460 – 2
461	ASPHALT PRIME COAT	461 – 1	461 – 1
466	ASPHALT PAVING FABRIC	466 – 1	466 – 2
467	HEAVY DUTY MEMBRANES	467 – 1	467 – 1
469	ASPHALT JOINT AND CRACK SEALING	469 – 1	469 – 1
470	ASPHALT SEAL COAT	470 – 1	470 – 2
471	ASPHALT SEAL COAT USING PRECOATED AGGREGATE	471 – 1	471 – 2
472	ASPHALT FOG SEAL FOR ASPHALTSEAL COATS	472 – 1	472 – 2
473	ASPHALT SEAL COAT USING AGGREGATE FROM RAP	473 – 1	473 – 2
480	ASPHALT SURFACE TREATMENT	480 – 1	480 – 2
481	ASPHALT SURFACE TREATMENT USING PRECOATED AGGREGATE	481 – 1	481 – 1
482	SLURRY SEAL	482 – 1	482 – 3
483	POLYMER-MODIFIED EMULSIFIED ASPHALT PAVING SYSTEM (MICRO SURFACING)	483 – 1	483 – 6
489	ULTRA-THIN BONDED WEARING COURSE	489 – 1	489 – 5
490	REMOVAL OF EXISTING SURFACE COURSE	490 – 1	490 – 1

SECTION 400 – FLEXIBLE PAVEMENTS

Section		Page From	Page To
491	MILLING OF ASPHALT PAVEMENT SURFACE	491 – 1	491 – 1
492	PROFILE MILLING OF ASPHALT PAVEMENT SURFACES	492 – 1	492 – 2
496	ASPHALT CONCRETE PAVEMENT, 60-MONTH WARRANTY	496 – 1	496 – 8

SECTION 500 – RIGID PAVEMENTS

Section		Page From	Page To
501	REINFORCED OR PLAIN CEMENT CONCRETE PAVEMENTS	501 – 1	501 – 18
502	ROLLER COMPACTED CONCRETE PAVEMENT	502 – 1	502 – 7
503	PROTECTIVE COATING FOR CEMENT CONCRETE PAVEMENT	503 – 1	503 – 1
504	PAVEMENT RELIEF JOINT	504 – 1	504 – 2
505	BRIDGE APPROACH SLABS	505 – 1	505 – 1
506	REINFORCED OR PLAIN CEMENT CONCRETE PAVEMENTS, RPS	506 – 1	506 – 6
507	EVALUATION OF CONCRETE PAVEMENT RIDE QUALITY AND PAYMENT OF INCENTIVE	507 – 1	507 – 3
509	NEXT GENERATION CONCRETE SURFACE	509 – 1	509 – 2
510	LONGITUDINAL GROOVING OF EXISTING CONCRETE PAVEMENT	510 – 1	510 – 1
511	PRESSURE RELIEF JOINT	511 – 1	511 – 1
512	LONGITUDINAL JOINT CLEANING AND SEALING	512 – 1	512 – 1
513	JOINT REHABILITATION	513 – 1	513 – 1
514	DIAMOND GRINDING OF CONCRETE PAVEMENT	514 – 1	514 – 2
515	SAWING AND SEALING OF ASPHALT OVERLAYS	515 – 1	515 – 2
516	CONCRETE PAVEMENT PATCHING	516 – 1	516 – 5
517	TRANSVERSE GROOVING OF CONCRETE PAVEMENT FOR RETEXTURING	517 – 1	517 – 1
518	CONTINUOUSLY REINFORCED CONCRETE PAVEMENT PATCHING	518 – 1	518 – 2
519	FULL DEPTH LONGITUDINAL CONCRETE JOINT REPAIR	519 – 1	519 – 2
520	PERVIOUS CONCRETE PAVEMENT SYSTEM	520 – 1	520 – 3
521	TRANSVERSE JOINT CLEANING AND SEALING	521 – 1	521 – 1
523	ULTRA-THIN PORTLAND CEMENT CONCRETE OVERLAY	523 – 1	523 – 3
525	CONCRETE PAVEMENT PARTIAL-DEPTH REPAIR	525 – 1	525 – 4
526	RUBBLIZING OF CONCRETE PAVEMENTS	526 – 1	526 – 2
527	DOWEL RETROFIT	527 – 1	527 – 2
528	CONCRETE PAVEMENT CROSS-STITCHING	528 – 1	528 – 2
530	LONG-LIFE CONCRETE PAVEMENT (LLCP)	530 – 1	530 – 9
540	BONDED CONCRETE OVERLAY OF ASPHALT-SURFACED PAVEMENT	540 – 1	540 – 5
545	BONDED CONCRETE OVERLAY OF CONCRETE-SURFACED PAVEMENTS	545 – 1	545 – 5
548	UNBONDED CONCRETE OVERLAY OF CONCRETE-SURFACED PAVEMENTS	548 – 1	548 – 5
590	CRACK CLEANING AND SEALING	590 – 1	590 – 1
591	MILLING OF CEMENT CONCRETE PAVEMENT SURFACE	591 – 1	591 – 1

SECTION 600 – INCIDENTAL CONSTRUCTION

Section		Page From	Page To
601	PIPE CULVERTS	601 – 1	601 – 17
602	CORRUGATED METAL PIPE-ARCH CULVERTS	602 – 1	602 – 1
603	METAL PLATE CULVERTS	603 – 1	603 – 4
604	COMBINATION STORM SEWER AND UNDERDRAIN	604 – 1	604 – 3
605	ENDWALLS, INLETS, MANHOLES, AND SPRING BOXES	605 – 1	605 – 4
606	GRADE ADJUSTMENT OF EXISTING MISCELLANEOUS STRUCTURES	606 – 1	606 – 1
607	REBUILT MISCELLANEOUS STRUCTURES	607 – 1	607 – 1
608	MOBILIZATION	608 – 1	608 – 2
609	INSPECTOR'S FIELD OFFICE AND INSPECTION FACILITIES	609 – 1	609 – 7
610	PIPE UNDERDRAIN AND PAVEMENT BASE DRAIN	610 – 1	610 – 6
612	SUBGRADE DRAINS	612 – 1	612 – 1
613	STONE BACKFILL FOR MISCELLANEOUS DRAINAGE	613 – 1	613 – 1
615	SUBSURFACE DRAIN OUTLETS	615 – 1	615 – 1
616	END SECTIONS AND SLOPE PIPE FITTINGS	616 – 1	616 – 1
617	SLOTTED DRAINS	617 – 1	617 – 1
618	CONCRETE COLLAR FOR PIPE EXTENSION	618 – 1	618 – 1
619	PERMANENT IMPACT ATTENUATING DEVICES	619 – 1	619 – 1
620	GUIDE RAIL	620 – 1	620 – 3
621	METAL MEDIAN BARRIER	621 – 1	621 – 2
622	CONCRETE GLARE SCREEN	622 – 1	622 – 2
623	CONCRETE MEDIAN BARRIER	623 – 1	623 – 3
624	RIGHT-OF-WAY FENCE	624 – 1	624 – 2
625	CRIBBING	625 – 1	625 – 3
626	GABIONS	626 – 1	626 – 2
627	TEMPORARY BARRIER	627 – 1	627 – 1
628	RESET TEMPORARY BARRIER	628 – 1	628 – 1
630	PLAIN CEMENT CONCRETE CURB	630 – 1	630 – 2
633	PLAIN CONCRETE MOUNTABLE CURB	633 – 1	633 – 1
636	ASPHALT CONCRETE CURB	636 – 1	636 – 2
640	PLAIN CEMENT CONCRETE GUTTER	640 – 1	640 – 1
641	PLAIN CEMENT CONCRETE CURB GUTTER	641 – 1	641 – 1
643	TEMPORARY CONCRETE BARRIER, STRUCTURE MOUNTED	643 – 1	643 – 7
644	TEMPORARY CONCRETE BARRIER, STRUCTURE MOUNTED, RESET	644 – 1	644 – 1
651	PAVED SHOULDERS, TYPE 1, TYPE 1-F, TYPE 1-S, AND TYPE 1-SP	651 – 1	651 – 1
653	PAVED SHOULDERS, TYPE 3	653 – 1	653 – 1
654	PAVED SHOULDERS, TYPE 4	654 – 1	654 – 2
656	PAVED SHOULDERS, TYPE 6, TYPE 6-F, TYPE 6-S, AND TYPE 6-SP	656 – 1	656 – 1
657	PAVED SHOULDERS, TYPE 7	657 – 1	657 – 1
658	CONCRETE SHOULDERS	658 – 1	658 – 2
659	HIGH FRICTION SURFACE TREATEMENT (HFST)	659 – 1	659 – 5
660	RUMBLE STRIPS	660 – 1	660 – 1
663	BRICK MASONRY	663 – 1	663 – 1
664	MODULAR ARCHITECTURAL BLOCK SYSTEM	664 – 1	664 – 1

SECTION 600 – INCIDENTAL CONSTRUCTION

Section		Page From	Page To
665	MASONRY REPOINTING	665 – 1	665 – 1
667	CEMENT CONCRETE PAVING FOR STREAM BEDS	667 – 1	667 – 1
673	PRECAST CEMENT CONCRETE BLOCK SLOPE WALL CAST-IN-PLACE CEMENT CONCRETE SLAB SLOPE WALL	673 – 1	673 – 2
674	STONE SLOPE WALLS	674 – 1	674 – 1
675	RANDOM STONE SLOPE WALL	675 – 1	675 – 1
676	CEMENT CONCRETE SIDEWALKS	676 – 1	676 – 3
677	SELECTED MATERIAL SURFACING	677 – 1	677 – 1
678	PERMANENT BARRICADES	678 – 1	678 – 2
679	SLAB STABILIZATION	679 – 1	679 – 6
680	WATERPROOFING	680 – 1	680 – 4
681	SLABJACKING	681 – 1	681 – 3
686	CONSTRUCTION SURVEYING	686 – 1	686 – 10
688	MICROCOMPUTER SYSTEM	688 – 1	688 – 3
689	CONSTRUCTION SCHEDULING	689 – 1	689 – 6
690	PARTNERING	690 – 1	690 – 3
692	SHOULDER RELIEF JOINT	692 – 1	692 – 1
695	DETECTABLE WARNING SURFACE	695 – 1	695 – 1
696	TEMPORARY IMPACT ATTENUATING DEVICES	696 – 1	696 – 1
697	RESET TEMPORARY IMPACT ATTENUATING DEVICES	697 – 1	697 – 1

SECTION 700 – MATERIAL

Section		Page From	Page To
701	CEMENT	701 – 1	701 – 2
702	ASPHALT MATERIAL	702 – 1	702 – 2
703	AGGREGATE	703 – 1	703 – 13
704	CEMENT CONCRETE	704 – 1	704 – 21
705	JOINT MATERIAL	705 – 1	705 – 8
706	CONCRETE BONDING COMPOUND	706 – 1	706 – 1
709	REINFORCEMENT STEEL	709 – 1	709 – 4
711	CONCRETE CURING MATERIAL AND ADMIXTURES	711 – 1	711 – 4
713	MASONRY UNITS	713 – 1	713 – 1
714	PRECAST CONCRETE PRODUCTS	714 – 1	714 – 6
720	WATER	720 – 1	720 – 1
721	CALCIUM CHLORIDE	721 – 1	721 – 1
722	SODIUM CHLORIDE	722 – 1	722 – 1
723	HYDRATED LIME	723 – 1	723 – 1
724	SUPPLEMENTARY CEMENTITIOUS MATERIAL	724 – 1	724 – 1
725	LIME POZZOLAN	725 – 1	725 – 1
727	ASPHALT IMPREGNATED PAPER	727 – 1	727 – 1

SECTION 700 – MATERIAL

Section		Page From	Page To
735	GEOTEXTILES	735 – 1	735 – 2
736	GEOMEMBRANE	736 – 1	736 – 1
737	GEOCELL	737 – 1	737 – 1
738	GEOGRIDS	738 – 1	738 – 4

SECTION 800 – ROADSIDE DEVELOPMENT

Section		Page From	Page To
801	STOCKPILING TOPSOIL OR TOPSOIL MIXTURE	801 – 1	801 – 1
802	TOPSOIL FURNISHED AND PLACED	802 – 1	802 – 1
803	PLACING STOCKPILED TOPSOIL OR TOPSOIL MIXTURE	803 – 1	803 – 1
804	SEEDING AND SOIL SUPPLEMENTS	804 – 1	804 – 8
805	MULCHING	805 – 1	805 – 7
806	ROLLED EROSION CONTROL PRODUCTS	806 – 1	806 – 9
808	PLANTS, PLANTING, AND TRANSPLANTING	808 – 1	808 – 11
809	SODDING	809 – 1	809 – 2
810	TREE TRIMMING AND SELECTIVE TREE REMOVAL	810 – 1	810 – 2
811	TEMPORARY PROTECTIVE FENCE	811 – 1	811 – 1
845	UNFORESEEN WATER POLLUTION CONTROL	845 – 1	845 – 1
849	ROCK CONSTRUCTION ENTRANCE	849 – 1	849 – 1
850	ROCK LINING	850 – 1	850 – 2
851	OUTLET PROTECTION: ROCK	851 – 1	851 – 2
852	PAVED ENERGY DISSIPATOR	852 – 1	852 – 1
854	TEMPORARY SLOPE PIPE	854 – 1	854 – 1
855	PUMPED WATER FILTER BAG	855 – 1	855 – 2
856	ROCK BARRIER	856 – 1	856 – 1
857	CONCRETE BLOCK REVETMENT SYSTEMS	857 – 1	857 – 2
858	GEOCELL CONFINEMENT SYSTEM	858 – 1	858 – 2
859	SEDIMENTATION POND	859 – 1	859 – 2
860	STORM INLET PROTECTION	860 – 1	860 – 2
861	CLEANING SEDIMENTATION STRUCTURES	861 – 1	861 – 1
864	DIVERSION DITCH	864 – 1	864 – 1
865	SILT BARRIER FENCE	865 – 1	865 – 1
866	HEAVY DUTY SILT BARRIER FENCE	866 – 1	866 – 1
867	COMPOST FILTER SOCK	867 – 1	867 – 2
868	COMPOST BLANKET AND COMPOST FILTER BERM	868 – 1	868 – 2
870	SEDIMENT TRAP – EMBANKMENT	870 – 1	870 – 2
871	SEDIMENT TRAP – RISER	871 – 1	871 – 2
872	SEDIMENT BASIN	872 – 1	872 – 2
873	TEMPORARY BAFFLE WALL	873 – 1	873 – 1
874	TEMPORARY RISER PIPE ASSEMBLY	874 – 1	874 – 1
875	CONCRETE OUTLET STRUCTURE	875 – 1	875 – 2

SECTION 900 – TRAFFIC ACCOMMODATION AND CONTROL

Section		Page From	Page To
901	MAINTENANCE AND PROTECTION OF TRAFFIC DURING CONSTRUCTION	901 – 1	901 – 11
902	MAINTENANCE AND PROTECTION DURING TEMPORARY SUSPENSION OF WORK	902 – 1	902 – 1
903	TEMPORARY BRIDGE AND APPROACHES	903 – 1	903 – 1
910	HIGHWAY LIGHTING	910 – 1	910 – 8
920	SIGN LIGHTING	920 – 1	920 – 2
930	POST MOUNTED SIGNS, TYPE A	930 – 1	930 – 3
931	POST MOUNTED SIGNS, TYPE B	931 – 1	931 – 1
932	POST MOUNTED SIGNS, TYPE C	932 – 1	932 – 1
933	POST MOUNTED SIGNS, TYPE D	933 – 1	933 – 1
934	POST MOUNTED SIGNS, TYPE E	934 – 1	934 – 2
935	POST MOUNTED SIGNS, TYPE F	935 – 1	935 – 1
936	STRUCTURE MOUNTED SIGNS	936 – 1	936 – 2
937	DELINEATION DEVICES	937 – 1	937 – 1
938	DISTANCE MARKERS	938 – 1	938 – 1
939	POST MOUNTED SIGNS, TYPE M	939 – 1	939 – 1
940	RESET POST MOUNTED SIGNS, TYPE A	940 – 1	940 – 1
941	RESET POST MOUNTED SIGNS, TYPE B	941 – 1	941 – 1
942	RESET POST MOUNTED SIGNS, TYPE C	942 – 1	942 – 1
943	RESET POST MOUNTED SIGNS, TYPE D	943 – 1	943 – 1
944	RESET POST MOUNTED SIGNS, TYPE E	944 – 1	944 – 1
945	RESET POST MOUNTED SIGNS, TYPE F	945 – 1	945 – 1
948	STEEL SIGN STRUCTURE	948 – 1	948 – 5
951	TRAFFIC SIGNAL SUPPORTS	951 – 1	951 – 1
952	CONTROLLER ASSEMBLY	952 – 1	952 – 2
953	TRAFFIC SIGNAL SYSTEMS AND COMMUNICATIONS	953 – 1	953 – 5
954	ELECTRICAL DISTRIBUTION	954 – 1	954 – 4
955	SIGNAL HEADS	955 – 1	955 – 1
956	DETECTORS	956 – 1	956 – 3
960	HOT THERMOPLASTIC PAVEMENT MARKINGS	960 – 1	960 – 2
961	COLD PLASTIC PAVEMENT MARKINGS OR LEGENDS	961 – 1	961 – 1
962	WATERBORNE PAVEMENT MARKINGS	962 – 1	962 – 3
963	PAVEMENT MARKING REMOVAL	963 – 1	963 – 1
964	EPOXY PAVEMENT MARKINGS	964 – 1	964 – 3
965	PREFORMED THERMOPLASTIC PAVEMENT MARKINGS	965 – 1	965 – 2
966	SNOWPLOWABLE RAISED PAVEMENT MARKERS	966 – 1	966 – 2
970	REMOVE POST MOUNTED SIGNS, TYPE A	970 – 1	970 – 1
971	REMOVE POST MOUNTED SIGNS, TYPE B	971 – 1	971 – 1
972	REMOVE POST MOUNTED SIGNS, TYPE C	972 – 1	972 – 1
973	REMOVE POST MOUNTED SIGNS, TYPE D	973 – 1	973 – 1
974	REMOVE POST MOUNTED SIGNS, TYPE E	974 – 1	974 – 1
975	REMOVE POST MOUNTED SIGNS, TYPE F	975 – 1	975 – 1

SECTION 1000 – STRUCTURES

Section		Page From	Page To
1001	CEMENT CONCRETE STRUCTURES	1001 – 1	1001 – 21
1002	REINFORCEMENT BARS	1002 – 1	1002 – 7
1003	DOWEL HOLES	1003 – 1	1003 – 1
1005	PILES	1005 – 1	1005 – 12
1006	DRILLED CAISSONS	1006 – 1	1006 – 15
1007	MICROPILES	1007 – 1	1007 – 9
1008	PREFORMED NEOPRENE COMPRESSION JOINT SEAL FOR BRIDGES	1008 – 1	1008 – 2
1012	PEDESTRIAN RAILING	1012 – 1	1012 – 2
1013	ALUMINUM BRIDGE RAILING	1013 – 1	1013 – 1
1014	STEEL BRIDGE RAILING	1014 – 1	1014 – 1
1015	PROTECTIVE BARRIER	1015 – 1	1015 – 2
1016	PROTECTIVE FENCE	1016 – 1	1016 – 1
1017	PRESSURE MORTAR POINTING AND SURFACING	1017 – 1	1017 – 3
1018	REMOVAL OF EXISTING BRIDGES OR CULVERTS	1018 – 1	1018 – 2
1019	PROTECTIVE COATING FOR REINFORCED CONCRETE SURFACES	1019 – 1	1019 – 4
1020	TOOTH EXPANSION DAM WITH DRAIN TROUGH	1020 – 1	1020 – 2
1021	ARMORED PREFORMED NEOPRENE COMPRESSION DAM	1021 – 1	1021 – 1
1022	STEEL BRIDGE HAND RAILING	1022 – 1	1022 – 1
1023	ALUMINUM BRIDGE HAND RAILING	1023 – 1	1023 – 1
1025	MODIFICATION OF EXISTING BARRIER	1025 – 1	1025 – 1
1026	NEOPRENE STRIP SEAL DAM	1026 – 1	1026 – 1
1031	TIMBER STRUCTURES	1031 – 1	1031 – 6
1032	HARDWOOD GLULAM TIMBER STRUCTURES	1032 – 1	1032 – 2
1039	CONCRETE BRIDGE DECK SURFACE PREPARATION, HYDRODEMOLITION	1039 – 1	1039 – 2
1040	CONCRETE BRIDGE DECK REPAIR	1040 – 1	1040 – 3
1041	SCARIFICATION	1041 – 1	1041 – 1
1042	LATEX MODIFIED MORTAR OR CONCRETE WEARING SURFACE	1042 – 1	1042 – 8
1043	SHOTCRETE	1043 – 1	1043 – 5
1044	AESTHETIC COATING FOR CONCRETE SURFACES	1044 – 1	1044 – 5
1046	EPOXY OVERLAY	1046 – 1	1046 – 7
1050	STEEL BRIDGE SUPERSTRUCTURE	1050 – 1	1050 – 12
1051	DOWNSPOUTING	1051 – 1	1051 – 1
1052	METAL CURB DRAIN	1052 – 1	1052 – 1
1060	SHOP PAINTING STRUCTURAL STEEL	1060 – 1	1060 – 5
1070	PAINTING EXISTING STRUCTURAL STEEL	1070 – 1	1070 – 9
1071	SPOT/ZONE MAINTENANCE PAINTING OF EXISTING STRUCTURAL STEEL	1071 – 1	1071 – 2
1080	PRESTRESSED CONCRETE BRIDGE SUPERSTRUCTURE	1080 – 1	1080 – 6
1085	PRECAST REINFORCED CONCRETE BOX CULVERT	1085 – 1	1085 – 6
1086	SOUND BARRIERS	1086 – 1	1086 – 8
1087	PA HT BRIDGE BARRIER	1087 – 1	1087 – 2
1088	PA TYPE 10M BRIDGE BARRIER	1088 – 1	1088 – 1
1089	PA BRIDGE BARRIER	1089 – 1	1089 – 2
1090	BRIDGE PRESERVATION AND REHABILITATION	1090 – 1	1090 – 3

SECTION 1000 – STRUCTURES

Section		Page From	Page To
1091	EPOXY INJECTION CRACK SEAL	1091 – 1	1091 – 2
1092	EPOXY PROTECTION FOR STRUCTURAL STEEL	1092 – 1	1092 – 3

SECTION 1100 – MANUFACTURED MATERIAL

Section		Page From	Page To
1101	HIGHWAY LIGHTING	1101 – 1	1101 – 21
1102	SIGN LIGHTING	1102 – 1	1102 – 2
1103	TRAFFIC SIGNING AND MARKING	1103 – 1	1103 – 8
1104	TRAFFIC SIGNALS	1104 – 1	1104 – 31
1105	FABRICATED STRUCTURAL STEEL AND ALUMINUM	1105 – 1	1105 – 31
1107	PRESTRESSED CONCRETE BRIDGE BEAMS	1107 – 1	1107 – 21
1108	POST-TENSIONING OPERATIONS	1108 – 1	1108 – 6
1109	GUIDE RAIL AND METAL MEDIAN BARRIER	1109 – 1	1109 – 2
1110	RIGHT-OF-WAY FENCE	1110 – 1	1110 – 3
1111	HIGH LOAD MULTI-ROTATIONAL BEARINGS	1111 – 1	1111 – 8
1112	GLUED LAMINATED HARDWOOD TIMBER MEMBERS	1112 – 1	1112 – 4
1113	PLAIN AND LAMINATED NEOPRENE BEARING PADS	1113 – 1	1113 – 5
1119	THRIE BEAM GUIDE RAIL	1119 – 1	1119 – 1
1124	TEMPORARY TRAFFIC CONTROL SIGNALS	1124 – 1	1124 – 5

SECTION 1200 – INTELLIGENT TRANSPORTATION SYSTEM (ITS) DEVICES

Section		Page From	Page To
1201	ITS DEVICES–GENERAL	1201 – 1	1201 – 13
1202	ATMS ITS DEVICE INTEGRATION	1202 – 1	1202 – 6
1204	ITS COMMUNICATIONS	1204 – 1	1204 – 10
1206	MAINTENANCE, ITS DEVICES-GENERAL	1206 – 1	1206 – 2
1210	CLOSED CIRCUIT TELEVISION CAMERA	1210 – 1	1210 – 6
1211	PORTABLE CLOSED CIRCUIT TELEVISION CAMERA	1211 – 1	1211 – 3
1216	MAINTENANCE, CLOSED CIRCUIT TELEVISION (CCTV) CAMERA	1216 – 1	1216 – 2
1217	MAINTENANCE, PORTABLE CLOSED CIRCUIT TELEVISION (PCCTV) CAMERA	1217 – 1	1217 – 2
1220	HIGHWAY ADVISORY RADIO SUBSYSTEM	1220 – 1	1220 – 7
1226	MAINTENANCE, HIGHWAY ADVISORY RADIO (HAR) SUBSYSTEM	1226 – 1	1226 – 2
1230	DYNAMIC MESSAGE SIGNS	1230 – 1	1230 – 13
1231	PORTABLE DYNAMIC MESSAGE SIGNS	1231 – 1	1231 – 5
1236	MAINTENANCE, DYNAMIC MESSAGE SIGNS (DMS)	1236 – 1	1236 – 2
1237	MAINTENANCE, PORTABLE DYNAMIC MESSAGE SIGN (PDMS)	1237 – 1	1237 – 2
1240	VEHICLE DETECTOR SUBSYSTEM	1240 – 1	1240 – 4
1246	MAINTENANCE, VEHICLE DETECTOR SUBSYSTEM	1246 – 1	1246 – 2

APPENDIX A – METRIC (SI) INFORMATION			
		Page	
		From	To
A	GENERAL	A – 1	A – 9

APPENDIX B – STANDARD SPECIAL PROVISIONS TO PUBLICATION 408			
		Page	
		From	To
B	GENERAL	B – 1	B – 1

APPENDIX C – DESIGNATED SPECIAL PROVISIONS (DSP) CONTAINED IN PUBLICATION 408/2020			
DSP		Page	
		From	To
C	GENERAL	C – 1	C – 1
DSP1	OFFSET PROVISION FOR STATE CONTRACTS	C1 – 1	C1 – 1
DSP2	CONTRACTOR RESPONSIBILITY PROVISIONS	C2 – 1	C2 – 1
DSP3	PROVISIONS FOR STATE CONTRACTS CONCERNING THE AMERICANS WITH DISABILITIES ACT	C3 – 1	C3 – 1
DSP4	DIVERSE BUSINESS (DB) REQUIREMENTS FOR NON-FEDERALLY FUNDED CONSTRUCTION PROJECTS	C4 – 1	C4 – 6
DSP7	DISADVANTAGED BUSINESS ENTERPRISE (DBE) REQUIREMENTS FOR FEDERALLY-FUNDED CONSTRUCION PROJECTS	C7 – 1	C7 – 9
DSP8	F.A.R. – REQUIRED CONTRACT PROVISIONS FEDERAL-AID CONSTRUCTION CONTRACTS – FHWA-1273 (Revised May 1, 2012)	C8 – 1	C8 – 18
DSP9	SPECIAL SUPPLEMENT – ANTI-POLLUTION MEASURES	C9 – 1	C9 – 11
DSP10	NONDISCRIMINATION/SEXUAL HARASSMENT CLAUSE	C10 – 1	C10 – 2
DSP11	CONTRACTOR INTEGRITY PROVISIONS	C11 – 1	C11 – 3
DSP12	EXECUTIVE ORDER 11246 (WITH APPENDIX A AND B)	C12 – 1	C12 – 8
DSP13	BUY AMERICA	C13 – 1	C13 – 1
DSP14	ENHANCED MINIMUM WAGE PROVISIONS	C14 – 1	C14 – 1

CHANGE LETTERS AND INDICES TO PUBLICATION 408/2020			
		Page	
CHGs		From	To
IE	Transmittal Letter Initial Edition (IE)	1	2
IE	Index of Changes Initial Edition (IE)	1	2

CHANGE LETTERS AND INDICES TO PUBLICATION 408/2020			
		Page	
CHGs		From	To

SECTION 100
GENERAL PROVISIONS

SECTION 101—ABBREVIATIONS AND DEFINITIONS OF TERMS

101.01 MEANING OF TERMS—These Specifications are generally written in the imperative mood. In sentences using the imperative mood, the subject, "the Contractor," is implied. Also implied in this language are "shall," "shall be," or similar words and phrases. In the Material sections, the subject may also be a Vendor, Fabricator, or Manufacturer, who may be supplying material, products, or equipment for use on the project. The word "will" generally pertains to decisions or actions of the Department or its Representative.

In these Specifications or on the drawings, the following words or similar words refer to actions of the Department or its Representative, unless otherwise stated: "directed," "required," "permitted," "ordered," "designated," "prescribed." Also, the words "approved," "accepted," "acceptable," "satisfactory," "considered," or words with similar intent, mean by or to the Department or its Representative, subject in each case to the final determination of the Secretary, and subject to further review, as permitted by law or permitted elsewhere in these Specifications.

In these Specifications, reference to a subsection of the Specifications includes all general requirements of the section of which the subsection is a part.

In these Specifications, the words "or equal," referring to a product, material, or process, mean "equal as determined by the Department or its Representative."

In these Specifications, the words, "as indicated," or "indicated" mean "as indicated or indicated on the prepared contract plans."

101.02 ABBREVIATIONS—The following is a list of abbreviations used in these Specifications, in the proposal, and on the drawings. The list includes the meanings along with the abbreviations.

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGC	Associated General Contractors of America
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ANSI	American National Standards Institute
API	American Petroleum Institute
ARA	American Railway Association
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWG	American Wire Gage
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
BDTD	Bridge Design and Technology Division
BOPD	Bureau of Project Delivery
BOMO	Bureau of Maintenance and Operations
CFR	Code of Federal Regulations

CBEMA	Computer Business Equipment Manufacturers Association
CCTV	Closed Circuit Television
CMD	Construction and Materials Division
CQAS	Construction Quality Assurance Section
CRSI	Concrete Reinforcing Steel Institute
CSA	Canadian Standards Association
CTC	Concrete Technology Corporation
DCNR	Pennsylvania Department of Conservation and Natural Resources
DEP	Pennsylvania Department of Environmental Protection
DME/DMM	District Materials Engineer/District Materials Manager
DMS	Dynamic Message Signs
ECMS	Engineering and Construction Management System
EEI	Edison Electrical Institute
EIA	Electric Institute of America
FCC	Federal Communications Commission
FHWA	Federal Highway Administration, U.S. Department of Transportation
FSS	Federal Specifications and Standards (General Service Administration)
HAR	Highway Advisory Radio
HDD	Highway Delivery Division
HMA	Hot Mix Asphalt
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronic Engineers
IEC	International Electrotechnical Commission
IES	Illuminating Engineering Society
IMSA	International Municipal Signal Association
IP	Internet Protocol
ISO	Insurance Services Organization
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
JMF	Job Mix Formula
LRFD	Load and Resistance Factor Design
LTS	Laboratory Testing Section, Bureau of Project Delivery, Pennsylvania Department of Transportation
MTL	Materials Testing Laboratory
MUTCD	Manual on Uniform Traffic Control Devices (FHWA)
NBFU	National Board of Fire Underwriters
NCSA	National Crushed Stone Association
NEC	National Electrical Code
NELA	National Electric Light Association
NEMA	National Electrical Manufacturing Association
NESC	National Electrical Safety Code
NFPA	National Fire Prevention Association
NTCIP	National Transportation Communications for Intelligent Transportation Systems
OSHA	Occupational Safety & Health Administration
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PennDOT	Pennsylvania Department of Transportation
PEI	Porcelain Enamel Institute, Incorporated
PTM	Pennsylvania Test Method
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
RAM	Reclaimed Aggregate Material
RAP	Reclaimed Asphalt Pavement
RPS	Restricted Performance Specification
RTMC	Regional Traffic Management Center
SAE	Society of Automotive Engineers

SMS	Structural Materials Section
SRL	Skid Resistance Level
SSPC	Society for Protective Coatings
TMC	Traffic Management Center
UL	Underwriters Laboratories, Incorporated
UNC	Unified National Coarse
U.S.C.	United States Code
WMA	Warm Mix Asphalt

101.03 DEFINITIONS—

ACCEPTANCE CERTIFICATE—The certificate of the Department, certifying that the project has been satisfactorily completed and accepted.

ACTIVE WORK ZONE: The portion of a work zone where construction, maintenance, or utility workers are on the roadway or on the shoulder of the highway and is adjacent to an open travel lane.

ADDITIONAL WORK—Work, of a type already provided by the contract and for which the contract has established a unit price.

ADVERTISEMENT—The public announcement, required by law, inviting bids for work to be performed or for materials to be furnished.

AGENCY HEAD—The Secretary.

AIR TEMPERATURE—The measured temperature in the degrees Fahrenheit (F) in the shade, not in the direct rays of the sun, and away from artificial heat.

AWARD—The Department's written acceptance of a bid.

BID—The offer of a bidder, using the internet, to construct the project, at the prices bid or predetermined.

BIDDER—Any individual, firm, partnership, corporation, or joint venture, submitting a bid for the work contemplated and acting either directly or through an authorized representative.

BRIDGE—A structure, including supports, spanning and providing passage over a waterway, a railroad, a highway, or other obstruction; more than 20 feet long, measured along the center of the roadway or railroad, between the faces of abutments. In the case of boxes or arches, the length is measured between the faces of the sidewalls and, in the case of multiple boxes, between the inside faces of the outside walls.

BULLETINS—Publications, prepared by the Department, indicating requirements for material and processes, listing approved material suppliers. A list of these bulletins follows:

Bulletin 14—Aggregate Producers (Publication 34)

Bulletin 15—Qualified Products List for Construction (Publication 35)

Bulletin 25—Specifications for Bituminous Materials (Publication 37)

Bulletin 27—Bituminous Concrete Mixtures, Design Procedures, and Specifications for Special Bituminous Mixtures (Publication 27)

Bulletin 41—Producers of Bituminous Mixtures (Publication 41)

Bulletin 42—Producers of Ready-Mixed Concrete (Publication 42)

BUSINESS PARTNER—An individual, firm, partnership, or corporation that has a valid Registered Business Partner Identification Number issued by the Department through ECMS.

CALENDAR DAY—Every day shown on the standard calendar.

CENTRAL OFFICE—The central office of the Department in Harrisburg, Pennsylvania.

CHIEF BRIDGE ENGINEER—The Engineer in charge of bridge design for the entire Department, or authorized designee.

CONTRACT—The written agreement between the Department and the Contractor for the construction of the project. The contract includes the following: Proposal; Plans; Specifications; Agreement; Performance Bond; Payment Bond; Insurance Certificates; Notice to Proceed; and all work orders and supplemental agreements that are required to complete the construction of the project.

CONTRACT ITEM (PAY ITEM)—A specifically described unit of work for which a price is provided in the contract. Individual units in the component item schedule of a lump sum payment item are not considered contract items.

CONTRACTING OFFICER—The District Executive.

CONTRACTOR—The individual, firm, partnership, corporation, or joint venture awarded the contract; acting directly through agents or employees, or the Surety in case of default; or each participant in a joint venture.

CROSS SECTIONS—Graphic representations of the original ground and the proposed highway, at right angles to the centerline or base line.

CULVERT—Any structure, not classified as a bridge, that provides an opening under the roadway.

DEPARTMENT—Pennsylvania Department of Transportation.

DIRECTOR OF PROJECT DELIVERY—The Engineer(s) in charge of all highway activities in the central office, or authorized designee.

DISTRICTS—Geographic divisions of the Department for the purposes of management, design, construction, and maintenance.

DISTRICT EXECUTIVE—The Engineer or Administrator in charge of an engineering district of the Department.

DRAWINGS—See PLANS.

ECMS WEBSITE – www.dot14.state.pa.us/ECMS

ELECTRONIC FILE—Any data digitally formatted, e.g., landXML.

ENGINEER—An individual licensed and registered under the Laws of the Commonwealth of Pennsylvania designated by the Deputy Secretary for Highway Administration, acting directly or through a duly authorized representative, acting within the scope of the particular duties assigned or the authority given.

EXTRA WORK—Work arising from changes that result in a significant increase or decrease in the cost of performing the work and work having no quantity and/or price included in the contract, that is determined by the District Executive to be necessary or desirable to complete the project.

FABRICATOR—A firm, company, or individual supplying fabricated material for the project.

FALSEWORK – Any temporary construction structure, and/or structural elements, utilized to support vertical loads and loads from wind and temperature. Falsework is utilized as temporary support for construction loads such as

people, materials, and equipment, as well as the loads from the structure being constructed, until the permanent structure becomes self-supporting. Temporary construction loads include, but are not limited to; the plastic concrete, equipment and placement of the concrete, any concrete that has not yet reached sufficient strength to carry the required loads, as well as steel or other structural elements under erection, not yet in final permanent load carrying condition. Falsework would include steel or timber beams, girders, columns, piles and foundations, and any proprietary equipment including modular shoring frames, post shores, and horizontal shoring.

FORMWORK – Any temporary construction structure utilized to retain and mold plastic or fluid concrete until it achieves sufficient strength to retain its shape. Formwork is vertical, and used to construct walls, columns, piers, abutments, beam-sides, and other vertical concrete surfaces.

FINAL SETTLEMENT CERTIFICATE—The certification made by the Secretary to the State Treasurer; of the amount due in final payment and settlement of the contract, after making all legal and equitable additions and deductions, including the amounts previously paid.

FINAL INSPECTION—The inspection, conducted by the Representative, to determine if the project or any substantial portion thereof, has been satisfactorily completed, according to contract requirements.

GRADE LINE—The profile of the finished roadway surface along the proposed construction centerline or base line.

HIGHWAY—The area between right-of-way lines, and/or between limit of slope lines, as ordained and/or indicated.

HINGE POINT—A slope-staking term for the point where cut or fill slope begins.

HOLIDAYS—Days designated by the Department as holidays, which include, but are not limited to: New Year's Day, Dr. Martin Luther King, Jr.'s Birthday, Presidents' Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans' Day, Thanksgiving Day, Day after Thanksgiving, and Christmas Day.

INSPECTOR—The person authorized and assigned by the Representative to make inspections of contract performance and of material furnished.

INSPECTOR-IN-CHARGE—The person authorized by the Representative to be in immediate charge of inspecting the performance of work on the project.

INVITATION FOR BIDS—The advertisement for bids for work or material. The advertisement will state, with reasonable accuracy, the quantity and location of the work to be done, the character and quantity of the material to be furnished, and the time and place of the opening of bids.

IN WRITING—Communication between parties delivered or sent, and received, in the form of a written letter, e-mail, or facsimile.

JOB-MIX FORMULA—A specific mixture of material established by test procedures, then adhered to during construction using the mixture.

JOINT VENTURE—A legal association of contractors, limited to three participants, formed for the purpose of bidding and executing a common contract identified in ECMS as Joint Venture Prime and Joint Venture Partner. Prequalification is required of each contractor, as specified in Section 102.01.

JOINT VENTURE PRIME—The lead contractor in a joint venture.

LABORATORY—Testing laboratories of the Department, or any other designated testing laboratories.

LOCALIZATION—A localization is a series of mathematical computations that transform World Geodetic System84 coordinates into local grid coordinates. A localization typically consists of a horizontal and a vertical adjustment.

LOCAL TRAFFIC—Vehicular traffic that originates or terminates within the project limits.

LOT—An isolated quantity of specified material from a single source, or a measured amount of specified construction, to be produced by the same process.

MANUFACTURER—A firm, company, or individual manufacturing material for the project.

MAJOR ITEM OF WORK—Any Item having a unit of measure of other than Lump Sum, Call, Dollar, or Predetermined Amount (PDA).

MATERIAL—Substances specified for use in the project construction.

MATERIALLY UNBALANCED BID—A bid that generates a reasonable doubt that awarding a contract to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the Department.

MATHEMATICALLY UNBALANCED BID—A bid containing lump sum or unit prices, which do not reflect reasonable actual costs plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs.

MILESTONE DATE—The date on which a specific portion of physical contract work is to be completed, before the Required Completion Date of all contract work.

MULTIPLE DEFICIENCY—Deficiency in more than one characteristic within the same lot.

NOTICE TO PROCEED DATE—The date, established in writing by the Department, on which work is to begin.

ONLINE BID—A bid submitted via the internet using the Department's Engineering and Construction Management System (ECMS).

PAVEMENT STRUCTURE—The combination of subbase, base course, and surface course placed on a subgrade to support the traffic load and to distribute the load to the roadbed.

PAYMENT BOND—The approved form of security, furnished by the Contractor and the Surety, as a guaranty to pay promptly, or cause to be paid promptly, in full, such sums as may be due for all material furnished, labor supplied or performed, rental of equipment used, and services rendered by public utilities in, or in connection with, the work under contract.

PennDOT'S HOMEPAGE – http://www.penndot.gov

PERFORMANCE BOND—The approved form of security, furnished by the Contractor and the Surety, as a guaranty on the part of the Contractor to execute the work, according to the terms of the contract.

PLANS—The approved documents or drawings, or exact reproductions of them, for construction of the project. The plans show the location, character, dimensions, approximate quantities, and other details of the prescribed work, including layouts, profiles, and cross sections; plans also include cited Standard Drawings. However, subsurface soil and geological data (e.g., the Soil Survey Report and Profile and Core Borings) are excluded from this definition.

PREQUALIFICATION—The system for establishing a qualification rating, determining the maximum amount of contract and one or more of the classified types of work on which a Contractor will be eligible to bid or subcontract, and the maximum amount the Contractor may have under contract and incomplete at any one time.

PRINTOUT—The processed data issued in printed form by a computer.

PROFILE GRADE—The elevation or gradient of a trace of a vertical plane intersecting the proposed surface, usually along the longitudinal centerline or base line of the roadway.

PROJECT—All of the work described in the contract.

PROPOSAL—The documents, designated by the Department, containing project requirements and other information upon which a bid for the project to be constructed is to be based. The proposal includes the Plans, Specifications, Special Provisions, referenced Standard Drawings, Addenda, and all other documents referred to therein, whether or not attached.

QUALITY CONTROL (QC) PLAN—A Contractor's or Vendor's prepared plan, submitted to and reviewed by the Representative, describing the proposed QC system. This plan contains, as a minimum, an inspection schedule, sample schedule, testing schedule, and required laboratory inspection reports.

QUALITY CONTROL (QC) SYSTEM—A system of controls, inspection, and tests, fully documented, providing reasonable assurance that all materials, products, and completed construction submitted for acceptance, conform to specifications.

REPRESENTATIVE—The authorized representative acting on behalf of the Secretary.

REQUIRED COMPLETION DATE—The date on which all physical contract work, including any authorized additional or extra work, is to be completed. The Required Completion Date is the completion date shown in the contract plus any time extensions issued in writing by the Representative less any time reductions issued in writing by the Representative.

RESTRICTED PERFORMANCE SPECIFICATION (RPS)—A presentation of required results, statistically verifiable as meeting specified criteria, and free of unnecessary construction limitations.

RIGHT OF WAY—The area that has been secured and reserved by the Department for highway purposes.

ROADSIDE DEVELOPMENT—Items for seeding, sodding, mulching, topsoiling, planting of ground covers, other planting, and items for erosion control.

SECOND-TIER OR LOWER-TIER SUBCONTRACTOR—Any individual, partnership, firm, or corporation, complying with the requirements of Section 102.01, who/which undertakes, with prior consent of the Department, the partial or total construction of one or more items of project work, under the terms of the contract, with and reasonable to the prime Contractor by virtue of an agreement with a subcontractor to the prime by virtue of an agreement.

SECRETARY—The Secretary of Transportation or a Deputy Secretary of Transportation of Pennsylvania.

SHOP DRAWINGS—See WORKING DRAWINGS.

SINGLE DEFICIENCY—Deficiency in one characteristic in a lot.

SKID RESISTANCE LEVEL (SRL)—The friction rating of a surface course material.

SPECIAL PROVISIONS—Additions and revisions to the Standard Specifications covering conditions pertaining to an individual project.

SPECIFICATIONS—This publication and all publications to which it refers. Also, special provisions and bulletins referred to in, or bound with, the proposal; together with all written agreements made or to be made, pertaining to the method and manner of performing the work, or to the quantities or qualities of material to be furnished under the contract.

SITE CALIBRATION—A site calibration is a series of mathematical computations that transform World Geodetic System84 coordinates into local grid coordinates. A site calibration typically consists of a horizontal and a vertical adjustment.

STANDARD DRAWINGS—Approved drawings, showing standard details, produced to be used repeatedly on projects. Publications that contain Standard Drawings are:

Publication 6M—Standards For Hardwood Glulam Timber Bridge Design

Publication 72M—Roadway Construction (RC) Standards

Publication 111—Traffic Control Standards-Pavement Markings and Signing (TC-8600 and 8700 Series)

Publication 148—Traffic Control Standards-Signals (TC-8800 Series)

Publication 218M—Bridge Design Standards - BD-600M Series

Publication 219M—Bridge Construction Standards - BC-700M Series

Publication 647—Intelligent Transportation Systems-Standard Drawings

STATE—The Commonwealth of Pennsylvania.

STRUCTURES—Bridges, culverts, storm sewer appurtenances, slope and retaining walls, sign support structures, and other similar items.

SUBCONTRACTOR—Any individual, partnership, firm, or corporation, complying with the requirements of Section 102.01, who/which undertakes, with prior consent of the Department, the partial or total construction of one or more items of project work, under the terms of the contract, with and responsible to the prime Contractor by virtue of an agreement.

SUBSTRUCTURE—That part of the structure not deemed as superstructure.

SUPERINTENDENT—The Contractor's authorized representative in charge of the work.

SUPERSTRUCTURE—All portions of the bridge, above the bridge seat, including bearings, bearings and anchors sunk in the substructure, abutment backwalls, cheekwalls, shear blocks, bridge drainage down to but not including the drain box, and portions of the wings and appurtenances above the horizontal construction joint nearest the bridge seat.

SUPPLIER—A firm, company, or individual supplying material for the project.

SURETY—A corporate body, which is bound with and for the Contractor, for the satisfactory performance of the Contractor's work and for the prompt payment in full for material, labor, equipment rentals, and utility services, as provided in the bonds.

TRAFFIC CONTROL PLAN—A developed method or scheme for safely and efficiently moving traffic through or around a highway work zone.

UTILITY ADJUSTMENT— The act of placing, setting, replacing, resetting, relocating, adjusting, reconstructing, altering, or removing a Utility Infrastructure.

UTILITY INFRASTRUCTURE— A public or private facility or structure, whether or not owned by a utility, that is or will be in, on, under, or over the project site or a waste or borrow area designated in the proposal, and that either must be placed, set, replaced, reset, relocated, adjusted, reconstructed, altered, or removed in order for the contract work to be performed or otherwise interferes with the performance of the contract work.

VALUE ENGINEERING—The identification of the function(s) of a contract item, establishing the cost of the function(s), considering life cycle costs, and providing the required functions at the lowest cost with no reduction in required quality or performance.

VENDOR—A firm, company, or individual supplying material or services for the project.

WORK—The furnishing of material, labor, equipment, and other incidentals necessary or convenient to successful project completion, plus the fulfillment of all duties and obligations imposed by the contract.

WORKING DRAWINGS—Required shop drawings, erection plans, falsework plans, stress sheets, framework plans, cofferdam plans, bending diagrams for reinforcing steel, and any other supplementary plans or similar data, all prepared by the Contractor.

WORK ORDER—An order, signed by the Representative, authorizing the performance of additional or extra work, or extra work on a force-account basis, as specified in Sections 110.02 and 110.03.

WORK ZONE: The area of a highway where construction, maintenance, or utility work activities are being conducted and which should have traffic-control devices installed according to Title 67 of the Vehicle Code.

SECTION 102—BIDDING REQUIREMENTS AND CONDITIONS

102.01 PREQUALIFICATION OF CONTRACTORS AND SUBCONTRACTORS—

(a) General. Unless otherwise stated in the proposal, contractors are required to prequalify before the date fixed for the opening of bids for State highway construction work. To do so, establish proof of competency and responsibility, according to 67 PA Code Chapter 457, Regulations Governing Prequalification of Prospective Bidders. Subcontractors are required to prequalify in the same manner, if listed in the proposal or if they subsequently undertake the partial or total construction of one or more items of work. To obtain a complete set of application forms, either download them from the ECMS website or contact the Prequalification Officer, Contract Management Section, Highway Delivery Division, Bureau of Project Delivery, Pennsylvania Department of Transportation, Harrisburg, Pennsylvania, 17120.

(b) Business Partner Registration. Unless otherwise stated, contractors are required to register with the Department as a business partner. To become a business partner, go to the ECMS website. Instructions for registration are available on the website.

102.02 CONTENTS OF PROPOSAL—The proposal will specify the place for delivery of a bid; the date, time, and place of bid opening; and the location and description of the project to be constructed. The proposal will also show the approximate quantities of work to be performed and/or material to be furnished, the contract time in which the project is to be completed. The proposal will include any special provisions and attachments pertaining to the project.

102.03 ISSUANCE OF PROPOSAL—The proposal and plans will be published on the ECMS website. The proposal will include any special provisions and attachments pertaining to the project. Any addenda will also be published on the ECMS website. These documents can be downloaded and printed. Copies of the proposal and plans can be purchased by contacting one of the printing partners listed under business partner search in ECMS.

Specifications or Standard Drawings listed or referred in the proposal are available for purchase upon request from the PennDOT Sales Store, P.O. Box 3451, Harrisburg, PA 17105-3451 (Telephone 717-787-6746).

102.04 INTERPRETATION OF APPROXIMATE ESTIMATE OF QUANTITIES—The estimate of quantities, shown on the proposal, and in the contract, is approximate and is shown only as a basis for the calculation upon which the contract award is to be made. The Department does not assume any responsibility that the quantities will actually be required in the project construction, nor will the Contractor be allowed to plead misunderstanding or deception because of the quantity estimates or because of the character of the work, the location, or other conditions. The Department reserves the right to increase, to decrease, or to omit any of the quantities of work. An increase or decrease of the quantities of the items will not be sufficient grounds for granting an increase in the unit prices bid, except as specified in Section 110.02.

102.05 EXAMINATION OF PROPOSAL, PLANS, SPECIFICATIONS, SPECIAL PROVISIONS, AND SITE OF WORK—The Department's plans and specifications are complete and are prepared so any competent contractor is able to complete the proposed work. The bidder is required to carefully examine the proposal, plans, specifications, and project site before submitting a bid. The submission of a bid will be considered proof that the bidder has made such examination and understands the conditions to be encountered; the character, quality, and quantities of work to be performed; the material to be furnished; and the requirements of the plans, specifications, and proposal. The Department will make no allowance or concession for a bidder's failure to make the required examination.

The proposed slope lines shown on the cross sections are approximate and are subject to revision and change by the Representative, depending upon the stability of material encountered during construction.

Subsurface soil and geological information indicated is based upon soundings, dug test pits, and/or test borings. Such information concerning the character of subsurface material is of an exploratory nature and has been obtained, for the Department’s use, as an aid in the project design. The information provided is representative of subsurface conditions only at the locations and depths where such information was obtained, and there is no expressed or implied agreement that uniformity of material exists between explored locations.

Preliminary construction schedules are intended to provide a general overview of the sequence of construction operations, based on currently available data. Such information is developed, for the Department's use, as an aid in the project design. Available construction scheduling information, if any, is being provided for informational purposes only. The Department makes no expressed or implied representation as to the completeness, accuracy, or correctness of the data, and accepts no responsibility for consequences resulting due to any actions undertaken based on the information provided. These schedules are not considered a part of the proposal.

102.06 PREPARATION OF BIDS—

(a) Submit properly completed bids for Department construction work in the electronic bidding format, online.

(b) Configure the electronic file for bidding to include Registered Business Partner Identification Number. For a joint venture bid, the lead joint venture will be required to furnish this information on behalf of the joint venture.

(c) Unless otherwise stated in the proposal, the Department will only accept bids from contractors who are prequalified on the date of the bid opening, as specified in Section 102.01, and who bid for work which, based on their available financial capacity and approved work classification codes, does not exceed their prequalification eligibility. Unless otherwise approved by the Chief of Highway Delivery Division (Prequalification Office), prequalification eligibility with regard to work classification will be determined using the applicable Work Classification Code(s) shown on the Design Items screen in the WCC column for the corresponding contract item number. The Design Items screen is accessed via the Project Items link on the ECMS Bid Package screen. If a bid item has multiple Work Classification Codes, the bidder must be prequalified for only one of the Codes listed.

In accordance with the provisions of 67 Pa Code 457.5(d), a prequalified contractor is: "eligible to bid on projects in which the types of work for which he is classified constitute at least 50% of the project." Items of work that are coded X or ZZ on the bid package Design Items will be excluded from the total bid price when determining compliance with the 50% requirement. Only the classification codes listed in the bid package Design Items will be credited towards meeting the 50% requirement. To determine compliance with the 50% requirement, all bidders will be credited for the Q and Z items. For lump sum contract items requiring a Component Item Schedule (CIS), neither the work code classifications for component items on the CIS nor the component item dollar values submitted by the contractor on the CIS will be considered in evaluating compliance with the 50% requirement.

In accordance with the provisions of 67 Pa Code 457.8(b): "...the types of work on which the contractor has been classified and eligible to bid on do not constitute over 50% of the total bid price, the bid will be excluded and rejected."

With regard to available financial capacity, prequalification eligibility will be determined by ensuring that the bidder's current maximum financial capacity exceed the total amount of the bid, less any credit for subletting as specified in Section 108.01(a), plus the total amount of all uncompleted work a bidder has under contract at the time of bid opening.

(d) Execute bids as follows:

When an item in the bid contains a choice to be made by the bidder, indicate this choice, according to the specifications for that particular item. When preparing the bid, leave blank the unit price(s) of the alternate(s) that are not bid. Thereafter, no further choice will be allowed.

Submit an online bid via the ECMS website by using a business partner password with the security level of an authorized general partner or corporate officer properly designated to execute and attest to bids. For a joint venture bid, submit an online bid via the ECMS website by using a business partner password with the security level of an authorized general partner or corporate officer properly designated to execute and attest to bids of the lead joint venture.

For a joint venture bid, only one Joint Venture Business Partner is required to submit and electronically sign the bid and will be considered the Joint Venture Prime.

(e) All electronic data files to be made available will be included in the bid package. In order to access electronic data files made available in the bid package, potential bidders must sign a one-time legal agreement, in ECMS, to acknowledge that the information being provided is for informational purposes only. (NOTE: The agreement can be found by logging into ECMS and clicking on the link entitled "Pre-Bid Design Files Agreement" under Bulletins.) Make no assumption of available files if not included in the bid package. Perform necessary conversion of the files for the selected grade control equipment.

(f) Anti-Collusion Requirements. The authorized signer of the bid, under penalty of perjury as provided in 18 Pa. C.S.A. Section 4904, or if applicable, 18 U.S.C., Section 1020, certifies that they are authorized to make and does make the following statement on behalf of the bidder:

1. The bid item prices and the total bid amount have been arrived at independently and without consultation, communication, or agreement for the purpose of restricting competition with any other contractor, bidder, or potential bidder.

2. Neither the item prices nor the total bid amount, and neither the approximate bid item prices nor approximate total bid amount, have been disclosed to any other firm or person who is a bidder or potential bidder, and they will not be disclosed before bid opening.

3. No attempt has been made or will be made to solicit, cause, or induce any firm or person to refrain from bidding on this project, or to submit a bid higher than this bid, or to submit any intentionally high or noncompetitive bid or other form of complementary bid.

4. The bid submitted by the bidder is made in good faith and not pursuant to any agreement or discussion with, or inducement from, any firm or person to submit a complementary or other noncompetitive bid.

5. The bidder has not offered or entered into a subcontract or agreement regarding the purchase of materials or services from any firm or person, or offered, promised, or paid cash or anything of value to any firm or person, whether in connection with this or any other project, in consideration for an agreement or promise by any firm or person to refrain from bidding or to submit a complementary bid on this project.

6. The bidder has not accepted or been promised any subcontract or agreement regarding the sale of materials or services to any firm or person, and has not been promised or paid cash or anything of value to any firm or person, whether in connection with this or any other project, in consideration for this firm's submitting a complementary bid, or agreeing to do so, on this project.

7. The authorized signer of the bid has made a diligent inquiry of all members, officers, employees, and agents of the bidder with responsibilities relating to the preparation, approval, or submission of this firm's bid on the project and has been advised by each of them that the authorized signer has not participated in any communication, consultation, discussion, agreement, collusion, act, or other conduct inconsistent with any of the statements and representations made in this Statement.

8. No attempt has been made to take any action in restraint of free competitive bidding in connection with the bid.

9. It is understood that if any incidents resulting in conviction or being found liable are specified in Section 102.06(f)10, the Pennsylvania Anti Bid Rigging Act, 73 P.S. 1611 et. seq. provided that it does not prohibit a governmental agency from accepting a bid from or awarding a contract to that person, but may be a ground for administrative suspension or debarment at the discretion of a governmental agency under rules and regulations of that agency.

10. The bidder, its affiliates, subsidiaries, officers, directors, and employees are not aware that they are currently under investigation by any governmental agency and have not in the last 3 years been convicted or found liable for any act prohibited by State or Federal law in any jurisdiction, involving conspiracy or collusion with respect to bidding on any public contract, except as indicated on a separate page attached to the bid document.

The authorized signer of the bid hereby states that they understand and acknowledges that the above representations are material and important, and will be relied on by PennDOT, in awarding the contract for which the bid is submitted. The authorized signer and their firm understands that any misstatement in this statement is and shall be treated as fraudulent concealment from PennDOT of the true facts relating to the submission of bids for this contract.

(g) Contract Unit Price. Wherever an identical item number and description are used more than once, provide the same unit bid price for each bid entry. If the bidder provides different bid prices for an identical item number and description, the bid will be rejected.

102.07 NON-ECMS (Paper Let) Bids—Wherever references are made to ECMS or electronic submission, for the purpose of a non-ECMS/paper let contract, it will mean the paper let process identified in the proposal.

The DBE commitment (Attachment A) is to be submitted via Fax to 717-705-1504.

Bid the unit price. The extension and total bid amount are for informational purposes but may be used by the Department to determine bidder's intent if the unit price is left blank.

102.08 BID GUARANTY FOR EXECUTION OF CONTRACT—Bid guaranty is associated and supported by the bidder's prequalification requirements.

102.09 DELIVERY OF BIDS—Submit bid(s) to the location designated, before the hour of the opening date shown in the proposal.

Electronic online bids will not be accepted after the time for the opening date of the bids shown in the proposal. Bid(s) received after the time for opening of bids will be returned unopened to the bidder.

102.10 WITHDRAWAL OR REVISION OF BIDS—

(a) Withdrawal of Bids Before Bid Opening. Each bidder who submits a bid waives any right to withdraw it, except as provided herein. Bidders will be given permission to withdraw any bid, after it has been submitted to the Department, if the bidder electronically withdrawals or makes the request in person or by an accredited personal representative, by telephone, or in writing to the Secretary. Deliver requests for withdrawal to the Secretary's office before the time set for opening bids.

A bidder may withdraw any bids, which have not been read, after having been declared the apparent low bidder on any other project. In withdrawing bids, make the withdrawal request to the official in charge of the bid opening, either in person or by an authorized representative, before any such bids are read. Provide satisfactory credentials, showing authority to act for the interested bidder, at the time that the official in charge requests that any contemplated withdrawals be made. The bid withdrawn by such a request will be deleted in ECMS and will not be considered by the Department.

(b) Revision of Bids Before Bid Opening. A bidder will be allowed to revise a bid after it has been submitted, if the bidder electronically withdraws the bid, or appears in person or provides an accredited personal representative to make the revision. Present all such requests to the Secretary's office expeditiously so that the revision can be completed and the bid resubmitted before the time set for opening bids.

(c) Withdrawal of Bids After Bid Opening. Withdrawal of erroneous bids after the bid opening but before award based on bid mistakes will be allowed by the written determination of the Secretary when the bidder requests relief and presents credible evidence that the reason for the lower bid price was a clerical mistake as opposed to a judgment mistake and was actually due to an unintentional arithmetical error or an unintentional omission of a substantial quantity of work, labor, material, or services made directly in the compilation of the bid. The request for relief and the supporting evidence must be received by the Secretary's office within 3 business days after the bid opening but before the award of the contract.

The Secretary will not allow a withdrawal of a bid if the withdrawal of the bid would result in the awarding of the contract on another bid of the same bidder, its partner or a corporation or business venture owned by or in which the bidder has a substantial interest. No bidder who is allowed to withdraw a proposal shall supply any material or labor to or perform any subcontract or other work agreement for any person to whom a contract or subcontract is awarded in the performance of the contract for which the withdrawn bid was submitted without the written approval of the Secretary.

102.11 JOINT VENTURE—A joint venture bid will be considered a bid by each of the participants, jointly and individually, for the entire contract performance as a joint venture, according to the proposal terms and conditions. The number of participants in a joint venture is limited to three.

In the proposal, contract, specifications, drawings, or any writing constituting a part of these, the term "Bidder" or

"Contractor," or any other term intending to refer to "Bidder" or "Contractor," as defined in Section 101, will include and mean each participant in any joint venture.

(a) Line Item Joint Venture. Initiate a Joint Venture bid in ECMS. Select the Joint Venture Business Partner. Add the items to be undertaken by each Joint Venture Business Partner. For each item added, specify the Quantity and Unit Price in whole or in part.

Each Joint Venture Business Partner will be evaluated for prequalification work classifications and capacity based on the items designated, as specified in Section 102.01.

(b) Percent Joint Venture (Two Party). Initiate a two-party 50/50 Joint Venture bid in ECMS. Select the Joint Venture Business Partner Each two-party 50/50 Joint Venture Business Partner will be evaluated for prequalification work classifications for all items, as specified in Section 102.01. Capacity will be calculated using 50% for all items.

(c) Percent Joint Venture (Three Party). Initiate a three-party 34/33/33 Joint Venture bid in ECMS. Select the Joint Venture Business Partners Each three-party 34/33/33 Joint Venture Business Venture will be evaluated for prequalification work classifications for all items, as specified in Section 102.01. Capacity will be calculated using 34% for the lead joint venture and 33% for the second and third partners of the joint venture for all items.

102.12 OPENING OF BIDS—Bids will be opened and announced publicly at the time, on the date, and at the place shown in the proposal. Bidders and/or their authorized representatives and other interested persons are invited to be present.

In case of an emergency, which causes evacuation of the building at the time of the bid opening, the official in charge of the bid opening will publicly announce any necessary changes in the time of depositing, opening, and announcing of bids.

102.13 DISQUALIFICATION OF BIDDERS AND REJECTION OF BIDS—

(a) The following may be considered sufficient reasons for bidder disqualification and the rejection of the bids(s):

1. submittal of more than one bid for the same work from an individual, a firm, a partnership, an association, a subsidiary, an affiliate, or a corporation under the same or different name;

2. evidence of collusion among bidders. Any participant in such collusion will receive no recognition as a bidder for future work of the Department until the participant has been reinstated as a qualified bidder;

3. lack of competency, of adequate machinery, plant, or of other equipment;

4. inability, in the judgment of the Department, to promptly complete the project, because of uncompleted work;

5. failure to pay, or satisfactorily settle, all bills due for material furnished, for labor supplied or performed, for rental of equipment used, and for services rendered by public utilities;

6. failure to comply with any Department prequalification regulations;

7. judgment of default under a previous contract;

8. contractor currently debarred by Federal or State Authority; or

9. material or intentional failure to comply with contract, drawings, or specifications, or material or intentional failure to adequately maintain and control traffic during construction on a previous contract.

(b) In addition to rights under 67 Pa. Code, Chapter 457, the Secretary reserves the right to reject any or all bids if, in his or her judgment, the rejection is in the State's best interest.

1. In addition, bids will be rejected for any of the following reasons:

1.a failure to submit the bid using the electronic format furnished or approved by the Department;

1.b failure to properly sign the bid, the required affidavits, or certificates, or any other required documents as specified in the proposal;

1.c failure to include a price for each item on the bid schedule, except in the case of alternate bidding; in alternate bidding, failure to include a price for one of the required alternate items on the bid schedule;

1.d failure to submit Diverse Business Participation Requirements as specified in the proposal;

1.e failure to submit Disadvantaged Business Enterprise Participation Requirements as specified in the proposal; or

2. In addition, bids may be rejected for the following reasons:

2.a the proposal was not furnished or approved by the Department;

2.b part of the bid is detached;

2.c the bid contains omission(s) or alteration(s), addition(s) not specified, or deviation(s) of any other kind;

2.d the bid is materially unbalanced;

2.e the bid is not submitted under the name listed on the prequalification certificate;

2.f the bidder provides different bid prices for an identical item number and description; or

2.g failure to properly execute, approve, and return the contract, together with the Surety Bonds and the Insurance Certificate(s), as specified in Section 103.05.

SECTION 103—AWARD AND EXECUTION OF CONTRACT

103.01 CONSIDERATION OF BIDS—After the bids are opened, the total bid amount and the name of the apparent low bidder will be publicly announced. Bids will then be promptly verified and, if determined by the Secretary to be satisfactory, the results of the determination of the lowest responsive and responsible bidder will be made available to the public.

(a) Submission of Component Item Schedule. The apparent low bidder is required to complete and submit a Component Item Schedule for each lump sum item requiring a Component Item Schedule (CIS) in the bid, providing quantities and unit prices for the component items associated with that lump sum pay item. The completed CIS becomes part of the contract.

The proposal will include a CIS for each applicable "as-designed," lump sum item. When the proposal indicates that an equivalent structure or facility of an alternate design may be constructed in lieu of the "as-designed" structure or facility and the alternate design is bid, the necessary CIS must be prepared by the bidder.

The apparent low bidder is required to submit CIS electronically using the ECMS website after the bid opening. No payments will be made for any item of work until the CIS is submitted and approved.

In the event a deficiency is discovered in the information provided on the CIS, the bidder will be notified to correct the deficiency. In the event the apparent low bid is rejected, the next lowest bidder will be notified to prepare and submit the CIS in the manner as specified herein.

103.02 AWARD OF CONTRACT—When a bid received has been determined by the Secretary to be satisfactory, a contract will be awarded in writing to the lowest responsive and responsible bidder within 60 days from the opening date of the bids. Thirty-day extensions of the award date may be made by the mutual written consent of the Representative and the lowest responsive and responsible bidder. The Department will base the award exclusively on the total in the bid schedule and on compliance with all the bidding requirements. No prices will be negotiated due to any extensions.

Contract award on a joint venture bid will place upon the joint participants complete liability, jointly and individually, for contract performance.

Contracting corporations, which are chartered in a state other than Pennsylvania, as well as individuals or firms doing business under fictitious names, are required to register with the Secretary of the Commonwealth and obtain a certificate authorizing them to do business in Pennsylvania, before they can be awarded a contract.

103.03 CANCELLATION OF AWARD—The Secretary reserves the right to cancel the award of any contract at any time before its approval by the Chief Counsel, the General Counsel, and/or the Attorney General, or their designees, when such cancellation is in the best interests of the State. In the event of such cancellation, payment will be made for the documented costs of insurance and surety bonds required under Sections 103.04 and 103.05, and the documented cost of actual expenses reasonably incurred in accordance with a Letter of Intent, when specified and issued by the Deputy Secretary for Highway Administration. No payment will be made for damages of any other kind including, but not limited to, lost profits.

103.04 SURETY BONDS—When awarded the contract, furnish an electronic Performance Bond using ECMS, with sufficient surety or sureties, in an amount equal to 100% of the contract price. Have the bond specify that the contracted work will be completed in a manner satisfactory to the Secretary. Have the bond state that the State is not liable for any expenses incurred through the failure to complete the work as specified, nor liable for any damages growing out of the carelessness of the Contractor, the Contractor's employees, or subcontractors. Also furnish an electronic Payment Bond using ECMS in the amount of 100% of the contract price. Have a corporate surety, legally authorized to transact business in the State and satisfactory to the Secretary, execute both bonds. If the Secretary decides the bond surety is unsatisfactory, promptly furnish any additional required security to protect the State's interests and the interests of all persons, firms, or corporations who/which have furnished material, provided equipment on rental, or supplied/performed labor or services on, or in connection with, the performance of the work for this contract.

Have each participant in a joint venture submit a separate electronic Performance Bond and a separate electronic Payment Bond using ECMS. Have a corporate surety, legally authorized to transact business in the State and satisfactory to the Secretary, execute all bonds.

103.05 EXECUTION AND APPROVAL OF CONTRACT—Electronically sign the awarded contract and properly executed surety bonds, and return them to the Secretary of Transportation, Harrisburg, Pennsylvania, within 10 days after notification by the Secretary. Within the 10 days, provide an insurance certificate or certificates, listing the project number, naming the State as an additional insured party and saved harmless (if local authority/sponsor project, name the local authority/sponsor as additional insured), and proving property damage and public liability insurance is adequate to cover any loss that might accrue.

Procure only occurrence-based insurance coverage with general aggregate limit on a per project basis and so note on the certificate or demonstrate exhaustive efforts to purchase such insurance where it is unavailable. If able to demonstrate factual impossibility of obtaining occurrence-based insurance, then purchase insurance in a form and amount to be determined by the Department. Provide a minimum 30 day cancellation notice with a minimum 15 days cancellation notification for non-payment. The insurance certificate can be emailed to certificateofinsurance@pa.gov or faxed to 717-265-7206.

(a) When the joint bidder returns the signed contract for a joint venture, to be signed by the Secretary, a certified copy of a resolution of the board of directors of each participating corporation must be included. Have the resolution authorize the joint venture with the other party participant(s) for the specific contract. Have the corporation also submit a copy of its corporate powers. Have the participants in any joint venture make the designation in writing, addressed to the Secretary, with a copy directed to the Deputy Secretary for Highway Administration.

The designations are as follows:

1. The name of the person who will be in charge of the project for the joint contractors. Give this person complete authority to speak for and bind the joint contractors in all matters relating to the contract. It is this person to whom all notices, orders, directions, and determinations concerning the project may be given by the Secretary or the Representative. Notices, orders, directions, or determinations given to this designated person, or to one of the joint contractors, will be considered to have been given to all parties.

No change in the person designated to be in charge of the project will be recognized by or be binding upon the Secretary or the Representative, until the participants in the joint venture give written notice of such change. In the event of the death or disability of the person in charge of the project, it is the responsibility of the joint contractors to advise the Secretary or the Representative, in writing, over their joint signatures, of such death or disability within 24 hours after the occurrence, and then to designate a successor.

2. A mailing address for the receipt of all estimates, acceptance and final settlement certificates, payments, notices, orders, directions, and determinations for the performance of the work. The mailing address will be considered the joint contractors' address and any communications directed to such address will be considered to have been received by the joint contractors.

All checks for the payment of estimates and the final settlement certificate will be made to the order of the joint contractors in the same form in which they have signed the contract and will be mailed to the designated mailing address.

Change of the mailing address will not be recognized by or be binding upon the Secretary or the Representative, until written notice, signed by the joint contractors, has been received by the Secretary or the Representative.

(b) No bid will be considered binding upon the State or fully executed until the form and legality of the contract is approved by the Chief Counsel, the General Counsel, and/or the Attorney General, or their designee. If any proposal includes work to be contracted with more than one agency, the contracts will be entered into as specified in the proposal.

103.06 FAILURE TO EXECUTE CONTRACT—If the contract, together with the Surety Bonds and the Insurance Certificate(s) providing adequate insurance coverage, as provided in Section 103.05, is not properly executed and returned, liquidated damages may be assessed and/or the Contractor's prequalification may be suspended according to 67 PA Code, Chapter 457, Regulations Governing Prequalification of Prospective Bidders.

103.07 CANCELLATION OF CONTRACT—The contract may be canceled by either party if the Notice to Proceed is not issued on or before the Anticipated Notice to Proceed Date specified in the bid package or within 30 days of the Award of the contract, whichever is later. Extension(s) of the cancellation period will be made only by mutual written consent of the parties to the contract provided such written consent is given before the expiration of the cancellation

period. Prices will not be renegotiated. The Secretary also reserves the right to cancel the contract any time before the actual Notice to Proceed Date. If the contract is canceled, payment will be made for the documented costs of insurance and surety bonds required under Sections 103.04 and 103.05, and the documented cost of actual expenses reasonably incurred in accordance with a Letter of Intent, when specified and issued by the Deputy Secretary for Highway Administration. No payment will be made for damages of any other kind including, but not limited to, lost profits.

103.08 ASSIGNMENT OF ANTI-TRUST CLAIMS—It is recognized that in actual economic practice, overcharges by suppliers resulting from violations of State or Federal antitrust laws are in fact borne by the State. As part of the consideration for the award of the contract, and intending to be legally bound, the Contractor assigns to the State all right, title, and interest in and to any current claims or claims hereafter acquired under State or Federal anti-trust laws relating to the subject matter of the contract.

103.09 RECIPROCAL LIMITATIONS—For projects that do not include any Federal Funding, see the Reciprocal Limitations Act, found at Section 107 of the Commonwealth Procurement Code, 62 Pa.C.S. §107, and any successor or related statutes enacted by the Commonwealth's General Assembly, for certain prohibitions and limitations relating to supplies produced in states other than Pennsylvania and non-resident bidders and offerors that may apply to the solicitation and award of certain contracts incorporating these specifications.

SECTION 104—SCOPE OF WORK

104.01 INTENT OF PLANS AND SPECIFICATIONS—The intent of the plans and specifications is to prescribe a complete project undertaken according to the contract. Therefore, according to the contract, furnish material, equipment, tools, labor, and incidental work complete in place, unless otherwise provided, and be responsible for the complete supervision, performance, and completion of the work.

104.02 ALTERATION OF DRAWINGS OR WORK—The Department reserves the right to order, at any time during the progress of the work, increases or decreases in quantities and alterations in the construction drawings or specifications, including alterations in the grade or alignment of the road or structures. Any such order will be in writing by the Representative. Also, should any item contained in the proposal and contract be found unnecessary for the proper completion of the work, a written order will be given to eliminate such item from the contract. Such increases, decreases, eliminations, and/or alterations will not invalidate the contract, nor release the surety.

If the aforementioned changes in quantities or alterations of the construction drawings will significantly increase or decrease the cost of performing the work directly affected, perform such work only when authorized in writing, as specified in Section 110.03(a). Payment for such work will be made under Section 110.03.

With the exception of advance warning signs, detour signs, work zone traffic control devices, and other items specified in the contract, perform no work beyond the limits of the project, except as authorized in writing by the Deputy Secretary for Highway Administration.

When an item of work is eliminated, reimbursement of actual expenses will be made as specified in Section 110.03(d). If the aforementioned changes in the quantities or alterations of the drawings are of such magnitude as to require a change in the time to complete the project, a time adjustment will be made as specified in Section 108.06.

104.03 EXTRA WORK—Anticipate that extra work might be necessary in order to complete the project as contemplated. Perform extra work according to the specifications and only when authorized in writing, as specified in Section 110.03. Compensation will be made as specified in Section 110.03.

104.04 VALUE ENGINEERING—Value engineering applies to cost reduction proposals that are initiated, developed, and submitted to the Department for modifying the plans, the specifications, or other contract requirements. These provisions do not apply to a proposal unless it is identified as a value engineering proposal at the time it is submitted. The Department is not required to accept or act upon submitted value engineering proposals.

Value engineering proposals are those that would require a change in the contract and would result in either no cost increase or a net cost savings to the Department. They are initiated by the Contractor who proposes to provide the function of an improved product or service at the same cost or a lower cost, and to accomplish the original purpose of the project without impairing essential functions and characteristics.

Submit the following minimum information with each proposal, allowing enough time for Department investigation and implementation without interfering with the project schedule:

- a description of the difference between the existing contract requirements and the proposed change, with the comparative advantages and disadvantages of each;
- an itemized list of the contract requirements which are to be changed if the proposal is adopted, with a recommendation for making each change;
- a detailed estimate of the net savings in construction costs that will result from the adoption of the proposal;
- a prediction of any effects the proposed change will have on other Department costs, such as maintenance and operations, and rehabilitation;

- a statement of the deadline for adopting the change in order to obtain maximum cost reduction during the remainder of the contract, noting any effect on the Required Completion Date or any specified Milestone Date(s) and any other schedule impacts; and

- the contract items of work affected by the proposed change, including any quantity changes, as well as any extra work items to be established, including prices and back-up data.

When preparing the detailed estimate of the net savings in construction cost that will result from the adoption of the proposal, the cost of the new work must include any increase in future maintenance or operational costs. One-half of the engineering and development costs incurred may also be included in the cost of the new work.

The Department reserves the right to make the changes, without compensation, if a value engineering proposal is based upon, or similar to, standard specifications, standard special provisions, or standard drawings adopted before the award date for the contract.

The Department will judge the acceptability of a value engineering proposal and the estimated net cost savings to be realized from adoption of all or any part of the proposal. In evaluating the estimated net cost savings, the Department may disregard the contract bid prices if, in the judgment of the Department, such prices do not represent a fair measure of the value of the work to be performed or to be deleted. Within 30 calendar days after receipt of the required minimum information, as specified herein, the Department will review and provide notification of its acceptance or rejection of the value engineering proposal.

If the proposal is accepted in whole or in part, such acceptance will be by a letter from the District Executive or the Director of Project Delivery, as applicable. If the approval of the Department is conditional, the letter will note the conditions. The letter will serve as authorization for the District to process a contract work order to incorporate the necessary changes in the plans and specifications to permit the value engineering proposal, or any part of it accepted, to be put into effect.

Continue to perform the work according to the requirements of the contract until the Department processes a work order incorporating the value engineering proposal, in whole or in part.

Acceptance and/or preparation of the value engineering proposal and performance of the work will not extend the Required Completion Date and/or any specified Milestone Date(s) unless a request for an adjustment is submitted, as specified in Section 108.03(b), and approved by the Representative.

The Department reserves the right to adopt all, or any part, of a value engineering proposal for general use on other contracts.

Value engineering proposals that are either identical or similar to previously submitted proposals, will be eligible for consideration and compensation under the provisions of this section if the previously submitted proposals were not adopted for general application to other contracts administered by the Department.

Compensation for the Contractor's share of the actual net cost savings associated with a value engineering proposal will be as specified in Section 110.07.

104.05 CLEANING OF PROJECT SITE—Remove silt and other deposits from newly constructed culverts, inlet, outlet and parallel ditches, bridges, and other drainage structures, including stream channels. Clean and remove surplus and discarded material, equipment, and temporary structures from the project and adjacent properties, including waste and borrow areas. Remove debris and objectionable material from areas used or disturbed by the construction operations on, or within sight of, the highway. Remove paint marks or spills, stains, rust marks, oil, or any other unsuitable marks, as directed. Restore waste and borrow areas, as specified in Section 105.14.

Maintain the vegetation within the constructed slope limits, including waste and borrow areas, and leave the project in a presentable condition.

The project will not be considered complete until the above work has been completed.

104.06 DISPOSAL OF EXISTING HIGHWAY STRUCTURES AND MATERIAL WITHIN THE PROJECT—Satisfactorily remove and dispose of all existing highway structures and material which are not to remain in place or to be used in the new construction. Unless otherwise directed, dispose of these structures and material off the project site. However, if indicated, the Department will retain drainage pipes, drainage grates or castings, guide rail posts, guide rail, bridges not under the authority of the Department, and/or portions of Department bridges. Such structures on all other highways become the property of the local authorities having jurisdiction. If the local authorities do not want to retain any portion or portions of structures or material under their jurisdiction, then remove and dispose of them off the project site.

(a) Slurry Management. Concrete slurry is a construction and demolition waste as defined in 25 Pa Code 271. If construction and demolition waste is segregated at the generation site to be re-used, then it could be considered clean fill. As a clean fill the direct use of the segregated material would not need to be permitted as specified in 25 Pa Code 271.101(b)(3). However, any further processing (e.g. grinding, treating or mixing) of the construction and demolition waste will require a waste management permit.

The impoundment on the generation site of the concrete slurry must meet 25 Pa Code 285, 285.123 Impoundments. Do not spread, discharge, store, or treat slurry within 50 feet of storm drains, water filled ditches or surface waters. The DEP Clean Water Program will not need to be involved unless there will be an impact to the waters of the Commonwealth, such as through an overflow over a spillway.

The beneficial use on the generation site (e.g. dust control) of any decanted water (also a waste) pumped from the impoundment will need to be approved by DEP or the County Conservation District (CCD) if DEP delegated authority to the CCD, to ensure that the characteristics of the waste material when used is not harmful to the environment or public health and safety. If the waste is not approved to be beneficially used, then it must be properly disposed at a site permitted to properly treat and/or dispose of the waste.

If a DEP permit is required, after consultation with the District, prepare and submit a proposed Slurry Management Plan for approval to DEP or to the CCD if DEP has delegated authority to the CCD. Additionally, submit a copy of the Slurry Management Plan to the Department through the PPCC upon submission to DEP or CCD for information and tracking purposes. If a DEP permit is not required, prepare and submit the Slurry Management Plan to the Department through the PPCC for approval. Do not begin operations or allow the discharge of untreated slurry without an approved Slurry Management Plan. Preparation of this slurry management plan, construction and restoration of the evaporation basins and removal and disposal of slurry are incidental to the construction item creating the slurry. The Slurry Management Plan will include the following:

1. General Summary. Provide a general summary outlining the project scope including means and methods for slurry management, a site map for the project, and a list of permits required for Slurry Management Plan (e.g., NPDES, Beneficial Use Permit, Erosion and Sedimentation Control Plan approval, etc.)

2. Slurry Volume. Provide an estimate of the expected volume of slurry that will be generated from the project.

3. Slurry Hauling. Describe the method to collect and transport slurry to prevent spills.

4. Water Management. Describe management of the water. While means and methods are up to contractor, the following examples are provided: Allowing the water to evaporate, re-using the water in the grinding operation, disposing of the water via sanitary sewer (provide proper permits), hauling the water to a treatment facility (provide the name of the treating facility), approved quarry waste site, or other commercially useful application.

5. Solids Management. Describe management of the precipitated solids. While means and methods are up to contractor, the following examples are provided: evaporation basins, using solids as a component in recycled aggregate, or other commercially useful application. Evaporation basins must meet requirements specified below and any area used for an evaporation basin must be in accordance with Section 105.14.

6. Corrective Action. If any of the following conditions occur stop operations and perform the necessary corrective actions before proceeding:

- Rain during operations results in discharge of slurry into buffer areas,
- Equipment fails to contain or remove slurry,
- Defined QC requirements are not being followed,
- Slurry discharge into areas not approved in the Slurry Management Plan,
- Slurry discharge into Waters of the Commonwealth*, or
- A spill occurs*.

Note:
*Notify the Department immediately if condition occurs.

7. Evaporation Basin. When an evaporation basin is proposed, provide design detail for the evaporation basin including the following:

- Ownership and location of the temporary or permanent containment basin(s), including any required permitting.
- Designation of basins as temporary or permanent.
- Number of basins proposed.
- Basin sizing including oversizing to account for rainwater.
- Method used to line the evaporation basin including material type and thickness.
- Plan showing all dimensions of the basin and distances to environmentally sensitive areas such as Waters of the Commonwealth, including jurisdictional wetlands
- Restoration plan for the evaporation basin area. At a minimum, include fill material, topsoil, seed mixtures, temporary cover, and schedule for restoration.

104.07 MAINTENANCE OF EXISTING ROADWAY—The Department reserves the right to enter upon a project and, at its own expense, maintain the existing roadway. Notwithstanding the performance of such work by the Department, continue to comply with all the provisions specified in Sections 105.13 and 901.

104.08 UNEXPECTED HAZARDOUS WASTE—The encountering of hazardous waste will be considered a differing site condition, as specified in Section 110.02(b), unless the presence of such waste is indicated in the proposal or contract. Hazardous waste is defined as material meeting the definition of a hazardous waste or Toxic Substance Control Act, Regulated PCB Waste, as specified in 40 CFR 260 or 25 PA Code, Chapters 260 to 270, Hazardous Waste Regulations.

If unexpected hazardous waste is encountered at the site, the Representative will investigate the conditions, determine the extent of the affected area, and authorize the Contractor, in writing, to remove and dispose of the waste. Payment for such work will be made as specified in Section 110.03.

The Contractor will not be required to perform or arrange for any work relating to the removal and disposal of unexpected hazardous waste. If the Contractor elects not to perform authorized waste removal and disposal work, notify the District Executive of that decision, in writing, within 2 working days of receipt of the Representative's written authorization. Cooperate fully with the Department and any authorized remediation Contractor, as specified in Section 105.07.

104.09 UNEXPECTED RESIDUAL OR MUNICIPAL WASTE—The encountering of materials that do not meet the definition of Clean Fill under the Pennsylvania Department of Environmental Protection (DEP) "Management of Fill Policy" will be considered a differing site condition, as specified in Section 110.02(b), unless the presence of such material is indicated in the bid documents. The determination of whether waste material is Residual Waste or Municipal Waste will be made in accordance with the DEP "Management of Fill Policy", applicable DEP Regulations, and the requirements of Publication 281.

If unexpected Residual or Municipal Waste is encountered at the site, the Representative, working with the Contractor, will investigate the conditions, determine the extent of the affected area, and develop and execute a mitigation plan. If deemed necessary, the Contractor will be authorized, in writing, to dispose of the material as Residual Waste or Municipal Waste, as appropriate. Payment for such work will be made as specified in Section 110.03.

SECTION 105—CONTROL OF WORK

105.01 AUTHORITY OF THE REPRESENTATIVE—

(a) General. The work will be subject at all times to the inspection of the Representative. Do not restrict or hinder this inspection.

To prevent disputes and litigation, the Representative will:

- determine the quantity of the kinds of work and the quality of material for which payment will be made under the contract;
- determine the answer to questions in relation to the project and its construction; and
- decide differences concerning the performance of the work covered by the contract.

All such determinations, decisions, directions, and explanations necessary to complete, explain, or make definite any provisions of these Specifications and Plans will be given promptly, in writing, to the Contractor.

As a condition precedent to filing a claim directly against PennDOT submit notice of intent to claim to the Contracting Officer, in writing, within 10 days of the act or omission. For projects managed using the PennDOT Project Collaboration Center (PPCC) website, submit the notice of intent to claim to the Contracting Officer through PPCC.

The filing must include a completed CS-105 "Contractor Notice of Intent to Claim" Form, otherwise it will not be accepted or processed as such. This notice of intent will give the Department the opportunity to investigate the claim and to maintain and document information for future resolution or litigation of the claim.

File the claim in writing with the Contracting Officer within 6 months of the date it accrues and not thereafter. If the Contractor fails to file the claim or does not timely file the claim, the Contractor is deemed to have waived its right to assert the claim in any forum. Claims not filed within the specified time period will be disregarded by the Contracting Officer. The claim, when filed, must state all grounds upon which the claim is based and must include a copy of the previously submitted notice of intent to claim.

The Contracting Officer will attempt to settle and resolve the claim with the Contractor. The Contracting Officer, at his or her discretion, may conduct a claim review meeting to attempt to settle and resolve the claim with the Contractor. If a claim review meeting is held, it will be attended by representatives of the Contractor and such Department representatives as the Contracting Officer considers appropriate.

If the claim is not resolved by agreement between the Contracting Officer and the Contractor, the Contracting Officer will issue a determination in writing regarding the claim and will mail it to the Contractor by first class mail. The determination will be mailed within 120 days of the date on which the Contracting Officer received the claim, unless the 120 day period is extended by consent of the Contracting Officer and the Contractor. If the Contracting Officer fails to issue a final determination within the 120 days, unless extended by consent of the Contracting Officer and the Contractor, the claim will be deemed denied. The determination of the Contracting Officer will be the final order of the Department regarding the claim. The determination of the Contracting Officer will be conclusive and binding upon the Contractor unless the Contractor appeals the determination by filing a statement of claim with the Board of Claims within 15 days of the mailing date of the determination, or, if no extension is agreed to by the Contracting Officer and the Contractor, within 135 days of the receipt by the Contracting Officer of the claim, whichever occurs first.

(b) Authority to Suspend Work. The Representative may suspend the work, wholly or in part, for the following reasons:

- failure to carry out orders;
- failure to comply with any provisions of the contract;
- unforeseen conditions not anticipated in estimating the contract time necessary for the completion of the work;

- the District Executive determines that the work will create roadway conditions that will hinder the Department's ability to safely maintain traffic or provide necessary services such as winter maintenance operations; or

- the District Executive determines that it is in the Department's best interest to delay the work until such time that a higher quality product can be obtained.

Written notification will be given of the suspension and the reason(s) for the suspension.

(c) Review and Acceptance. Review and acceptance by the Department as specified, stated, or indicated in the contract will be made on the basis of limited, general inspections.

It is understood that, because of such limited reviews, ultimate responsibility for the satisfactory completion of the project, including but not limited to:

- the quality of all materials;

- the quality of all workmanship;

- compliance with all terms of the contract;

- sufficiency, correctness, and accuracy of all working or shop drawings; and

- sufficiency of all QC Plans,

rests solely with the Contractor. Notwithstanding review and/or acceptance, save and hold harmless the Department from the consequences of all defective work as well as all defects, errors and omissions in the working or shop drawings, QC Plans, and plans of every other kind prepared by the Contractor.

105.02 DRAWINGS—The following drawings, when applicable, are required to perform the work:

(a) Contract Drawings. These drawings will be furnished. They show roadway lines, grades, and typical cross sections; location and design of structures; related construction features and details; and construction quantities. Keep one set of the drawings available on the project.

(b) Standard Drawings. Section 101.03

(c) Working Drawings. Prepare these drawings to supplement the plans. They include falsework drawings, field sketches, erection diagrams, erection stresses and loads, and other details, as necessary to construct the project. Submit two copies of the drawings to the Representative, for review and acceptance, before beginning work on the item involved. Design Computations and all drawings for load-bearing falsework submissions are to be signed and sealed by a Professional Engineer, registered in the State.

(d) Shop Drawings. Prepare these drawings in accordance with the requirements of design drawings, Department Standards, Design Manual Part 4 Structures, and the contract special provisions unless otherwise specified. Prepare original drawings using pencil or ink, or prepare drawings electronically (CAD), using standard ANSI D size, 22 inch by 34 inch sheets with 1 1/2 inch margin on the left side and 1/2 inch margins on remaining three sides. All lines on the drawing are to be of sufficient density and width so as to have residual density when reduced by 50% or microfilmed. Use a minimum U.S. Customary LeRoy size of 120 for lettering, symbols, and characters. Make details clear and uncluttered. Show complete details, dimensions, materials, notes, camber diagrams, welding details and sequences, and any other information required to fabricate the item.

Provide a title block in the lower right-hand corner of each drawing that indicates the county, route, section number, segment and offset, station, contract number, (ECMS No.), name of Contractor, name of Fabricator, title of drawing, drawing number, structure number (S-Number), initials of the drawer, initials of the checker, and date of the drawing. Include a revision block to the left of the title block and an empty block, approximately 4 inch by 3 inch above the title block to be used by the shop drawing reviewer for the shop drawing stamp.

Submit drawings electronically through the PennDOT Project Collaboration Center (PPCC) or other electronic file sharing protocol using the following requirements:

Scan original drawings or convert electronic drawings, to produce a portable document format (PDF) file for each drawing. Include structure number (S-Number) and drawing number in the file name. It is required that the PDF files be created with the "end user commenting" and "digital signature" features enabled. These features allow electronic comments to be added directly to the PDF using only reader software and create a log of comments that cannot be changed once the digital signature is added. Submit PDF files to the District Executive or to an agent designated by the District Executive, for review and acceptance. Provide files on compact disk through the PPCC or other electronic file sharing. As an alternate, files may be sent by e-mail provided attachments total to no more than 15.0 MB per e-mail message. Provide electronic transmittal forms regardless of submittal method. PDF files will be returned with corrections noted. Modify original or electronic drawings as required, scan or convert into new PDF files, and resubmit. Continue until PDF files are accepted.

After acceptance, submit final shop drawings (electronic PDF files) and, if a hard-copy is requested, one set of full-size prints. After erection is complete (if applicable), but before project completion, submit final drawings showing as-built conditions as electronic PDF files to the District Executive.

105.03 CONFORMITY WITH DRAWINGS AND SPECIFICATIONS—

(a) General. Perform work within reasonably close conformity to the lines, grades, dimensions, and indicated details, and/or as specified.

(b) Determination by the Representative.

1. Restricted Performance Specifications. The Representative will determine acceptability of material or construction. When material or construction is not within specification limits, acceptance will be as specified within the individual specification sections, except where test result variations are so great that the material or construction is unacceptable.

2. Other Than Restricted Performance Specifications. For each individual case, the Representative will determine the limits of reasonably close conformity; the judgment given will be final and conclusive.

If it is determined that material or the finished product in which the material was used is not within reasonably close conformity, but that reasonably acceptable work has been produced, the Representative will then determine if the work will be accepted and remain in place. In this event, written documentation will be provided for acceptance by required contract modification, and/or to provide for an appropriate adjustment in the contract price for such work or material.

If it is determined that material or the finished product is not within reasonably close conformity and has resulted in an inferior or unsatisfactory product, remove or replace it.

(c) Certification of Falsework Adequacy. Have a Professional Engineer, registered in the State, certify that the falsework system has been assembled as shown on the Professional Engineer's signed and sealed falsework drawings prepared as specified in Section 105.02(c). Submit the certification to the Representative before placing loads on the falsework.

(d) Compliance with Specified Milestone Date(s). Complete all work in a manner that ensures specified Milestone Date(s) and/or contractually specified sequences are met. Failure to meet any specified Milestone Date(s) or sequence will result in the withholding of payment for completed work until the associated activity or activities have been completed to the satisfaction of the Representative.

105.04 COORDINATION OF PLANS AND SPECIFICATIONS—Perform the work according to the intent of the Plans and Specifications. Do not take advantage of any error on/or omission in the Plans or discrepancy between the Plans and Specifications. In the event such an error, omission, or discrepancy is discovered, immediately notify the Department. Failure to notify the Department will constitute a waiver of all claims for misunderstandings, ambiguities, or any other reasons resulting from the errors, omissions, or discrepancies. If requested, corrections and

interpretations necessary for the fulfillment of the Plans and Specifications will be made. Do not use scaled measurements where dimensions on the drawings are given or can be computed.

In case of a discrepancy among the contract documents, the following order of precedence will apply:

(1) Special Provisions
(2) Plans (excluding cited Standard Drawings)
(3) Specifications (other than Special Provisions)
(4) Standard Drawings
(5) Electronic Files

If any Special Provisions or information on the Plans conflict with these Specifications, the Special Provisions or information on the Plans will govern. If a conflict exists between any portion of the Plans designed specifically for this project and any portion of the Standard Drawings, the former will govern.

If necessary, the District Executive will determine and order, in writing, any modifications or changes in the Plans, Standard Drawings, or Specifications to update, adjust, accept, or complete the work contemplated by the contract as specified in Section 104.02. Wherever reference specifications or publications are specified, comply with the issue or edition (including interim AASHTO specifications and ASTM tentative designations) in effect on the date bids are opened, unless the date or year of the reference specification or publication is indicated or specified. If there is a conflict between a cited title and a cited section number, the title will take precedence over the section number.

105.05 RESPONSIBILITY OF CONTRACTOR—

(a) General. Keep direct control of the contract and see that the work is properly supervised and is performed satisfactorily and efficiently. Supervise the work personally or appoint a competent superintendent or representative to be on the project at all times. Give this superintendent or representative the authority to receive orders and directions; to execute orders and directions without delay; and to make arrangements for all necessary material, equipment, and labor.

Keep on the project, at all times, a copy of the plans, a copy of the specifications, and a copy of the contract, and a copy of all subcontracts.

The Department is not responsible for the Contractor's satisfactory completion of the contract work as a consequence of the presence of Department representatives or inspectors and their inspection.

Notify the Assistant District Executive for Construction in the District having responsibility for the project 3 days before the actual start of work. Keep the Assistant District Executive for Construction informed as to any changes in the scheduled date for starting work.

(b) Work By Others. For work to be done without the supervision of the Department, investigate the work and anticipate its execution and completion. The Department will not be liable for failure to anticipate the time of performance and completion of such work, except in those cases where, upon timely request, the Department has agreed to cooperate.

(c) Gratuities and Penalties. Do not give or offer, or allow agents, employees, or representatives to give or offer, either directly or indirectly, money, property, entertainment, or other valuable things, to any employee or representative of the Department for any reason, purpose, or cause, or as an inducement, bribe, or reward for doing or omitting to do any act, or for showing any favor or disfavor in relation to any matter relating to the contract. Any such action will constitute a violation of the contract. Upon satisfactory proof to the Secretary of such violation, the Department may terminate performance of the work and take steps to complete the project, as specified in Section 108.08.

105.06 UTILITY INFRASTRUCTURE AND UTILITY ADJUSTMENTS—

(a) Utility Infrastructure and Utility Adjustments Interfering with Contract Operations. Before submitting a bid for the project, examine the project site and any waste or borrow sites designated in the proposal to determine the location of all Utility Infrastructure and the need for any Utility Adjustments. The Department has indicated in the contract documents such Utility Infrastructure and Utility Adjustments as have been brought to its attention. The Department is not responsible for waste and borrow areas not designated in the contract documents. Accept the

responsibility and risk relating to the conditions to be encountered regarding Utility Infrastructure and Utility Adjustments that are indicated in the contract documents or that can be ascertained from a careful pre-bid examination of the project site for any waste or borrow sites designated in the proposal.

Notify the responsible parties of the plan for construction operations, in writing, no later than 15 calendar days after contract award. Responsible parties include all public service companies, utilities, municipal authorities, municipal utilities, individuals, and others owning or controlling any facilities or structures within the limits of the project, which may have to be relocated, adjusted, or reconstructed. Give due notice to the responsible party in sufficient time for that party to organize and perform such work in conjunction with or in advance of construction operations. Provide verification to the Department upon request that notification to responsible parties was done in accordance with the 15 calendar day contract award requirement.

- Schedule the date for the initial utility coordination meeting within 15 calendar days after contract award. This meeting may be scheduled in conjunction with or immediately following the pre-construction meeting but it must occur before the start of construction. At this meeting, be prepared to discuss:

  - The project schedule;
  - All project milestones, required completion dates, and all activities related to Utility Infrastructure and Utility Adjustments; and
  - How the project schedule differs from the utility relocation schedule prepared by the Department during project design.

  Include as attendees:

  - All utilities within the project limits (including the Utility's contractors and subcontractors),
  - Applicable contractor team members and subcontractors,
  - Department representatives, and
  - All Utility Infrastructure owners.

  Incorporate appropriate information from this meeting into the project schedule as specified in Section 108.03(b). Provide a record of the meeting. Minutes must be provided to the Department and Utility representatives for their review no later than 7 calendar days after the meeting. Allow 7 calendar days for Department and Utility representatives to review the minutes for acceptance or notification of needed revisions/clarifications and follow up with final minutes no later than 7 calendar days after the review period. Action items should be discussed and documented thoroughly at all meetings and monitored for completion to prevent impacts to the project schedule.

- Following the initial utility coordination meeting, notify the Department representatives of any unforeseen or potential conflicts discovered that were not discussed at the initial meeting and schedule follow up meetings to discuss these unforeseen or potential conflicts with the respective Utility representatives. Provide a record of the meeting. Minutes must be provided to the Department and Utility representatives for their review no later than 7 calendar days after the meeting.

- On projects where utility relocations and/or adjustments are a significant part of the construction operations and phasing as determined by the Department representative, bi-weekly utility meetings are to be scheduled by the contractor and attended by the Department, the contractor and the Utility representatives. Provide a record of the meeting. Minutes must be provided to the Department and Utility representatives for their review no later than 7 calendar days after the meeting.

Cooperate with the Utility Infrastructure owners and the owners of all waste and borrow areas not on the project site. Make arrangements for Utility Adjustments necessary to perform the work as indicated in the contract documents. Arrange and perform contract work in and around such Utility Infrastructure in accordance with recognized and accepted engineering and construction practices and in a manner that assists the Utility Infrastructure owners in their required Utility Adjustments.

Refer to the provisions of Act 287-1974, which specifies project responsibilities in regard to public health and safety during excavation and demolition operations in areas of underground utilities.

Failure to perform and document these actions could impact the acknowledgement or approval of any associated delays or time extension requests.

(b) Delays in the Performance of Work. No additional compensation will be paid because of an impact to the contract work from Utility Infrastructure and Utility Adjustments unless the Contractor establishes, to the satisfaction of the District Executive and the Director of Project Delivery, that the impact was unforeseen and unforeseeable by a reasonable contractor; that losses could not have been avoided by the judicious handling of forces, equipment and plants, or by reasonable revisions to the schedule of operations; and that the impact has resulted in a documented increase in the cost of performing the contract work, in which case only delay damages will be paid as specified in Section 111.

The following are conditions precedent to the right, if any, of the Contractor to an adjustment in compensation:

- Comply with the requirements specified in Section 105.06(a).
- Furnish all schedule updates specified in Section 108.03(b) to all affected Utility Infrastructure owners.
- Comply with the requirements specified in Section 111.

(c) Utility Adjustments by Others. When required, owners or lessees are to bring railway tracks to the established line and grade. Utility Adjustments are to be performed by the owners of the Utility Infrastructure, unless otherwise indicated. Check the line and grade as soon as possible after Notice to Proceed, but no later than 30 calendar days before the placement of base or pavement adjacent to or around such Utility Infrastructure.

(d) Damage to Utility Infrastructure. Compensate the owner for all cost of repairing, replacing, or resetting any Utility Infrastructure damaged or disturbed by contract construction as specified in Section 107.12.

Coordinate with the railroad company to provide accepted measures for protection of railroad tracks and ballast from debris, silt, or other foreign matter.

Provide required means of protection, maintenance, cleaning, repair, and replacement of ballast. This work will be subject to the approval of the Railroad's Chief Engineer or authorized representative.

105.07 COOPERATION BETWEEN CONTRACTORS—The Department reserves the right to contract for and perform other work on or near the work covered by the contract.

If separate contracts are awarded within the limits of, or adjacent to any one project, or utility work not included or identified in the contract becomes required, conduct the work to complete the Department's project and to avoid interfering with or hindering the progress or completion of the work being performed by other entities. Coordinate with the Department and schedule meetings among all entities performing work. Plan and coordinate all work activities with all entities involved to ensure efficient completion of work by all parties. Satisfactorily join work with and in proper sequence with the work of others.

This section does not necessarily preclude the contractor from claiming additional costs, if any, provided for under other provisions of the contract or specifications, provided all reasonable efforts are made by the contractor to mitigate its losses, including, without limitation, attempts to re-sequence work when reasonable and practical opportunities exist.

105.08 CONSTRUCTION SURVEYING—

(a) Projects that Do Not Include a Construction Surveying Pay Item. If the project plans and specifications do not indicate a separate pay item for Construction Surveying, control stakes will be furnished and placed, offset from the proposed roadway base line, and a grade sheet will be furnished showing the horizontal and vertical measurements from the stakes to the base line and grade of the roadway as planned, including adjusted alignment and grades, as directed, to meet conditions. Where the highway is to be constructed on a grade of more than 4%, an offset stake will be set on each side of each designated grade point. The stakes will be on a direct line through the grade point or base line, or otherwise, as may be required. Slope stakes will be placed adjacent to the top of cut and toe of embankment slopes where these points are more than 5 feet vertically above or below the finished grade line. Applicable base line, abutment, pier, sidewall, and wingwall stakes, together with offset, reference, and grade stakes for bridges, arches,

slab and box culverts, including metal plate and pipe culverts and other special structures, will also be placed, as required, to facilitate and control the work.

Employ a Professional Land Surveyor or Professional Engineer, registered in the State, qualified in the use of plans, cross sections, and specifications, to establish lines and grades, as may be required. Assume full responsibility for dimensions and elevations taken from the control stakes and the setting of lines and grades.

Furnish templates and other material and place additional stakes and markers necessary for control and guidance of construction operations. Also, furnish the Inspector with any assistance required for checking lines, grades, and measurements established (other than by the Department) and necessary for the performance of the work. The Department does not assume responsibility for the performance of the work as a consequence of this checking.

Preserve survey points and stakes, as placed. If any of these surveying controls are disturbed or destroyed by construction operations, the cost to the Department for replacement will be charged against and deducted from money due or to become due.

(b) Projects that Include a Construction Surveying Pay Item. If the project plans and specifications indicate a separate pay item for Construction Surveying, perform the work as specified in Section 686.

105.09 AUTHORITY AND DUTIES OF INSPECTOR-IN-CHARGE—The Inspector-in-Charge will have immediate responsibility for administering the performance of work on the project.

In case a dispute arises concerning material to be furnished or the manner of performing the work, the Inspector-in-Charge will have authority to reject material or suspend the work until the question at issue can be referred to and be decided by the Representative. A rejection of material or suspension of work will be confirmed by written notice from the Representative.

105.10 INSPECTION OF WORK—The work will be subject to the inspection of the Representative or authorized assistants. Provide them access to the work and furnish them with every reasonable facility for determining whether the work being performed or which has been completed is according to the requirements of the plans, specifications, and contract, except as otherwise provided. Provide all labor and equipment necessary for such examination.

Should the work thus exposed or examined prove satisfactory, the uncovering or removing and restoring of the uncovered or removed work will be paid for, as specified in Section 110.03, except the incidental work for testing the depth of base and surface courses and pavement will not be paid for separately. Should the work exposed or examined prove defective or unsatisfactory, promptly uncover or remove and satisfactorily restore the defective or unsatisfactory work, at no expense to the Department.

When any unit of government or political subdivision, or any public or private corporation, is to pay a portion of the cost of the work covered by the contract, the respective representatives will have the right to inspect the work. Such inspection will not make any unit of government or political subdivision, or any public or private corporation, a party to this contract and will in no way interfere with the rights of either party to this contract.

105.11 DUTIES OF THE INSPECTOR—Authorized inspectors, who perform their duties under the direction of the Representative, will be assigned to the project.

Execute work under the observation and subject to examination of an inspector(s); carry out such work during the normal working hours of the day, unless specifically directed otherwise. If work is performed during nighttime hours with permission, provide sufficient artificial lighting to assure proper inspection and workmanship.

The inspector is not authorized to do the following: revoke, alter, enlarge, relax, or release any requirements of the specifications; approve or accept any portion of the work; or issue instructions contrary to the plans and specifications.

The presence of the inspector during the performance of any work on the project will not relieve the Contractor of the responsibility for work that is later determined by the Representative to be defective.

105.12 DEFECTIVE WORK AND MATERIAL—If any work and/or material does not meet the requirements of the plans and specifications, or is not within reasonably close conformity, as determined by the Representative, such work and/or material will be declared defective.

Unless otherwise specified, repair, as directed, or remove and replace defective work and/or material at no expense to the Department.

105.13 MAINTENANCE OF PERFORMED WORK—

(a) Maintenance of Performed Work. Maintain performed and completed work, making continuous and effective efforts, with adequate equipment and forces, to keep the roadway or structures in satisfactory condition at all times during construction. Provide such maintenance, at no additional cost to the Department, until relieved of responsibility for further physical work, and maintenance as specified in Section 110.08(a).

If, at any time, performed work is not maintained, the Department reserves the right to perform such work as may be considered necessary for traffic accommodation and to deduct the cost thereof from money due or to become due the Contractor.

Provide removals, renewals, restorations, and repairs as required to remedy damage to performed work occurring before relief of Contractor responsibility as specified in Section 110.08(a). Perform such work, according to the terms and conditions of the contract, at no expense to the Department. Seek reimbursement of the costs of such work from legally responsible third parties and their liability insurers, asserting all available claims, including claims of the Department as the Department's subrogee where appropriate. If, as determined by the Representative, all such claims have been exhausted without full recovery of the costs of such work, and the damage was due to unforeseeable causes beyond the control of the Contractor and occurred despite satisfactory maintenance precautions taken, the Department will pay for the unrecovered portion of the costs of such work as specified in Section 110.03.

(b) Maintenance During Temporary Suspension of Work. If the work is temporarily suspended, wholly or in part, for a sustained or indefinite period, satisfactorily store all materials and take every precaution to prevent damage or deterioration of preformed work. Provide suitable drainage for the roadway by constructing temporary shoulders; by opening culverts, inlets, and parallel ditches; and by erecting temporary drainage structures where necessary.

During suspension, the entire project under contract, or any section, may be opened to traffic, as directed. If opened to traffic, maintain the roadway in satisfactory condition and maintain local traffic as specified in Section 902. Perform such work at no expense to the Department, except as specified in Section 902.4. During work suspension, remove all protective devices installed on the project. However, if directed, maintain protective devices in certain areas.

If work is suspended in part, the Representative will have the authority to direct that other parts or items of work be performed.

Satisfactorily protect the ends of any sections of rigid-type base course, pavement, or wearing surface opened to traffic during a temporary, partial suspension of work. Maintain this protection, remove it when no longer required, and satisfactorily dispose of protective material.

During any period of work suspension, properly and continuously maintain, in an acceptable growing condition, all living material in newly established plantings, seedings, and soddings furnished under the contract. Take adequate precautions to protect new tree growth and other desirable vegetative growth.

105.14 BORROW AREAS AND WASTE AREAS—

(a) Non-Designated Areas. Locate proposed areas for obtaining borrow material and/or areas for disposal of waste material, when required. Locate waste, borrow, or staging areas inside or outside of the right-of-way in upland areas not impacting Waters of the United States, including jurisdictional wetlands, unless already authorized by the U.S. Army Corps of Engineers and DEP. Situate areas so cross sections may be taken by the Department to measure the volume of material removed or deposited. Before cross sectioning borrow areas, remove topsoil and stockpile it for replacement when removal of borrow material has been completed.

Review proposed areas with the Representative for approval to negotiate a "Borrow and/or Waste Agreement." Waste and borrow areas that impact Waters of the United States are prohibited unless already permitted, as agreed to with the U.S. Army Corps of Engineers. Obtain waterway and/or other required permits as applicable. Prepare and submit an Erosion and Sediment Pollution Control Plan to the Conservation District for approval. Negotiate with the owner(s) of property to be obtained by using the Department's standard "Borrow and/or Waste Agreement," available from the District Executive. This standard agreement may be modified to cover unusual or special conditions, provided such conditions are acceptable to the Department. Submit one copy of the executed agreement to the Representative for review and acceptance. Do not proceed with work in the area until such review and acceptance is completed and until written notification of the acceptance is received.

Also submit one copy of applicable permits and of the approved Erosion and Sedimentation Control Plan to the Representative before starting work.

Have the agreement provide for cleaning and leaving the premises and area in a well-drained and, if required, smoothly graded condition, blending into the existing topography. Scarify, lime, fertilize, seed, and mulch any

disturbed areas with material, and formulae, at rates typical for the project. When directed, satisfactorily remove and dispose of surplus material.

Perform the clean fill determination for all borrow materials entering the construction right-of-way by completing and submitting the Environmental Due Diligence Form D-1, and, if necessary, Form D-2 to the Department for acceptance.

(b) Designated Areas. If the Department has previously selected areas from which to obtain borrow or areas in which to deposit waste, the proposal will specify the location(s).

For such designated area(s), complete the standard agreement as specified above for Non-Designated Areas. The Department will provide all applicable permits and Erosion and Sediment Pollution Control Plans.

105.15 ARCHEOLOGICAL AND HISTORICAL FINDINGS—In areas where remains of prehistoric people's dwelling sites or where artifacts of historical or archeological significance are encountered, discontinue construction operations in the general area. Contact will be made with the State Historical and Museum Commission to determine how to proceed. When directed, satisfactorily excavate the site to preserve the artifacts encountered, then remove them for delivery to the custody of the Pennsylvania Historical and Museum Commission. In the event construction operations are halted or delayed because of archeological or historic findings, appropriate adjustments will be made in the contract time as specified in Section 108.06. Such site excavation will be considered extra work as specified in Section 104.03.

105.16 COAL OR VALUABLE MINERAL FINDINGS—If coal or other valuable minerals are uncovered, during prosecution of the work, that are not addressed by contract special provisions, store and handle the coal and other valuable minerals according to the directions of the Representative.

Do not claim or assume ownership rights.

If direction is given to handle and dispose of the material in a manner other than as unsuitable material, the contract time and contract price may be adjusted as specified in Section 110.02.

105.17 ACCEPTANCE OF CONSTRUCTION LOADINGS AND MATERIAL STOCKPILING ON BRIDGES—Do not stage equipment or stockpile materials on a bridge unless a written request has been submitted and accepted by the Representative. Submissions are to be signed and sealed by a Professional Engineer, registered in the State. The Representative will review the documentation, supporting analysis, if required, and respond to the written request within:

- 10 calendar days of receipt for a load limit submission
- 21 calendar days of receipt for a review of analytical calculations for cases that exceed the specified loading limits, or for a crane placement submission.

Acceptance by the Representative will not relieve the Contractor of liability for damages resulting from the stockpiling of materials or from the operation and movement of construction equipment.

A bridge is considered completed if all the following conditions are satisfied:

- All applicable structural members are erected.
- Spans proposed for construction loading and material stockpiling are completed from expansion joint to expansion joint or from abutment to abutment excluding barriers and deck joints.
- If staged construction for maintenance-of-traffic, spans of staged width proposed for construction loading and material stockpiling are completed from expansion joint to expansion joint or from abutment to abutment excluding barriers and deck joints, and the staged width has been designed for and will be opened to all legal loads without restriction.

For construction equipment on deck slabs, the written request must describe the loading magnitude, arrangement, movement, and position of the equipment on the structure, including the mechanism of load transfer (load path) to the bridge.

(a) Loading limits. For spans over 40 feet, carrying live traffic loads (staged construction) or over live traffic, limit the stockpiling of material and staging of equipment on a non-weight posted completed bridge the following:

1. Individual material stockpile (including but not limited to pallets of products, reinforcement bar bundles, aggregate piles) - Limited to one individual stockpile with a maximum weight of 250 pounds/square foot and a maximum size of 100 square feet.
2. Multiple material stockpiles - Maximum weight of 65 pounds/square foot with a maximum total stockpile area of 1000 square feet.
3. Combinations of material stock piles, vehicles, other materials, and equipment are limited to a maximum total weight of 100,000 pounds per span in any for work zone width less than 24 feet, and a maximum total weight of 200,000 pounds per span for work zones ≥ 24 wide, provided loading limits in Sections 105.17(a)1 and 2 are not exceeded. The force effects produced by combinations of material stockpiles, vehicles and other materials and equipment are limited to the force effects produced by vehicles of legal configuration evaluated at operating rating levels as defined in Publication 238.

On a weight posted completed bridge, the above thresholds are to be reduced proportionately based on the ratio of the posted load limit(s) to the legal load limit(s).

If loads are proposed that will exceed the above loading limits or loads are proposed to be placed on an incomplete bridge, submit analytical calculations showing the flexural, shear, and axial stresses due to construction loadings do not exceed the operating stress levels as defined in Publication 238 for the main load carrying members of the structure or the deck slab.

(b) Placement of a crane. Submit a working drawing showing the location of crane, matting, and all other loads and denote their weights. Submit analytical calculations showing that flexural, shear, and axial stresses due to construction loadings do not exceed the operating stress levels as defined in Publication 238 for the main load carrying members of the structure or the deck slab. Provide matting to protect the deck slab from damage. Placement of cranes is not allowed on newly constructed bridge decks until the deck concrete has cured for a minimum of 14 calendar days and has attained a minimum compressive strength of 4,000 pounds per square inch.

SECTION 106—CONTROL OF MATERIAL

106.01 GENERAL—Use material complying with the requirements of these specifications. At the pre-construction conference, submit a list of material to be sampled and tested by the Contractor and a list of material to be sampled and tested by the Department.

Comply with the provisions of the Pennsylvania Trade Practices Act, 71 P.S. Section 773.101, et seq., concerning the purchase of aluminum and steel products produced in a foreign country. On Federal-Aid projects, also comply with the provisions specified in Section 106.10.

Comply with the provisions of the Steel Products Procurement Act, 73 P.S. Section 1881, et seq. in the performance of the contract or any subcontract.

Following contract execution, furnish to the Department a complete statement of the project construction material's origin, composition, and manufacture.

For Fabricated Structural Steel materials, as identified in Section 1105.01(a) and inspected in accordance with Section 1105.01(e), and any other fabricated aluminum, precast or prestressed concrete products inspected during manufacturing, stamped and approved for shipment by the Department's Representative, furnish Form CS-4171 to the Inspector-in-Charge. Certified mill test reports for any steel included will be reviewed by the Department's Inspector and retained by the fabricator.

For all other steel products or products containing steel that will be permanently incorporated in the project, provide the Inspector-in-Charge the following when the product is delivered to the project site:

- For any "identifiable" steel products, certification that Section 4 of the Steel Products Procurement Act, 73 P.S. Section 1884, has been complied with. Identifiable steel products are steel products which contain permanent markings which indicate the material was both melted and manufactured in the United States.
- For all other "unidentifiable" steel products, documentation such as invoices, bills of lading, and mill certification that positively identify that the steel was melted and manufactured in the United States.

The provisions of the Steel Products Procurement Act will not be waived unless the Secretary has determined, under authority granted in Section 4(b) of the act, that a certain steel product or products is not produced in the United States in sufficient quantities to meet contract requirements. Such a determination will be set forth in a proposal for the Department's review and response. Include with the proposal a comprehensive list of sources, including names and contact information, for verification. The Secretary does not have the authority to waive the provisions specified in Section 106.10.

Steel products are defined as products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated, otherwise similarly processed, or processed by a combination of two or more of these operations from steel made in the United States by the open hearth, basic oxygen, electric furnace, Bessemer, or any other steel-producing process. Included are cast iron products and machinery and equipment as listed in United States Department of Commerce Standard Industrial Classification 25, 35, and 37 and made of, fabricated from, or containing steel components. If a product, as delivered to the project, contains both foreign and United States steel, such product is considered to be a United States steel product only if at least 75% of the cost of the articles, materials, and supplies have been mined, produced, or manufactured, as the case may be, in the United States. On Federal-Aid projects, comply with the provisions specified in Section 106.10.

No payment will be made on the contract if unidentified steel products are supplied, until the hereinbefore requirements are met.

Any payments made that should not have been made may be recoverable from a manufacturer or supplier as well as from a contractor or subcontractor.

Any person who willfully violates the Steel Products Procurement Act will be prohibited from submitting bids for any contract for a period of 5 years from the date of determination that a violation has occurred. If a subcontractor, manufacturer or supplier, violates the Steel Products Procurement Act, such person will be prohibited from performing any work or supplying any materials to the Department for a period of 5 years from the date of determination that a violation has occurred.

If steel products are used as a construction tool or appurtenance and will not serve a permanent functional use in the project, compliance with the Steel Products Procurement Act is not required.

When standard manufactured items are specified and these items are identified by unit mass (unit weight), section dimensions, or similar characteristics, their identification will be considered to be nominal masses (weights) or dimensions. Unless more stringently controlled by specified tolerances, industry established manufacturing tolerances

will be accepted.

106.02 MATERIAL—

(a) Preliminary Acceptance and Approval. Have each material and material source of supply listed on Form CS-200 (Source of Supply – Materials) or Form CS-201 (Source of Supply – Traffic Control Devices) and approved before delivery to project. Department Bulletin listed material and material sources are available for use by the Contractor. If non-Bulletin material or material sources are proposed for use, the requirements specified in 106.02(a)2 must be met before these materials are delivered to the project. The Department reserves the right to obtain samples of any material provided by the Contractor for laboratory testing to verify compliance with specifications.

1. Bulletin Material, Material Application, and Material Source. Defined as any of the following:

- Any material and material source listed in Bulletin 14 and used in the material application as specified in the Bulletin, Publication 408, or a Special Provision.
- Any material and material source listed in Bulletin 15 and used in the material application as specified in the Bulletin, Publication 408, or a Special Provision.
- Any asphalt material and material application specified in Publication 408 and produced at a source listed in Bulletin 41.
- Any cement concrete material and material application specified in Publication 408 and produced at a source listed in Bulletin 42.

Submit a CS-200 or CS-201 to the Representative with the following information: contract item number, item description, material description/type/class, product name, manufacturer/producer plant location, applicable Bulletin supplier code, Bulletin number, and Publication 408 or Bulletin Section.

If a previously submitted Bulletin material source no longer provides the specified material, submit a change in material to the Representative as outlined on Form CS-200 or CS-201. Once written acceptance is received, furnish material from another Bulletin material source listed in Bulletin 14, 15, 41, or 42.

2. Non-Bulletin Material, Material Application, or Material Source. Defined as any of the following:

- Any material, product, or material source not listed in Bulletin 14 or Bulletin 15.
- Any material, product, or material source listed in Bulletin 14 or Bulletin 15 being used in an application not intended or specified in the Bulletin, Publication 408, or a Special Provision.
- Any asphalt material or product not produced at a source listed in Bulletin 41.
- Any asphalt material or product not specified in Publication 408 or a Special Provision.
- Any ready-mixed, cement concrete material or product not produced at a source listed in Bulletin 42.
- Any ready-mixed, cement concrete material or product not specified in Publication 408 or a Special Provision.

2.a. Construction-Aid Material. A necessary, temporary, or ancillary material that is not specified for use as part of a contract item or extra work item, but used by the Contractor only to aid in the completion of the work. The material is typically not a permanent part of the specified work (example: wood and nails for temporary formwork). The material need not be listed on Form CS-200 and does not require any Department approval for delivery to or use on the project. The Representative reserves the right to determine whether a material is a construction-aid material. Note temporary traffic control items are not construction-aid materials and do need listed on Form CS-201 since these items must be from Bulletin 15 listed sources and are specified for use as part of contract items or extra work items.

2.b. Project-Specific, LTS Approved Material. Non-Bulletin material proposed for use on a particular project as part of a contract item or extra work item, which requires approval by the LTS. Use of material is not meant to circumvent the use of available material sources listed in Bulletin 14, 15, 41, or 42. Have each material and material source listed on Form CS-200 or Form CS-201. The material is defined as any material, product, or material source that meets one or more of the following criteria:

- Meets specified requirements in Publication 408 or Special Provision, for the material and material application.
- Meets specified requirements in AASHTO or ASTM Standard for the material and material application.
- Meets specified requirements in project Special Provision for the material and material application.

Submit material to the LTS for evaluation and testing a minimum of 90 days before planned delivery to the project. Submit the following information to the LTS, with a copy to the Representative: source, description, specified use, QC Plan, independent lab test data showing material meets all specified requirements as determined on a single lot of material, and material samples of the kind and quality specified. Do not deliver material to the project until written acceptance is received from the Representative.

2.c. Project-Specific, Locally Approved Material. Non-Bulletin material proposed for use on a particular project as part of a contract item or extra work item, which does not require LTS approval because of the low risk to constructed Project performance, but does require local approval by the Representative (i.e. at the District or project level). This category of material is not meant to circumvent the use of available material sources listed in the Bulletins, or the requirements of Project-Specific, LTS Approved Materials. These materials must meet specification requirements and will be clearly identified in the specification as only needing local approval by the Representative. Have each material and material source listed on Form CS-200 or Form CS-201. Submit for local approval by the Representative all required information for the material, as indicated in the specification.

Examples of locally approved materials are project specific items, such as Section 860 (inlet filter bags), Section 867 (compost filter socks), and Section 868 (compost blanket and compost filter berms) where the specification indicates that these materials are to be locally approved. Bulletin 15 will reference specific Publication 408 Sections that apply to Locally Approved Materials. Bulletin 15 will not list actual materials or material sources for this category of materials as they will be accepted for use on a project-specific basis by local approval.

(b) Inspection. Inspect material delivered to the project and stockpile the material passing inspection for use. Do not incorporate questionable material, until material is tested by LTS and accepted in writing by the Representative. The Department reserves the right to reject questionable material delivered to the project when the LTS test results are not according to the specifications. Furnish assistance to the Inspector, as required to obtain samples.

Allow designated Department representatives to inspect material being used, or intended to be used, at any time before, during, or after material preparation, while being used during the progress of the work, or after the work has been completed. Furnish or arrange with producers or manufacturers to provide necessary material, labor, tools, and equipment for such inspection.

Inspections and tests, if made at any point other than the point of incorporation in the work, will not guarantee acceptance of the material. Inspection and testing performed by the Department will not relieve the Contractor's responsibility for QC.

106.03 TESTS AND ACCEPTANCE OF MATERIAL—

(a) Restricted Performance Specifications.

1. Responsibility. The Department will be responsible for determining the acceptability of the material and construction. Material will be reviewed for acceptance through the Department's specified acceptance procedures. Sample locations for acceptance testing will be determined by the Department.

Perform sampling and testing for acceptance in the presence of the Inspector, unless otherwise specified. Lot size will be specified. In the event that operational conditions cause work to be interrupted before the specified lot size has been achieved, the lot may be redefined by the Inspector. It is the intent of these specifications that each lot be evaluated based on the same number of samples. Transport acceptance samples from sampling point to testing site or other designated location in the presence of the Inspector.

The Contractor is responsible for the control and quality of the material and construction.

Prepare a QC Plan as specified in Section 106.03(a)2.a and submit it to the Inspector-In-Charge for review at the start of the project. Include QC sampling and testing frequencies and action points to initiate corrective measures. Notify the Inspector before performing QC sampling and testing. Perform QC sampling and testing and report results to the Inspector.

Obtain and test samples according to the Department's PTMs. If the required test method is not specified, use methods described in the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and Supplements, Standards and/or Tentatives of ASTM, or other testing procedures adopted by the Department.

Verification sampling and testing will be performed by the District, unless otherwise specified.

QA sampling and testing will be performed or witnessed by the BOPD.

Independent Assurance sampling and testing will be administered by the CQAS.

2. QC.

2.a Maintain a QC system that provides reasonable assurance that materials, products, and completed construction, submitted for acceptance, conform to contract requirements whether self-manufactured, processed, or procured from subcontractors or vendors. When specified, submit for review, a plan of the QC system to be used. Have performed or perform the inspections and tests required to substantiate product conformance to contract requirements. Make the inspection and test results available for review throughout the contract life. Procedures will be subject to the review of the Department before the work is started. Charts and records documenting QC inspections and tests are the property of the Department. Submit a QC Plan for use in compliance with the following guidelines, as a minimum:

2.a.1 Raw Materials. List the source of material along with methods of documentation and testing performed to assure the material quality.

2.a.2 Production Control. List lot size and samples required; include sample selection, labeling and test procedure; also include manufacturing phase.

2.a.3 Product Testing. List type and frequency of tests to be performed, along with method of documenting and reporting test results. List test equipment and calibration procedure (frequency) required. List procedure for retesting or rejecting items failing the tests. List the disposal methods and location for test samples and rejected lots.

2.a.4 Personnel. List the personnel in charge of QC and define their areas of responsibility.

2.a.5 Packaging and Shipping. List method of identifying, storing, loading, transporting, and unloading to assure safe delivery of acceptable material and products.

2.a.6 Documentation. List the procedures used for documentation and certification.

The QC Plan and process are subject to periodic review and inspection by the Department.

2.b Promptly record conforming and non-conforming inspection and test results on acceptable forms or charts. Keep these records complete and keep them available for inspection at all times during the performance of the work.

2.c Promptly correct any errors, equipment malfunctions, process changes, or other assignable causes which have resulted or could result in the submission of material, products, and completed construction not conforming to specification requirements.

2.d When required, provide or have provided and maintain measuring and testing devices necessary to ensure that material and products conform to contract requirements. In order to ensure continued accuracy, calibrate these devices at established intervals against Department standards.

2.e When required, make the measuring and testing equipment available to the Representative for use in determining conformance of material, products, or completed construction with contract requirements. In addition, make personnel available for the operation of such devices and for verification of the accuracy and condition of the devices. Have calibration results available at all times. The Department reserves the right to conduct periodic inspections of the measuring and testing devices to confirm both calibration and condition of operation.

2.f Failure to comply with the QC Plan may result in suspension of approval to provide material for Department use and/or removal from the approved list of material suppliers in the applicable bulletins.

3. Acceptance Plans.

3.a Percent Within Limits. The percentage of each lot within the specified limits will be determined by the following procedures:

3.a.1 The "n" sampling positions on the lot will be located by use of the table of random numbers found in PTM No. 1.

3.a.2 A measurement will be made at each location, or a test portion taken and the measurement made on the test portion.

3.a.3 The lot (X) measurements are averaged to find $\overline{X}$.

$$\overline{X} = \sum_{i=1}^{n} \frac{X_i}{n}$$

3.a.4 The Standard Deviation, "s," of the lot measurements will be determined as follows:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{n-1}}$$

3.a.5 The Quality Index (Q_U) is found by subtracting the average (X) of the measurements from the upper specification limit (U) and dividing the result by "s."

$$Q_u = \frac{(u - \overline{X})}{s}$$

3.a.6 The Quality Index (Q_L) is found by subtracting the lower specification limit (L) from the average and dividing the result by "s."

$$Q_L = \frac{(\overline{X} - L)}{s}$$

3.a.7 The percentage of material that will fall within the upper limit (U) is estimated by entering Table A or Table B with Q_U, using the column appropriate to the total number of measurements (n). Use Table A if Q_U has a negative value, or use Table B if Q_U has a positive value.

3.a.8 The percentage of material that will fall within the lower limit (L) is estimated by entering Table A or Table B with Q_L, using the column appropriate to the total number of measurements (n). Use Table A if Q_L has a negative value, or use Table B if Q_L has a positive value.

3.a.9 In cases where both upper (U) and lower (L) limits are concerned, the percentage of material that will fall within limits is found by adding the percent (P_U) within the upper limit (U) to the percent (P_L) within the lower limit (L) and subtracting 100 from the sum.

$$\text{Total percent within limits} = (P_U + P_L) - 100$$

3.a.10 When determining the percentage within limits when the calculated Quality Index (Q.I.) value is between two tabular values in Table A or Table B, the following procedure is used:

- The difference between the tabular Q.I. values on either side of the calculated value Q.I. value will be determined.

- The difference will be divided by 2 and the quotient added to the lower tabular Q.I. value, resulting in the interpolated Q.I. value.

- If the calculated Q.I. is equal to or greater than the interpolated value, the higher listed percent within limits will be used.

- If the calculated Q.I. is less than interpolated value, the lower listed percent within the limits will be used.

TABLE A
Estimating Percent of Lot Within Limits
(Standard Deviation Method)
Negative Values of Q_U or Q_L

Percent Within Limits	n=3	n=4	n=5	n=6	n=7
50	0.0000	0.0000	0.0000	0.0000	0.0000
49	0.0361	0.0300	0.0281	0.0272	0.0267
48	0.0722	0.0600	0.0562	0.0545	0.0535
47	0.1083	0.0900	0.0843	0.0818	0.0802
46	0.1444	0.1200	0.1124	0.1091	0.1070
45	0.1806	0.1500	0.1406	0.1364	0.1338
44	0.2158	0.1800	0.1689	0.1639	0.1608
43	0.2510	0.2100	0.1972	0.1914	0.1878
42	0.2863	0.2400	0.2256	0.2189	0.2148
41	0.3215	0.2700	0.2539	0.2464	0.2418
40	0.3568	0.3000	0.2823	0.2740	0.2689
39	0.3912	0.3300	0.3106	0.3018	0.2966
38	0.4252	0.3600	0.3392	0.3295	0.3238
37	0.4587	0.3900	0.3678	0.3577	0.3515
36	0.4917	0.4200	0.3968	0.3859	0.3791
35	0.5242	0.4500	0.4254	0.4140	0.4073
34	0.5564	0.4800	0.4544	0.4426	0.4354
33	0.5878	0.5101	0.4837	0.4712	0.4639
32	0.6187	0.5401	0.5131	0.5002	0.4925
31	0.6490	0.5701	0.5424	0.5292	0.5211
30	0.6788	0.6001	0.5717	0.5586	0.5506
29	0.7076	0.6301	0.6018	0.5880	0.5846
28	0.7360	0.6601	0.6315	0.6178	0.6095
27	0.7635	0.6901	0.6619	0.6480	0.6395
26	0.7905	0.7201	0.6919	0.6782	0.6703
25	0.8164	0.7501	0.7227	0.7093	0.7011
24	0.8416	0.7801	0.7535	0.7403	0.7320
23	0.8661	0.8101	0.7846	0.7717	0.7642
22	0.8896	0.8401	0.8161	0.8040	0.7964
21	0.9122	0.8701	0.8479	0.8363	0.8290
20	0.9342	0.9001	0.8798	0.8693	0.8626
19	0.9555	0.9301	0.9123	0.9028	0.8966
18	0.9748	0.9601	0.9453	0.9367	0.9315
17	0.9940	0.9901	0.9782	0.9718	0.9673
16	1.0118	1.0201	1.0125	1.0073	1.0032

TABLE A (continued)
Estimating Percent of Lot Within Limits
(Standard Deviation Method)
Negative Values of Q_U or Q_L

Percent Within Limits	n=3	n=4	n=5	n=6	n=7
15	1.0286	1.0501	1.0469	1.0437	1.0413
14	1.0446	1.0801	1.0819	1.0813	1.0798
13	1.0597	1.1101	1.1174	1.1196	1.1202
12	1.0732	1.1401	1.1538	1.1592	1.1615
11	1.0864	1.1701	1.1911	1.2001	1.2045
10	1.0977	1.2001	1.2293	1.2421	1.2494
9	1.1087	1.2301	1.2683	1.2866	1.2966
8	1.1170	1.2601	1.3091	1.3328	1.3465
7	1.1263	1.2901	1.3510	1.3813	1.3990
6	1.1330	1.3201	1.3946	1.4332	1.4562
5	1.1367	1.3501	1.4408	1.4892	1.5184
4	1.1402	1.3801	1.4898	1.5500	1.5868
3	1.1439	1.4101	1.5428	1.6190	1.6662
2	1.1476	1.4401	1.6018	1.6990	1.7615
1	1.1510	1.4701	1.6719	1.8016	1.8893

TABLE B
Estimating Percent of Lot Within Limits
(Standard Deviation Method)
Positive Values of Q_U or Q_L

Percent Within Limits	n=3	n=4	n=5	n=6	n=7
99	1.1510	1.4701	1.6719	1.8016	1.8893
98	1.1476	1.4401	1.6018	1.6990	1.7615
97	1.1439	1.4101	1.5428	1.6190	1.6662
96	1.1402	1.3801	1.4898	1.5500	1.5868
95	1.1367	1.3501	1.4408	1.4892	1.5184
94	1.1330	1.3201	1.3946	1.4332	1.4562
93	1.1263	1.2901	1.3510	1.3813	1.3990
92	1.1170	1.2601	1.3091	1.3328	1.3465
91	1.1087	1.2301	1.2683	1.2866	1.2966
90	1.0977	1.2001	1.2293	1.2421	1.2494
89	1.0864	1.1701	1.1911	1.2001	1.2045
88	1.0732	1.1401	1.1538	1.1592	1.1615
87	1.0596	1.1101	1.1174	1.1196	1.1202
86	1.0446	1.0801	1.0819	1.0813	1.0798
85	1.0286	1.0501	1.0469	1.0437	1.0413
84	1.0118	1.0201	1.0125	1.0073	1.0032
83	0.9940	0.9901	0.9782	0.9718	0.9673
82	0.9748	0.9601	0.9453	0.9367	0.9315
81	0.9550	0.9301	0.9123	0.9028	0.8966
80	0.9342	0.9001	0.8798	0.8693	0.8626
79	0.9122	0.8701	0.8479	0.8363	0.8290
78	0.8896	0.8401	0.8161	0.8040	0.7964
77	0.8661	0.8101	0.7846	0.7717	0.7642
76	0.8416	0.7801	0.7535	0.7403	0.7320
75	0.8164	0.7501	0.7227	0.7093	0.7011
74	0.7905	0.7201	0.6919	0.6782	0.6703
73	0.7635	0.6901	0.6619	0.6480	0.6395
72	0.7360	0.6601	0.6315	0.6178	0.6095
71	0.7076	0.6301	0.6018	0.5880	0.5846
70	0.6788	0.6001	0.5717	0.5586	0.5506
69	0.6490	0.5701	0.5424	0.5292	0.5211
68	0.6187	0.5401	0.5131	0.5002	0.4925
67	0.5878	0.5101	0.4837	0.4712	0.4639
66	0.5564	0.4800	0.4544	0.4426	0.4354
65	0.5242	0.4500	0.4254	0.4140	0.4073

TABLE B (continued)
Estimating Percent of Lot Within Limits
(Standard Deviation Method)
Positive Values of Q_U or Q_L

Percent Within Limits	n=3	n=4	n=5	n=6	n=7
64	0.4917	0.4200	0.3968	0.3859	0.3791
63	0.4587	0.3900	0.3678	0.3577	0.3515
62	0.4252	0.3600	0.3392	0.3295	0.3238
61	0.3912	0.3300	0.3106	0.3018	0.2966
60	0.3568	0.3000	0.2823	0.2740	0.2689
59	0.3215	0.2700	0.2539	0.2464	0.2418
58	0.2863	0.2400	0.2256	0.2189	0.2148
57	0.2510	0.2100	0.1972	0.1914	0.1878
56	0.2158	0.1800	0.1689	0.1639	0.1608
55	0.1806	0.1500	0.1406	0.1364	0.1338
54	0.1444	0.1200	0.1124	0.1091	0.1070
53	0.1083	0.0900	0.0843	0.0818	0.0802
52	0.0722	0.0600	0.0562	0.0545	0.0535
51	0.0361	0.0300	0.0281	0.0272	0.0267
50	0.0000	0.0000	0.0000	0.0000	0.0000

3.b Resampling of Lot. It is the intent of these specifications that lots will meet specification requirements at the time of submission. If permitted, nonconforming lots that can be corrected may be reworked and sampled.

3.c General Basis of Adjusted Payment. The related adjusted percentage of contract price will be determined by the method designated in the appropriate specification section.

(b) Specifications, Other than Restricted Performance.

1. Responsibility. The Department will be responsible for determining the acceptability of the material and construction. Material will be reviewed for acceptance through the Department's specified acceptance procedures. Sample locations for acceptance testing will be determined by the Department.

Perform sampling and testing for acceptance in the presence of the Inspector, unless otherwise specified. Transport acceptance samples from sampling point to testing site or other designated location in the presence of the Inspector.

The Contractor is responsible for the control and quality of the material and construction.

Prepare a QC Plan as specified in Section 106.03(a)2.a and submit it to the Inspector-In-Charge for review at the start of the project. Include QC sampling and testing frequencies and action points to initiate corrective measures. Notify the Inspector before performing QC sampling and testing. Perform QC sampling and testing and report results to the Inspector.

Do not incorporate any material into the work that is determined to be outside the specification limits.

Obtain and test samples according to the Department's PTMs. If the required test method is not specified, use methods described in the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and Supplements, Standards and/or Tentatives of ASTM, or other testing procedures adopted by the Department.

Verification sampling and testing will be performed by the District, unless otherwise specified.

QA sampling and testing will be performed or witnessed by the BOPD.

Independent Assurance sampling and testing will be administered by the CQAS.

2. QC. Section 106.03(a)2. and as follows:

Provide a plan of the QC system to be used for all construction work requiring acceptance testing by the Department, including QC test frequencies and action points to initiate corrective measures. Submit a copy of the QC Plan to the Project Engineer, to be maintained at the Department's project field office, before the start of work. A QC Plan is not required for items specified in Section 901.

3. Compliance Certification of Bulletin Materials. The Contractor is responsible for the control and quality of all materials, both Bulletin and non-Bulletin materials, arriving at the project. Each Bulletin material must be certified to be from a Bulletin source and to be in compliance with the specification requirements for the material. A properly completed and submitted Form CS-4171, Certificate of Compliance, is the means for certification of Bulletin materials. Bulletin materials are defined in Section 106.02(a)1.

The Department reserves the right to sample and test any material for verification that specification requirements are met. Materials of questionable quality delivered to the project will be sampled, tested, and approved by LTS before incorporation in any work. Materials on a reduced certification level may be required to be sampled, tested, and approved by LTS before incorporation in any work. Random field verification samples of the material may be taken by the Representative at the material source, from delivered project material, or at the place of the last manufacturer, fabricator, or producer before delivery. Random QA samples may also be taken by the Representative from delivered project material, at the place of supply, or at the place of the last manufacturer, fabricator, or producer before delivery. The random samples will be sent to the LTS for testing.

3.a Form CS-4171 Completion. Form CS-4171 is completed by the manufacturer, fabricator, or producer (Producer) of Bulletin material provided to the project. The Producer maintains the original Form CS-4171 and provides a copy of Form CS-4171 with each direct shipment to the project.

When a Producer sells a Bulletin 15 material to a distributor/supplier (shipper), the Producer provides a copy of Form CS-4171 with each delivery to the shipper. When a shipper provides Bulletin 15 material directly to the project, the shipper completes and signs a new Form CS-4171 and provides a copy with each direct shipment to the project. The shipper will maintain the copy of the Producer's Form CS-4171that they have received.

Form CS-4171 must be properly signed by a legally responsible company official.

3.b Form CS-4171 Submission for Project Shipments. Ensure that Form CS-4171 is received for each project shipment of Bulletin material. Submit to the Representative a properly completed and signed copy of Form CS-4171 for each project shipment. Do not incorporate any Bulletin material in the work until certification arrives on the project, unless otherwise approved by the Representative. Payment for material will be withheld until proper certification documentation is received.

Form CS-4171 may be submitted to the Department either in hard copy format or electronically. Contractors who wish to submit certification documentation to a project electronically, e.g. via e-mail, facsimile or through a PennDOT Project Collaboration Site, must notify the Department at the preconstruction meeting.

3.c Supplemental or Alternate Certification. Certain Bulletin materials require the submission of supplemental CS-4171 certification in addition to Form CS-4171, to provide traceability of materials in multi-step manufacturing processes.

- Epoxy coated or galvanized reinforcement steel requires the submission of supplemental certification Form CS-4171C (Epoxy Coating or Galvanizing Facility) and/or Form CS-4171F (Fabrication Facility).
- Structural steel, aluminum, or precast/prestressed concrete products, produced in a Bulletin 15 approved facility with an on-site Inspector or a Representative, must be stamped with an approved inspection stamp at the plant and certified with a Form CS-4171.
- Steel products containing foreign steel require the submission of supplemental Form CS-4171S.

Certain Bulletin materials require a form of certification other than the Form CS-4171, as identified in the particular material specification.

- Section 701 and Section 702 materials require a properly completed vendor bill of lading.
- Certification of daily asphalt mixtures by submission of Form CS-4171B.

- Certification of locally approved non-Bulletin materials by submission of Form CS-4171LA.

Organize and submit only Forms CS-4171 and supplemental or alternate certifications for material supplied to the project. Submissions containing irrelevant forms or documentation for materials not incorporated into the project will not be accepted.

3.d CS-4171 Record Retention. Retain Form CS-4171 and supplemental and alternate certifications as defined in Section 106.03(b)3.c, for a period of not less than 3 years from the date of the last project shipment. Make files available for inspection and verification by the Department.

Notify shippers that a certification file must be maintained for purchased Bulletin materials to provide an audit trail to the Producer. Certifications for purchased Bulletin materials must be maintained at their place of business for a period of not less than 3 years from the date of the last shipment to the project and must be available for inspection by the Department.

Notify Producers that all component certifications for purchased Bulletin materials must be maintained at their place of business for a period of not less than 3 years from the date of the last shipment to the project and must be available for inspection by the Department.

3.e Levels of Certification for Bulletin 15 Producers. The BOPD determines the Level of Certification for each Producer based on the Producer's ability to comply with the material specifications. The Levels of Certification are defined in Table C. Bulletin 15 will indicate if a Producer is at a certification level other than Level 1. Material provided by Producers listed in Bulletin 15 is approved for use only in its intended application(s).

TABLE C

Levels of Certification for Bulletin 15 Producers		**Producer Material Shipment Procedure**	**Producer Additional Requirements**
Level 1	Standard Certification	Ship on Certification with Form CS-4171*	None
Level 2	Standard Certification - Reduced	Ship on Certification with Form CS-4171*	See Section 106.03(b)3.e.2
Level 3	Lot Approval Certification	Ship only after Material Lot Approval using Modified Certification, with Form CS-4171*	See Section 106.03(b)3.e.3
Suspension or Removal	According to the State's Contractor Responsibility Program: • Producer may be suspended or removed from Bulletin 15 for any of the reasons stated in the Bulletin 15 Preface, regardless of Producer certification level. • Failure of Producer to advance above Certification Level 3 will result in PennDOT's initiating action for suspension or removal from Bulletin 15.		

* Certain Bulletin materials require supplemental or alternate forms of certification, as specified in Section 106.03(b)3.c.

3.e.1 LEVEL 1 (Standard Certification).

- Initial Level of Certification typically issued to Bulletin 15 listed Producers.
- Material is produced and tested in accordance with the Producer's approved QC Plan.
- No known material performance or quality issues exist that warrant a reduced level of certification.
- Material is shipped on certification using Form CS-4171.

3.e.2 LEVEL 2 (Standard Certification - Reduced).

- Reduced Level of Certification issued to Bulletin 15 listed Producers who have exhibited minor/moderate material performance or quality issues.

- Producer is required to work with PennDOT on submission of an improvement plan that may include, but is not limited to, any or all of the following items: a revised QC Plan, a failure analysis/action plan to assess why failures are occurring and how to prevent these failures from occurring in the future, correlation testing between in-house and independent lab testing to assist with validating results.
- Material is produced and tested in accordance with the improvement plan approved by PennDOT.
- Material is shipped on certification using Form CS-4171.

3.e.3 LEVEL 3 (Lot Approval Certification).

- This Level of Certification is issued to Bulletin 15 listed Producers who have exhibited major material performance or quality issues.
- Producer is required to work with PennDOT on an improvement plan as defined in Level 2.
- Material cannot be shipped to projects using the standard CS-4171 certification process.
- Producer must arrange for independent, in-plant acceptance testing (IPAT) that will be conducted side-by-side with "in-house" Producer testing at the designated frequencies in the revised QC plan. IPAT will be at the Producer's expense. PennDOT's LTS must approve the Producer's proposed IPAT provider, before it begins.
- Any material lot to be used on a project must be tested and approved by the IPAT as meeting the required PennDOT specification prior to shipment to the project.
- Each material lot meeting the specification may be shipped to a project using a modified certification process as follows: submit, to both the Project Representative and LTS, Form CS-4171 along with a signed letter from the IPAT (on their official letterhead) indicating that the material lot meets testing and specification requirements.
- Correlate results from parallel "in-house" Producer testing and IPAT testing, and submit to the LTS on a monthly basis.

106.04 USE OF MATERIALS FROM WITHIN THE PROJECT—With written permission, material found in the excavation areas and meeting the Department's specifications may be used in the project construction. Material used will be paid for, as specified in Section 110.01. However, replace any portion removed with suitable material, if required to complete the embankments. The replaced quantity will be 110% of the volume of stone or gravel removed and 100% of the volume of sand and other material removed. Do not use reserved material, as specified in Section 104.06, or as indicated in the proposal.

106.05 STORAGE OF MATERIAL—

(a) General. Store material to assure preservation of specified quality and fitness for the work.

Stored material, even though accepted before storage, may again be inspected before use in the work. Locate stored material to facilitate prompt inspection and control.

Adhere to the restrictions below for the storage of construction materials with known physical hazards (explosive, flammable, or combustible) or storage of any motorized equipment under any structure with vertical clearance measured:

- Less than 16 feet – No storage is allowed.
- Between 16 feet and 24 feet – Short term operational storage will be allowed provided the materials are stored in an enclosure which meets all ANSI and OSHA requirements for said material(s) and a fire prevention plan has been submitted for the short term operational storage. Short term operational storage is limited to the amount of material and/or equipment required for a 24-hour period.
- Greater than 24 feet – No restriction.

Vertical clearance is measured from the lowest structure member to the ground level below that member.

Do not use private property for storage purposes without written permission of the owner or lessee. Make copies of this permission available to the Department. Restore storage sites to conditions acceptable to property owners and the Department.

(b) Storage of Aggregates. Provide a separate stockpile for each aggregate size and type at cement concrete plants. Do not use aggregates that become segregated or mixed with earth or foreign material.

If divided aggregate bins are used for storage or for proportioning, take measures to prevent mixing of aggregates.

Provide an area for storage of aggregates for use in Portland cement concrete and asphalt concrete. Store aggregates on one of the following constructed according to standard practice:

- Asphalt concrete base course, 4 inches minimum depth.
- Class C concrete, or better, 4 inches minimum depth.

(c) Control of Aggregates. Have aggregates available for use in cement concrete at the proportioning plant in enough time before batching to allow inspection and testing. Handle the aggregates so they may be field tested and accepted, before storing them with previously accepted aggregates. Batch fine and coarse aggregates separately. Properly control uniformity of moisture and uniformity of gradation. Provide a system of water sprays, then use when required, to maintain coarse aggregate moisture control.

During cool and cold weather concrete production, maintain aggregates required for individual concrete placements, whether stored in proportioning bins or stockpiles, at a temperature of not less than 40F before and during batching operations, for a sufficient length of time to eliminate the presence of frost in or around the aggregate particles.

(d) Storage of Reinforcement. Satisfactorily store reinforcement above ground, in a clean and dry condition on a platform, in an orderly manner, plainly marked to facilitate inspection.

106.06 HANDLING AND TRANSPORTATION OF MATERIAL—

(a) General. Carefully handle material to preserve quality and fitness for the work and to prevent loss, segregation, or inconsistency in quantities after weighing or measuring for incorporation in the work.

(b) Aggregates. In dry batching operations, measure aggregates or weigh before placing in the compartments of the vehicle, unless otherwise specified or permitted. Clean the vehicles and provide tight batch partitions at least 4 inches higher than the batched aggregate level being hauled, to prevent any spillage from one compartment to another.

(c) Bulk Cement. Bulk cement may be used, as specified in Section 701.

If bulk cement is used, transport to the mixer in acceptable metal, rubber, or plastic, watertight containers or compartments.

(d) Bag Cement. If bag cement is used, dump the contents of the correct number of bags required for each batch into the mixer skip. If permitted, bag cement may be transported from storage to the mixer by placing the correct number of bags per batch on the batched aggregate in the aggregate compartments. When transported, the bag cement may be dumped on the aggregate after having been checked by the inspector, and if done not more than 100 feet from the mixer. Bag cement that is allowed to lie on the batched aggregates longer than 2 hours, or cement dumped on the batched aggregate longer than 1 hour, will be rejected.

106.07 UNACCEPTABLE MATERIAL—

(a) Restricted Performance Specifications.

1. Acceptance or Rejection. Following the application of the appropriate acceptance plan, the Representative's decision will be final as to the acceptance, rejection, or acceptance at an adjusted price of sampled lots.

2. Disposition of Lots. If permitted, lots not conforming to specifications may be reworked and resubmitted for acceptance sampling. For nonconforming lots that are not adaptable to correction by reworking, remove and replace them, have them accepted without payment, or have them accepted at an adjusted price as stated in the specifications or, if not stated, as directed.

(b) Specifications, Other than Restricted Performance. Material not conforming to the requirements of the specifications, whether in place or not, will be rejected. Remove such material promptly from the site of the work, unless otherwise directed. Do not return rejected material to the work site until defects have been corrected and the material has been accepted for use.

(c) Serviceable Precast or Prestressed Concrete, Fabricated Structural Steel and Aluminum Products. Plant produced fabricated materials or products having materials substitutions, dimensional deviations, specifications deficiencies, or damage which result in materials or products which may be serviceable but, do not meet all contract requirements will be addressed as follows:

1. Minor Deficiency or Defect. For materials or products with one or more minor deficiencies or defects, resolution of the deficiencies or defects will be made directly by the precaster or fabricator with the BDTD's Structural Materials Section. Minor defects and deficiencies are generally defined as those which will not require:

- engineering design review
- revisions to approved installation or erection plans or methods
- anticipated premature maintenance or rehabilitation

The Structural Materials Section may determine that one or more of the minor deficiencies or defects are actually significant deficiencies or non-conformances and require the precaster or fabricator to resolve the deficiency or defect as a significant deficiency or non-conformance as specified in Section 106.07(c)2.

2. Significant Deficiency or Non-Conformance. For materials or products having one or more significant deficiencies or non-conformances, which cannot be corrected to meet the contract specifications and which the Department determines may require one or more of the bulleted items listed in Section 106.07(c)1., submit documentation to support acceptance of the material or product (provided by the precaster or fabricator) and a request for Department evaluation and final disposition of the materials or products.

Where visible defects are present, or when otherwise requested, include detailed sketches, drawings, or photographs along with the supporting documentation form the precaster or fabricator to support acceptance of the material or product. Include a detailed repair procedure to correct the deficiency, if applicable.

For requests submitted for acceptance of the material or product "as is", provide supporting justification to demonstrate that the significant deficiency or non-conformance will not result in additional constructability issues during erection or construction or unanticipated premature maintenance work. Obtain approval of any revisions required to the shop drawings to reflect as built conditions prior to shipment.

Submit engineering calculations, when required or requested, to support the acceptability of the significant deficiency or non-conformance, sealed by a registered Professional Engineer that is licensed in the State. Submittals must include a statement by the Engineer that the defect will not compromise either the structural capacity or service life of the original design.

Submit the above to the District Assistant Construction Engineer with copies to the following:

- Chief Structural Materials Engineer, Bridge Design and Technology Division, Bureau of Project Delivery
- District Structural Control Engineer
- District Bridge Engineer
- Chief Bridge Engineer, Bridge Design and Technology Division, Bureau of Project Delivery (when calculations are required or requested).

Include the following minimum information on a cover page, attached to the submission:

- ECMS or other contract identification including State Route, Section and County
- Structure Number, if applicable
- Specific identification of the affected unit(s), i.e. girder-beam-culvert number, etc.
- Anticipated shipping date
- Detailed sketches, drawings or photographs of the defect, if visible or when requested.

After evaluation, the disposition of the material or product, including any conditions of acceptance, will be

provided by the Chief Structural Materials Engineer from information provided by the Engineering District. Replace materials or products which are rejected via this policy with those complying with the contract specifications and requirements.

106.08 DEPARTMENT FURNISHED MATERIAL—The Department will furnish material, if specified in the proposal, in the quantities required. Material will be delivered or made available at the point specified.

The cost of handling and placing material after delivery will be included in the contract price for the item.

After delivery and acceptance by the Contractor, the cost of replacing material due to shortages, deficiencies, or damage, including demurrage charges, will be deducted from money due or to become due.

106.09 PENNSYLVANIA TRADE PRACTICES ACT—This section does not apply to projects which are partially or totally financed with Federal funds.

(a) General. Pursuant to the PA Trade Practices Act, Act 226-1968, the Department will not specify, purchase, or permit to be furnished or used in any contract aluminum or steel products as set forth below made in the countries set forth below.

The Department may utilize the discretionary waiver provision of Act 3-1978 as to steel products. As to aluminum products, if the sole source is from a banned country relief may be permitted under the Statutory Construction Act, 1 PA C.S. 1901 et seq.

1. Brazil. Welded carbon steel pipes and tubes; carbon steel wire rod; tool steel; certain stainless steel products including hot-rolled stainless steel bar; stainless steel wire rod and cold-formed stainless steel bar; pre-stressed concrete steel wire strand; hot-rolled carbon steel plate in coil; hot-rolled carbon steel sheet; and cold-rolled carbon steel sheet.

2. Spain. Certain stainless steel products, including stainless steel wire rod, hot-rolled stainless steel bars, and cold-formed stainless steel bars; pre-stressed concrete steel wire strand; certain steel products, including hot-rolled steel plate, cold-rolled carbon steel plate, carbon steel structural shapes, galvanized carbon steel sheet, hot-rolled carbon steel bars; and cold-formed carbon steel bars.

3. South Korea. Welded carbon steel pipes and tubes; hot-rolled carbon steel plate; hot-rolled carbon steel sheet; and galvanized steel sheet.

4. Argentina. Carbon steel wire rod and cold-rolled carbon steel sheet.

106.10 BUY AMERICA PROVISIONS AND CONVICT PRODUCED MATERIALS—This section only applies to projects partially or totally financed with Federal funds.

(a) Buy America Provisions. Furnish steel or iron materials, including coating for permanently incorporated work according to 23 CFR 635.410 and as follows:

- Pig iron and processed, pelletized, and reduced iron ore manufactured outside of the United States is acceptable for use in domestic manufacturing process for steel and/or iron materials.

- All manufacturing processes of steel or iron materials in a product, including coating; and any subsequent process that alters the steel or iron material's physical form or shape, or changes its chemical composition; are to occur within the United States. This includes rolling, extruding, machining, bending, grinding, drilling, and coating. Coating includes all processes that protect or enhance the value of the material, such as epoxy coatings, galvanizing or painting.

- Provide certification to the Inspector-in-Charge, that all manufacturing processes for steel and iron materials in a product, including coating, have occurred in the United States; certify as specified in Section 106.01.

Products manufactured of foreign steel or iron materials may be used, provided the cost of such products as they are delivered to the project does not exceed 0.1% of the total contract amount, or $2,500, whichever is greater.

(b) Convict Produced Materials. Pursuant to 23 CFR 635.417, materials produced by convict labor after July 1, 1991 may not be used for Federal-aid highway construction projects, unless produced at a prison facility which had been producing convict-made materials for Federal-Aid construction projects before July 1, 1987.

Material produced by convicts who are on parole, supervised release, or probation from a prison may be incorporated in a Federal-Aid highway construction project.

SECTION 107—LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 LAWS TO BE OBSERVED—At all times, observe and comply with the following, and post as required: all Federal, State, and local laws, ordinances, and regulations that have appropriate jurisdiction over the project and affect the conduct of the work or that apply to employees on the project; and all orders or decrees that have been or may be enacted by any legal bodies or tribunals having authority or jurisdiction over the work, material, employees, or contract. Protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, including violations by Contractor employees.

107.02 PERMITS, LICENSES, AND TAX RESPONSIBILITY—

(a) Permits and Licenses. Purchase and submit copies of permits and licenses. At the job site, post notices necessary for the proper and lawful performance of the work according to such permits and licenses. Do not start work until signing and submitting all documentation required to become a transferee/co-permitee for all applicable permits required for the project.

(b) Tax Responsibility. Ascertain the possible existence, scope and coverage of any local subdivision tax, sometimes called an occupation tax, wage tax, income tax, franchise tax, or excise tax on the construction operations within the limit of the political subdivision imposing such tax. Also indemnify and save harmless the State and its agents from liability for the collection and payment of any taxes assessed and levied by the constituted authority, including upon Contractor agents, employees, and/or representatives in connection with the performance of work on the project.

(c) Vehicle Registration. Attention is directed to 75 P.S. 1302(a) and 1303(a), (b), which requires vehicles to be registered in Pennsylvania when used on a project which is being built under traffic or where the vehicles are operated on a public highway opened to traffic.

107.03 PATENTED DEVICES, MATERIAL, AND PROCESSES—If any design, device, material, or process covered by letters of patent or copyright is used, provide for use by suitable legal agreement with the patentee or owner. Indemnify and save harmless the State or political subdivision from any claims for infringement, by reason of the use of any patented design, device, material, process, or any trademark or copyright, and indemnify the State for any costs, expenses, and damages which it may be obliged to pay by reason of any infringement, at any time during the performance or after the completion of the work. These provisions also apply to the surety.

107.04 RESTORATION OF SURFACE OPENED BY PERMIT—Do not allow any opening to be made within the right of way unless a valid permit is presented authorizing the opening. For such an opening, made before the date upon which the work provided for in the contract is finally accepted, repair at the time and in the manner directed in writing by the District Executive.

107.05 FEDERAL-AID PROVISIONS—If the Federal Government pays any portion of the project costs, observe the Federal laws pertaining to the project, as well as the rules and regulations made according to such laws. Work will be subject to the inspection of the appropriate Federal agency.

Such inspection will not make the Federal Government a party to the contract and will not interfere with the rights of either party to the contract.

107.06 SANITARY PROVISIONS—Incidental to contract items, provide and maintain, in a neat and clean condition, sanitary facilities (including toilet facilities, hand washing facilities, and drinking water) meeting the requirements of Section 609.2(a) for the exclusive use of Department personnel on the project. Clean, disinfect, and maintain to the satisfaction of the Representative any drinking water coolers or other drinking water delivery implements. Dispose of all wastes, both sewage and wastewater, in a manner approved by the DEP. As required,

obtain permits from local municipalities to install temporary toilet facilities. The requirement for sanitary facilities, as described in this section, are not waived for projects that do not include a PennDOT field office.

107.08 OCCUPATIONAL SAFETY AND HEALTH—Comply at all times with applicable Federal, State, and local laws and regulations, provisions, and policies governing safety and health, including the Federal Construction Safety Act (Public Law 91-54), 29 CFR Chapter XVII, Part 1926, Occupational Safety and Health Regulations for Construction, and the Occupation Safety and Health Act (Public Law 91-596), 29 CFR Chapter XVII, Part 1910 Occupational Safety and Health Standards for General Industry, and subsequent publications updating these regulations.

Take any other needed action or proceed as directed, to protect the life, health, and general occupational welfare of personnel employed on the project. Provide confined space training on the proper use of the testing equipment and all safety procedures to ensure a safe operation to Contractor personnel and Department Representatives required to access the area for inspection purposes and provide all safety and testing equipment required by 29 CFR 1910.146, to both Department Representatives and Contractor personnel to ensure the safety of all workers and inspectors during construction operations and inspection operations of any confined spaces. Also, provide proof of training, such as a course sign-in sheet or certificate of training. Provide appropriate rescue services, personnel, and equipment as per 29 CFR 1910.146(k).

Provide appropriate exposure controls, personnel, and equipment as per 29 CFR 1926.1153 for respirable crystalline silica (RCS). For operations which require Contractor personnel for RCS mitigation to employ respiratory protection or perform work within an enclosed cab, direct inspection by the Representative will be withheld from the operation. Perform the work in such operations to allow for inspections at hold points, as determined by the Representative.

If, in the Representative's opinion, employees are exposed to extraordinary conditions which could or do constitute a hazard, modify such equipment, devices, and job procedures to ensure protection against the hazard or to reduce the risk to the employees engaged in project work. The Department does not approve of the disengagement of any safety features on contractor equipment. If the contractor, as part of its means and methods, and at the responsibility of trained and certified operators, disengages any type of equipment safety feature, it will hold the Department harmless against any liability on any claims made against the Department due to the disengagement of the feature.

Prior to or at the preconstruction conference, submit a written Project Safety Program. Include at a minimum, the following procedures and information:

- A procedure to document lost time.
- Detailed confined space mitigation procedures and safety procedures as required by 29 CFR 1910.146 including procedures for conducting air monitor calibrations as required by the equipment manufacturer’s instructions and a written Confined Space Entry Permit system.
- Provide air monitoring equipment calibration documentation, for spaces that have actual or potential atmospheric hazards.
- Written verification of rescue services availability and qualifications for permit-required confined spaces.
- Written verification of annual training for internal/contractor employed rescue team if these services are provided by the contractor for permit-required confined spaces. Provide a list of employees that attended the training and the dates they attended.
- A written exposure control plan for RCS, as per 29 CFR 1926.1153(g) to also include:
  - A description of the tasks on the project that involve exposure to RCS.
  - A description of the engineering controls, work practices, and respiratory protection required to limit worker exposure to RCS for each task.
  - A description of the housekeeping measures used to limit worker exposure to RCS.
  - A description of the procedures used to restrict access to work areas when necessary, to minimize the number of workers exposed to RCS and their level of exposure.
- Provide a procedure for assuring compliance by subcontractors and suppliers working within the project’s limit of work.

All costs associated with the preparation and implementation and updates of Project Safety Program and complying with the requirements are considered incidental.

Give special emphasis to providing safeguards for any specially or unusually hazardous operations and health hazards. Include initial indoctrination and continuing instructions for all employees to enable them to perform work in a safe manner. Include in the instruction project safety practices, manner of reporting accidents, availability of

medical facilities, and explanation of individual responsibility for accident-free operations.

Require all persons to wear high-visibility safety apparel (orange or yellow-green) that is intended to provide conspicuity during both daytime and nighttime usage, and that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107-2004 publication entitled "American National Standard for High-Visibility Safety Apparel and Headwear" while in work zones exposed either to traffic or to construction equipment.

All areas of a project will be hard hat areas. Require all persons within the project limits to wear protective headgear, including persons in cement concrete and asphalt concrete plants operated exclusively for a project, even though the plant(s) may be remotely located.

For multi-season projects with a contract amount $\geq$ $5,000,000, provide and maintain one scoreboard safety sign 4 feet wide by 3 feet high to identify the number of days worked on the project without a lost time accident. Imprint on the sign, the name of the Contractor and an appropriate safety message. Prominently display the following on the sign in 4-inch letters:

a. Contractor's name and address.
b. "(***) Days Worked Since Last Lost-Time Injury"

NOTE: "(***)"—indicates space for three removable numbers. Number displayed to include subcontractors.

Place the sign in a prominent location at the project site. Update the sign at least bi-weekly.

Immediately take corrective action, upon notification by the Representative of any noncompliance with the provisions of this section. Upon receipt of this notice, failure or refusal to promptly comply will cause a written order to be issued, stopping all or part of the work until the corrective action has been taken. Claim for an extension of time, costs, or damages because of the time lost due to any such stop orders will not be considered.

107.09 RAILWAY-HIGHWAY PROVISIONS—Conform to regulations stipulated in the Pennsylvania Public Utility Commission's order when work is indicated to be performed within, or adjacent to, the right of way or trackage belonging to, or upon which a common carrier operates. Observe strict adherence to all requirements pertaining to the work, safety, and movement of trains; to public and personal liability insurance; and to any other related matters. If it is necessary to use crossings other than those indicated, make arrangements for the use of the crossings.

107.10 BRIDGES OVER NAVIGABLE WATERS—Conduct work on navigable waters according to the requirements of permits issued by the U.S. Army Corps of Engineers or U.S. Coast Guard, whichever is applicable.

107.12 CARE OF PUBLIC AND PRIVATE PROPERTY—Do not damage overhead and underground facilities and structures or property within or adjacent to the project. Use special care in the performance of the work in order to avoid interference or damage to operating utilities or plants; however, where there is any possibility of interference or damage, make satisfactory arrangements with responsible corporate officers of the utilities or plant, covering the necessary precautions to be used during the performance of the work. Make these arrangements, subject to review, before work is started.

Protect all land monuments and property markers which are to be affected by the construction until they have been correctly referenced by the Department. Beyond the construction area, reset monuments and markers which are disturbed by contract operations, either during the construction of the project or otherwise, when and as directed.

Promptly make restitution for or satisfactorily repair or restore damaged public or private property except in instances in which underground facilities are damaged because of a failure on the part of the owner of such facilities to accurately locate or mark the facilities.

Protect trees to be left standing. If these existing trees to be left standing are damaged, satisfactorily repair or replace them, at no expense to the Department, or compensate the Department for the damage by an equitable monetary amount as determined by, or agreed with, the Department.

107.13 PUBLIC USE LANDS—In performing work within or adjacent to public use lands, namely National or State Forests, State Gamelands, Wildlife or Waterfowl Refuges, recreation areas, parklands, and historic sites, comply with all applicable rules and regulations of the authority having jurisdiction.

Cooperate with the National or State Forest Officer or Supervisor and authorized subordinates in observing sanitary laws and in exercising every reasonable precaution to prevent and suppress forest fires and vandalism.

Do everything reasonable to prevent and suppress forest fires. Notify a forest supervisor, as soon as possible, of the location and extent of any fire observed. Before starting indicated work affecting stream channels, verify that the Department has the approval of the DEP and/or the DCNR.

107.14 RESPONSIBILITY FOR DAMAGE CLAIMS—Furnish insurance certificate(s), as specified in Section 103.05, to indemnify and save harmless the State, the Department, and all of its officers and employees from all suits, actions, or claims of any character, name, and description, brought for or on account of any injuries or damages received or sustained by any person, persons, or property during the performance of work by the Contractor, whether the same is due to the use of defective material, defective workmanship, neglect in safeguarding the work or public interests, or by or on account of any act, omission, neglect, or misconduct of the Contractor, or any Subcontractors, Fabricators, Manufacturers, or Vendors.

Also indemnify and save harmless the State, the Department, and all of its officers and employees from cases arising as specified in Sections 105.05 and 107.16, or from any claims for amounts arising or recovered under the Workers' Compensation Law, or any other law, bylaw, ordinance, order, or decree.

107.15 OPENING SECTIONS OF PROJECT TO TRAFFIC—The Representative will have the authority to order, in writing, any substantially completed section of the project opened to traffic when seasonal, local, or other conditions relating to the project or public convenience justify such action; however, such opening will not be held to be an acceptance or a waiver of any provisions of the specifications or the contract.

Furnish, place, and maintain necessary traffic control devices, as directed, at the Department's expense, as specified in Section 110.03. Conduct the remainder of construction operations so as to cause the least obstruction to traffic.

Any section of the project opened before project completion will be subject to the applicable requirements specified in Section 110.08(a).

After opening a section of the project to traffic, any damage to satisfactorily completed work items within the section which occurs due to vehicles, other than construction vehicles and equipment engaged on the project, and not to defective materials and/or workmanship, and which occurs despite satisfactory precaution taken, will be replaced or repaired, as directed, at the Department's expense, as specified in Section 110.03.

107.16 CONTRACTOR'S RESPONSIBILITY FOR WORK—

(a) Responsibility for Performed Work. The terms and conditions of the Contract will be in effect until the work is completed and accepted by the Department, as evidenced by the dated acceptance certificate issued by the Department. However, the Contractor will be relieved of responsibility for further physical work and maintenance as specified in Section 110.08(a). The issuance of the acceptance certificate does not relieve the Contractor and Surety from continuing liability for latent defects, as specified in Section 107.16(b).

(b) Responsibility for Latent Defects. The Representative will determine if a defect is a latent defect. The Contractor and the Surety continue to be liable for all latent defects; however, the Surety is liable only until the performance bond is released. Satisfactorily repair or correct latent defects at no expense to the Department. If defects cannot be satisfactorily repaired or corrected, provide reimbursement for any expenses or damages incurred by the State because of latent defects. Failure to satisfactorily correct latent defects, or to reimburse the State for expenses or damages incurred as a result of latent defects, will be considered sufficient cause to suspend or remove prequalification, according to 67 PA Code Chapter 457, regulations governing prequalification of prospective bidders, provided that any adjudication regarding such latent defects is final.

(c) Responsibility During Temporary Suspension of Work. Should the work be temporarily suspended, wholly or in part, according to the provisions specified in Section 105.01(b), written notification will be given of the suspension and the reason(s) for the suspension.

If the work is temporarily suspended, wholly or in part, due to the fault of the Contractor, the Required Completion Date and any specified Milestone Date(s) will not be changed, unless otherwise directed by the Director of Project Delivery.

After a whole or partial suspension, upon receipt of written notice from the Representative, actively resume work according to the detailed schedule of operations.

107.17 CONTRACTOR'S RESPONSIBILITY FOR PUBLIC OR PRIVATE FACILITIES AND STRUCTURES—Cooperate with others in the performance of corrective project work, as specified in Section 105.06.

The Department will cooperate in the issue of notices and will participate in all essential field conferences relating to the facilities and structures.

107.18 FURNISHING OF RIGHT OF WAY—The Department will be responsible for securing all necessary rights of way in advance of construction. Any exceptions will be indicated in the proposal and contract.

107.19 PERSONAL LIABILITY OF PUBLIC OFFICIALS—In carrying out any of the provisions of these specifications or in exercising any power or authority granted to them by or within the scope of the contract, no liability may be placed upon the Secretary, Engineer, or their authorized representatives, either personally or as officials of the State. In such matters, they act solely as State agents and representatives.

107.20 NO WAIVER OF LEGAL RIGHTS—The Department, the Secretary, the Engineer, or the Representative will not be prevented by an erroneous

- measurement,
- computation,
- estimate, or
- certificate

made or given by them or any agent or employee of the Department, under any provision or provisions of the contract at any time, either before or after the completion and acceptance of, and payment for the roadway, from showing at any time that any

- measurement,
- computation,
- estimate, or
- certificate

is untrue or incorrectly made in any particular or that the work or material or any part does not conform to the specifications and contract.

The Department will have the right to reject the whole or any part of the work or material, should any

- measurement,
- computation,
- estimate,
- certificate, or

- payment

be discovered or be known to be inconsistent with the contract terms or otherwise improperly given. The Department will not be prevented, notwithstanding any

- measurement,
- computation,
- estimate,
- certificate, or
- payment

from demanding and recovering from the Contractor or surety, such damages as it may sustain by the failure to comply with the terms of the specifications and contract or on account of any overpayment(s) made on any estimate or certificate.

Neither the payment on any estimate or certificate signed by the Department nor any extension or remission of contract time nor any possession taken by the Department or its employees, will operate as a waiver of any portion of the Contractor of any power herein reserved by the Department or any right to damages herein provided, nor will any waiver of any breach of contract held to be a waiver of other or subsequent breach.

The terms of this contract will not be waived or modified by any verbal communication between the Contractor and Department personnel.

107.21 WORKERS' COMPENSATION INSURANCE—Carry Workers' Compensation Insurance or file a proper Certificate of Exemption as provided for by the Workers' Compensation Act and execute a valid affidavit in accepting provisions of the Workers' Compensation Act as supplied with the contract.

107.22 MINIMUM WAGE SPECIFICATIONS AND RATES—

(a) Requirements. According to the provisions of the Pennsylvania Prevailing Wage Act 43 P.S. 165-1, and the implementing Regulations of the Pennsylvania Department of Labor and Industry, comply with the prevailing minimum wage predetermination requirements, as specified in the proposal, specifications, and contract.

(b) Responsibility for Payment of Wages. Accept responsibility for all wages paid or due to any employees engaged upon the project under contract, as mandated by the Pennsylvania Prevailing Wage Act, various applicable Federal acts, and the contract. Do not attempt to pass such responsibility elsewhere. Do not require employees to refund, directly or indirectly, any part of such wage(s). Where classification, reclassification, or additional classifications of workers are made according to the Pennsylvania Prevailing Wage Act and its regulations, make no claim against the Department for additional compensation for such classification, reclassification, or additional classification.

If after a contract has been awarded, it is decided, because of unforeseen construction development, to list an additional classification and wage rate, the Department, with or without application by the Contractor, will make written request for a wage determination by the Secretary of Labor and Industry.

No person may be employed on the project under contract, except according to the classification set forth in the decision of the Secretary of Labor and Industry.

(c) Certification and Payment of Rate of Wage. According to the provisions of the Pennsylvania Prevailing Wage Act and various applicable Federal acts, including their implementing regulations, file with the Department a weekly statement and a final statement at the conclusion of project work under contract, certifying that all employees have been paid wages in conformity with the provisions of the contract, as prescribed by the regulations of the Pennsylvania Department of Labor and Industry, implementing the Pennsylvania Prevailing Wage Act. If any wages remain unpaid, list on the statement the amount of wages due to each employee. Certify that, directly or indirectly, no

refunds are received from any employee of any such minimum wage(s), other than deductions authorized by the Pennsylvania Wage Payment and Collection Law, 43 P.S. 260.1. Use forms furnished by the Department and submit the forms to the District Executive within 7 days after the regular payment date of the payroll period. Payment of the current and semifinal estimates and final settlement certificate will be withheld if such certification is not submitted, using the proper form, within the prescribed time limit.

1. Furnish all payrolls via the PennDOT Project Collaboration Center (PPCC). Two submittals, in the Other Correspondence category have been created for payroll submissions: "Labor Compliance-Prime Contractor Payroll" and "Labor Compliance-Sub-Contractor Payroll". The Title for the Prime Contractor payrolls should consist of the Prime Contractor's name and the payroll week ending date (YYYYMMDD). The Title for the Sub-Contractor payrolls should consist of the Sub-Contractor's name and the payroll week ending date (YYYYMMDD). Example: the title for Prime Contractor ABC for payroll weekend ending January 30, 2019 is "ABC 20190130". The title for Sub-Contractor XYZ for the same week is "XYZ 20190130"

(d) Posting. Post a notice(s) in the manner and form prescribed by the current regulations of the State Department of Labor and Industry. This notice is to be clearly legible and to be placed in a prominent and easily accessible place at the project site under contract, as well as at places where employees are paid their wages.

(e) Records and Inspection. Keep accurate records of employment and wage payments, including all the information required by the regulations of the State Department of Labor and Industry implementing the State Prevailing Wage Act, as amended. Keep time cards of employees, as required by the cited regulations and act. In addition, keep the original signed indentures for each apprentice and the approvals of the Pennsylvania Apprenticeship and Training Council. Preserve the records for 2 years from the date of payment and keep open at all reasonable hours, for inspection by the Department and by the State Secretary of Labor and Industry. Make these records easily accessible within the State within a period of 7 days from the date on which the State Secretary of Labor and Industry requests in writing that such records be made available. For the purpose of such inspection, furnish the authorized inspectors of the Department every assistance in determining the wages paid in compliance with the regulations.

(f) Penalties. Failure to comply with the Pennsylvania Prevailing Wage Act and its regulations will result in withholding money due or to become due on the project contract. It will also result in termination of the right to proceed with the project work under contract and/or other penalties prescribed by law.

(g) Federal-Aid Projects. All Federal-Aid Projects are subject to the implementing rules and regulations of the various Federal departments. Accordingly, the contract provisions and the penalties prescribed for their violations, both of which are required to be incorporated verbatim in all contracts for such Federal-Aid Projects, will be set forth in the proposal and the contract applicable to each project.

107.23 HAULING RESTRICTIONS—

(a) General. Accept responsibility for all hauling done on the project and on adjacent highways, in connection with the contract. Hauling restrictions on highways will be according to the applicable sections of the Pennsylvania Vehicle Code, Act of 1976, No. 81.

Before submission of the bid, if truck delivery of long bridge members (in excess of 70 feet) is contemplated, obtain, in writing, a determination if a Department's hauling permit can be issued for the routing from the proposed source(s) of supply to the project.

Without written permission, do not move and/or operate heavy-duty construction grading and hauling equipment over existing or new pavements, subbase, base and surface courses, and structures which will remain in service.

No special permits will be required for the transfer of oversize or overweight equipment or vehicles from one work area to another work area within the project limits. However, correct any damage caused by the transfer of equipment or vehicles.

If, in special cases, further restrictions are necessary, such restrictions will be indicated and/or specified in the proposal.

(b) Weight Limits and Weighing.

1. Do not operate on public highways any vehicles which are in excess of the registered, gross, and/or axle weight limits established in Chapter 49 of the Vehicle Code, 75 PA C.S. Chapter 49, or as posted by the Department.

2. Submit to weighing by Department weigh teams when requested. If, as a result of such a weighing, it is determined that a vehicle owned or leased by the Contractor or any Subcontractor has been operated on public highways carrying a weight in excess of the above registered, gross or axle weight limits, the sum of $50 for each 500 pounds or part thereof of such excess weight will be deducted as liquidated damages from money due or to become due. These liquidated damages are attributable to inherent damage to the highway which is not readily ascertainable and do not relieve the Contractor of responsibility to pay ascertainable damage as may be required in other sections of these Specifications.

3. When a weight slip shows that a vehicle delivering material to the project exceeds limits specified in Section 107.23(b), the Contractor will be assessed liquidated damages as specified in Section 107.23(b)2. Weighing by a Department Weigh Team will not be required.

107.24 ACCESSIBILITY OF FIRE HYDRANTS—Make necessary arrangements with the local authorities to provide fire protection at all times. Keep the fire hydrants adjacent to the work readily accessible to fire apparatus and do not place material or other obstructions within 15 feet of any hydrant.

107.25 DISCRIMINATION ON ACCOUNT OF RACE, COLOR, RELIGIOUS CREED, ANCESTRY, SEX, AGE, OR NATIONAL ORIGIN PROHIBITED IN CONNECTION WITH EMPLOYMENT—

(a) General. Do not discriminate against any individual, who is qualified and available to perform the work to which the employment relates, by reason of race, color, religious creed, ancestry, sex, age, or national origin.

(b) Penalties. Failure to comply with the above provisions, prescribed in greater detail in 15 P.S. 7306, and modified by Pennsylvania Human Relations Act 43 P.S. 951, may result in the deduction of money due or to become due for each violation. A second or subsequent violation will result in cancellation or termination of the contract upon which the violation occurred, and forfeiture of all money due or to become due, and other penalties prescribed by law.

(c) Federal-Aid Projects. In addition to the above, the requirements specified in Section 107.22(g) also apply.

107.26 SELECTION OF LABORERS AND MECHANICS—This Section does not apply to projects which are partially or totally financed with Federal funds.

(a) Veteran Preference. In employment on public works, provisions of 51 P.S. 492.1 require a preferential rating, similar to that given to State employees, to any soldier making application for employment and on intended discharge for reduction in force. The word “soldier,” as used in the cited act, means a person who served in the armed forces of the United States or in any official women's organization, during any war or armed conflict in which the United States was engaged, and who has an honorable discharge from such service.

107.27 WATERWAY REGULATIONS AND WATER POLLUTION CONTROL—

(a) Waterway Regulations. Conduct indicated work in waterways, flood plains or their hydrologically connected wetlands according to the requirements of permits or approvals issued by the U.S. Army Corps of Engineers, the U.S. Coast Guard, the DEP, the DCNR, and/or the Pennsylvania Fish and Boat Commission, whichever is applicable. Do not conduct work, including borrowing or wasting material other than indicated, in waterways, floodplains or their hydrologically connected wetlands before obtaining the required permits or approvals.

(b) Water Pollution Control. Comply with all applicable State and Federal laws and regulations preventing the pollution of surface water and ground water resources.

(c) Act 247. According to Act 247, enacted by the General Assembly of the Commonwealth of Pennsylvania and approved by the Governor on October 26, 1972, the statutes, rules, and regulations concerning anti-pollution measures have been enumerated in Appendix C, Designated Special Provision 9. Include in the bid price all costs of complying with the terms of the listed statutes, rules, and regulations. No separate or additional payment will be made for such compliance. In the event that the listed statutes, rules, and regulations are amended, or if new statutes, rules, or regulations become effective, perform all additional and/or extra work deemed necessary, as ordered in writing and directed by the Representative, as specified in Section 110.03.

Determine what local ordinances, if any, will affect the project work. Check for any county, city, borough, or township rules or regulations applicable to the area in which the project is being constructed, and, in addition, for any rules or regulations of other organizations having jurisdiction, such as chambers-of-commerce, planning commissions, industries, or utility companies who have jurisdiction over lands which the project occupies. Include any costs of compliance with local controls in the prices bid, even though documents of such local controlling agencies are not listed herein. No separate or additional payments will be made for complying with existing, amended or new local ordinances, directives, or controls.

107.28 EROSION AND SEDIMENT POLLUTION CONTROL PLANS AND PERMITS—Install and maintain erosion and sediment (E&S) pollution control devices as indicated or submit an alternate plan for accomplishing equal or better temporary and permanent erosion and water pollution control. If an alternate plan is submitted, do not start work until the plan is approved by the County Conservation District and the Department. If a National Pollutant Discharge Elimination System (NPDES) Permit is involved, do not start work until the plan is approved by the DEP or the authorized County Conservation District and the Department. Concrete clean out areas, either contractor designed or indicated within the contract documents, are incidental to the contract items.

When a general or individual NPDES Permit is involved, do not start earth disturbance activities until written acknowledgement is received for the Transferee/Co-Permittee Application form completed as specified in Section 107.02(a). At the preconstruction conference, submit a Preparedness, Prevention and Contingency (PPC) Plan and identify a licensed professional (Professional Engineer, Geologist, Land Surveyor or Landscape Architect) registered in the State and if applicable, their designee to be present onsite and responsible for implementing critical stages of the approved Post Construction Stormwater Management (PCSM) Plan.

Immediately take corrective action, at no expense to the Department, upon notification by the Representative of any noncompliance with the provisions of this section. Failure or refusal to promptly comply with any such notice upon receipt may, at the Department's sole discretion, result in the withholding of payment of estimates for work completed until the requirements of the E&S Plan are met or result in the issuance of a written order stopping all or part of the work until the corrective action has been taken and the requirements of the E&S Plan are met. No claims for any extension of time, costs, or damages arising from, related to, or based upon any such notices of noncompliance or stop orders will be granted, paid, or considered.

If corrective action or noncompliance with the provisions of this section are determined to be a result of design errors or omissions, or a precipitation event exceeding the design storm criteria, any resulting claims for extensions of time, costs or damages arising from, related to, based upon any such notices of noncompliance, or stop work orders, will be resolved in accordance with Section 110.03 with regard to payment and or 108.06 with regard to an extension of time.

Utilize Department, DEP, or other authorized agency's form(s) included in the contract or project permits unless directed otherwise by the Representative, DEP, the County Conservation District or other authorized regulatory agency.

For the purpose of determining compliance with the provisions of this section, "substantial completion" will be considered to have been attained when all of the following project milestones have been reached:

- Either a semi-final or final inspection has been performed, physical work is complete, and an Environmental Commitments and Mitigation Tracking System (ECMTS) Sheet has been executed if applicable to the project.

- Earth disturbance activity has been permanently stabilized and sufficient vegetative growth has been achieved to meet permit conditions (uniform 70% perennial vegetative cover).

- Installation of PCSM Best Management Practices (BMPs) has occurred if applicable. Upon completion of PCSM conversions and facilities, the County Conservation District must approve the removal of all remaining E&S BMPs.

Once a project has reached substantial completion, submit to the Representative a DEP Notice of Termination (NOT) Form ensuring Sections 3 and 5, Appendix B, and Section 4 of the NOT Completeness Review and Fieldwork Checklist are fully executed. The NOT is to be accompanied by required record drawings, the final certification of a licensed professional, and the Contractor's executed portion of the ECMTS Construction Tracking Signature Sheet. The contractor shall include a completed DEP Co-Permittee Liability Release Form with the NOT Form and other necessary documentation required for submission of the NOT.

107.29 THIRD-PARTY LIABILITY—Contracts covered by these specifications are not to be construed for the benefit of any person or political subdivision not a party to this contract, nor will this contract be construed to authorize any person or political subdivision not a party to this contract to maintain a lawsuit on or under this contract.

107.30 SPECIFIC EQUAL EMPLOYMENT OPPORTUNITY RESPONSIBILITIES—This Section only applies to projects which are partially or totally financed with Federal funds.

(a) General.

1. Equal employment opportunity requirements not to discriminate and to take affirmative action to assure equal employment opportunity, as required by Executive Order 11246 and Executive Order 11375, are set forth in Required Contract Provisions (Form FHWA-1273) and these requirements; imposed pursuant to 23 U.S.C. 140, as established by Section 22 of the Federal-Aid Highway Act of 1968. The Equal Opportunity Construction Contract Specifications set forth under 41 CFR 60-43 and the provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. The requirements set forth herein constitute the specific affirmative action requirements for project activities under this contract and supplement the equal employment opportunity requirements set forth in the Required Contract Provisions.

2. Work with the Department and the Federal Government in carrying out equal employment opportunity obligations and in their review of contract activities.

3. Comply with and have subcontractors (not including material suppliers) comply with the following minimum specific requirement activities of equal employment opportunity. The Equal Employment Opportunity Requirements of Executive Order 11246, as set forth in 23 CFR 633, are applicable to material suppliers as well as contractors and subcontractors. Include these requirements in every subcontract of $10,000 or more with such modification of language as is necessary to make them binding on the subcontractor.

(b) Equal Employment Opportunity Policy. Accept as operating policy the following statement which is designed to further the provision of equal employment opportunity to all persons without regard to their race, color, religion, sex, or national origin, and to promote the full realization of equal employment opportunity through positive continuing programs:

It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, or national origin. Such action includes: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, preapprenticeship, and/or on-the-job training.

(c) Equal Employment Opportunity Officer. Designate and make known to the Department contracting officers an equal employment opportunity officer (hereinafter referred to as the EEO Officer) who has the responsibility for and is capable of effectively administering and promoting an active company program of equal employment opportunity and who has been assigned adequate authority and responsibility to do so.

(d) Dissemination of Policy.

1. Make all company staff members related to the project who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, fully cognizant of, and have them implement, the company's equal employment opportunity policy and contractual responsibilities to provide equal employment opportunity in each grade and classification of employment. To ensure that the above agreement is met, take the following actions as a minimum:

1.a Conduct periodic meetings of supervisory and personnel office employees before the start of work and then not less often than once every 6 months, at which time the contract equal employment opportunity policy and its implementation will be reviewed and explained. Have the meetings conducted by the EEO Officer or another knowledgeable company official.

1.b Give all new company supervisory or personnel office employees a thorough indoctrination by the EEO Officer or other knowledgeable company official covering all major aspects of the company's equal employment opportunity obligations within 30 days following their reporting for duty on the project.

1.c Instruct all company personnel who are engaged in direct recruitment for the project by the EEO Officer or appropriate company official in the company procedures for locating and hiring minority group employees.

2. In order to make the equal employment opportunity policy known to all company employees, prospective employees, and potential sources of employees, i.e., schools, employment agencies, labor unions (where appropriate), college placement officers, etc., take the following actions:

2.a Place notices and posters setting forth the equal employment opportunity policy in areas readily accessible to company employees, applicants for employment, and potential employees.

2.b Bring the equal employment opportunity policy and the procedures to implement such policy to the attention of company employees by means of meetings, employee handbooks, or other appropriate means.

(e) Recruitment.

1. When advertising for employees, include in all advertisements for employees the notation: “An Equal Opportunity Employer.” Publish all such advertisements in newspapers or other publications having a large circulation among minority groups in areas from which the project work force would normally be derived.

2. Unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minority group applicants, including, but not limited to, State employment agencies, schools, colleges and minority group organizations. To meet this requirement, through the company EEO Officer, identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority group applicants may be referred to for company employment consideration.

In the event a valid bargaining agreement exists providing for exclusive hiring hall referrals, observe the provisions of that agreement to the extent that the system permits compliance with equal employment opportunity contract provisions. (The U.S. Department of Labor has held that where implementation of such agreements have the effect of discriminating against minorities or women, or obligates the Contractor to do the same, such implementation violates Executive Order 11246, as amended.)

3. Encourage present company employees to refer minority group applicants for employment by posting appropriate notices or bulletins in areas accessible to all such employees. In addition, discuss information and procedures with regard to referring minority group applicants with employees.

(f) Personnel Actions. Establish and administer wages, working conditions, and employee benefits and take personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, without regard to race, color, religion, sex, or national origin. Follow the following procedures:

1. Conduct periodic inspections of the project site to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

2. Periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

3. Periodically review selected personnel actions in depth to determine where there is evidence of discrimination. Where evidence is found, promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, take corrective action to include all affected persons.

4. Promptly investigate all complaints of alleged discrimination made to the company in connection with obligations under this contract, attempt to resolve such complaints, and take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, include in such corrective action such other persons. Upon completion of each investigation, inform every complainant of all of his/her avenues of appeal.

(g) Training and Promotion.

1. Assist in locating, qualifying, and increasing the skills of minority group and women employees, and applicants for employment.

2. Consistent with company work force requirements and as permissible under Federal and State regulations, make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. Where feasible, provide 25% of apprentices or trainees in each occupation in their first year of apprenticeship or training. In the event the Special Provision for Trainees is provided under this contract, this subparagraph will be superseded.

3. Advise employees and applicants for employment of available training programs and entrance requirements for each.

4. Periodically review the training and promotion potential of minority group and women employees and encourage eligible employees to apply for such training and promotion.

(h) Unions. If reliance is made in whole or in part upon unions as a source of employees, use maximum effort to obtain the cooperation of such unions to increase opportunities for minority groups and women within the unions, and to effect referrals by such unions of minority and female employees. Actions either directly or through a contractor's association acting as agent will include the procedures set forth below:

1. Use maximum efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.

2. Use maximum efforts to incorporate an equal employment opportunity clause into each union agreement to the end that such union is contractually bound to refer applicants without regard to their race, color, religion, sex, or national origin.

3. Obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information, so certify to the Department and set forth what efforts have been made to obtain such information.

4. In the event the union is unable to provide a reasonable flow of minority and women referrals within the time limit set forth in the collective bargaining agreement, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, or national origin, making full efforts to obtain qualified and/or qualifiable minority group persons and women. (The U.S. Department of Labor has held that it is no excuse that the union with which the Contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees.) In the event the union referral practice prevents meeting obligations pursuant to Executive Order 11246, as amended, and these requirements, immediately notify the Department.

(i) Subcontracting.

1. Use maximum efforts to solicit bids from and to utilize minority group subcontractors or subcontractors with meaningful minority group and female representation among their employees. Obtain lists of minority-owned construction firms from Department personnel.

2. Use maximum efforts to ensure subcontractor compliance with their equal employment opportunity obligations.

(j) Records and Reports.

1. Keep such records as are necessary to determine compliance with the company's equal employment opportunity obligations. Design the records kept to indicate:

1.a The number of minority and non-minority group members and women employed in each work classification on the project.

1.b The progress and efforts being made in cooperation with unions to increase employment opportunities for minorities and women (applicable only to contractors who rely in whole or in part on unions as a source of their work force).

1.c The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees.

1.d The progress and efforts being made in securing the services of minority group subcontractors or subcontractors with meaningful minority and female representation among their employees.

2. Retain all such records for a period of 3 years following completion of the contract work and make them available at reasonable times and places for inspection by authorized representatives of the Department and the FHWA.

3. Submit to the Department a report each month after construction begins for the duration of the project, indicating the work hours, number of minority, women and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form EO-400, and according to the instructions included thereon. Form PR-1391 is to be submitted annually for the month of July, reflecting personnel figures for the project work force, for the last payroll period preceding the 31st of the month. If on-the-job training is being required by Special Provision for trainees, furnish Form EO-365 for each trainee employed, on a monthly basis, and Form FHWA-1409 semi-annually.

107.31 PUBLIC WORKS EMPLOYMENT VERIFICATION ACT—

(a) General. In accordance with Act 127 of 2012, known as the Public Works Employment Verification Act ("the Act"), effective January 1, 2013, 43 P.S. §§167.1-167.11, use the Federal Government's E-Verify system to ensure that all employees performing work on the project, including subcontractor's employees, are authorized to work in the United States.

(b) Verification Form. Verify the employment eligibility of each new employee hired after January 1, 2013 and submit the Commonwealth Public Works Employment Verification Form (Form), located in the ECMS File Cabinet (in References Tab). If assistance with the Form is needed, contact the ECMS Help Desk at 855-783-8330 or at 717-783-8330. ECMS Help Desk assistance is available 24 hours a day, 7 days a week.

(c) Contractor. Upload the form to ECMS or Email to publicworksform@pa.gov or fax the Form to 717-265-7207, signed by an authorized representative of the Contractor, possessing sufficient knowledge to make the representations and certifications on the Form by 3:00 P.M. prevailing local time within 7 calendar days after the bid opening. When the seventh (7th) calendar day after the bid opening falls on a day that the Department offices are closed, submit the Form by 3:00 P.M. prevailing local time on the next business day. Failure or refusal to provide the

Form will be considered a refusal to comply with bidding requirements, will result in rejection of the bid, and may subject the Contractor to the enforcement activities, sanctions and civil penalties specified in the Act.

(d) Subcontractor. Obtain a form signed by an authorized representative of the subcontractor performing work on the project, possessing sufficient knowledge to make the representations and certifications on the Form. Attach the Form on the Subcontractor Request Screen in ECMS before submitting the request for approval. Failure or refusal to provide the Form will be considered a refusal to comply with subcontractor approval requirements, will result in rejection of the subcontractor request, and may subject the subcontractor to the enforcement activities, sanctions and civil penalties specified in the Act. Include information about the requirements of the Act in all subcontracts.

(e) Department of General Services. The Department of General Services is the Commonwealth agency responsible for enforcement and administration of the Act. Please direct questions about the Act to:

Department of General Services Public Works
Employment Verification Compliance Office
Room 105 Tent Building
18th and Herr Streets
Harrisburg, PA 17125
Fax: 717-214-3669

107.32 USE OF UNITED STATES-FLAG VESSELS—For Federal-Aid contracts, the Contractor is referred to the requirements of Public Law 664 as further specified in Part 381, Title 46, Code of Federal Regulations.

(a) The Contractor Agrees:

1. To use privately owned United States-Flag commercial vessels to ship at least 50% of the gross tonnage involved (computed separately for dry bulk carriers, dry cargo liners, and tankers), whenever shipping any equipment, material, or commodities for this contract, to the extent such vessels are available at fair and reasonable rates for United States-Flag commercial vessels.

2. To furnish within 20 days following the date of loading for shipments originating within the United States or within 30 working days following the date of loading for shipments originating outside the United States, furnish a legible copy of a rated, "on-board" commercial ocean bill-of-lading. Furnish the bill-of-lading in English, for each shipment of cargo described above, to both the Department (through the prime Contractor in the case of subcontractor bills-of-lading) and to the Division of National Cargo, Office of Market Development, Maritime Administration, Washington, D.C. 20590.

3. To insert the substance of the provisions of this clause in all subcontracts issued pursuant to the contract.

SECTION 108—PERFORMANCE AND PROGRESS

108.01 SUBLETTING OR ASSIGNMENT OF CONTRACTS—

(a) General. Do not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion or rights, title, or interest, without the written consent of the Representative.

If consent is given, subletting a portion of the contract will be allowed; however, do not sublet a portion exceeding 50% of the original total contract price except as provided herein.

Use only prequalified subcontractors, classified for the type of work undertaken and not exceeding their assigned maximum capacity rating.

For prequalification capacity evaluation, the amount of subcontracted work will be charged solely to the subcontractor when the subcontractor and items of work to be undertaken are named in the bid and to both the prime contractor and the subcontractor when the subcontractor is named after the award of the contract.

Do not replace or cancel a subcontractor named in the bid without the approval of the Representative, which approval will not be unreasonably withheld.

Subcontracts or transfer of contract will not release Contractor liability under the contracts and bonds.

(b) Specialty Items. "Specialty Items," as identified in the proposal, may be performed by subcontract. The cost of any specialty items performed by subcontract may be deducted from the original total contract price before computing the amount of work allowed to be performed by subcontract.

(c) Disadvantaged Business Enterprises (DBE). For Federal-Aid contracts when requirements for DBE are included in the proposal, the cost indicated on the approved Minority Participation and Commitment in ECMS for DBE's utilization may be deducted from the original total contract price before computing the amount of work allowed to be performed by subcontract, provided the request to Perform Less Than 50% of Work Items has been submitted with the Minority Participation and Commitment submission. In cases where specialty items and DBE involvement overlap, any cost deducted is restricted to a single assignment of either specialty item or DBE goal amount, but not both. The maximum amount of the DBE cost that may be deducted is equal to 40% times the difference between the original total contract price and the specialty items' cost.

(d) Diverse Businesses (DB). For contracts financed with other than Federal funds when requirements for DB are included in the proposal, the cost of the Agreement Amount indicated on the approved Minority Participation and Commitment in ECMS for DB's utilization may be deducted from the original total contract price before computing the amount of work allowed to be performed by subcontract, provided the request to Perform Less Than 50% of Work Items has been submitted with the Minority Participation Commitment submission. In cases where specialty items and DB involvement overlap, any cost deducted is restricted to a single assignment of either specialty item or DB agreement amount, but not both. The maximum amount of the DB cost that may be deducted is equal to 40% times the difference between the original total contract price and the specialty items' cost.

(e) Subcontract Approval. Do not allow any work on the project that is assigned to others (including services) to be performed until a copy of the executed subcontract (agreement or any other assignment of the contract) has been reviewed and is available on the project to Department representatives for purposes of monitoring contract compliance. The Department will verify that the subcontract is evidenced in writing and that all pertinent provisions and requirements of the prime contract are physically incorporated or included by reference. It should be noted that the allowance for pertinent provisions to be included in a subcontract by reference does not apply to the provision entitled "FAR—Required Contract Provisions Federal-Aid Construction Contracts" (Form FHWA-1273/DSP8), which must be physically incorporated into all related subcontract agreements of $10,000 or more with the exception of material supply, engineering, or architectural service contracts. All firms listed on the approved Minority Participation and Commitment, including those business types other than subcontractor, must be submitted for subcontractor approval after the contract is executed.

108.02 NOTICE TO PROCEED—As soon as practical after approval of the contracts, bonds, and insurance certificates by the Chief Counsel, the General Counsel, or the Attorney General, or their respective designees, and subject to the provisions as specified in Section 103.07, a written Notice to Proceed will be sent, specifying the calendar date on which to begin the work.

(a) Requirements for Starting Work. Begin work on the Notice to Proceed Date specified in the Notice to Proceed and complete all physical work, including any authorized additional or extra work, on or before the Required Completion Date.

(b) Notice to Proceed Period. The Notice to Proceed will be issued on or before the Anticipated Notice to Proceed or within 30 days after the award of the contract, whichever is later. Extension(s) of the 30-day period will be made only by mutual written consent of the parties to the contract provided such written consent is given before the expiration of the 30-day period.

108.03 PERFORMANCE AND PROGRESS—

(a) Preconstruction Conference. Before the anticipated Notice to Proceed Date, a preconstruction conference will be held in the District office. The purpose of this conference will be to discuss the scope of the project work, to discuss all essential matters pertaining to the satisfactory project completion, and to resolve any questions regarding contract interpretation and/or contract time.

Submit the following to the Representative at the Preconstruction Conference:

- List containing names of the project superintendent, project engineer, foremen, surveyor and construction scheduling coordinator
- Names, titles, and contact information of the selected individuals required to complete Form CS-8 (Issue Escalation Matrix)
- Forms CS-200 (Source of Supply – Materials) and Form CS-201(Source of Supply – Traffic Control Devices)
- Work Plan (60 Calendar Day for Critical Path Method (CPM) and 60 Calendar Day for Resource Loaded CPM contracts)

Failure to submit the above documentation may result in the actual Notice to Proceed Date being after the anticipated Notice to Proceed Date in the proposal, but will not qualify for an extension of contract time.

If a preconstruction conference is not held before the anticipated Notice to Proceed Date in the proposal, an extension of contract time may be granted, provided the requirements as specified in Section 108.06(a) have been met (i.e., the extension is supported by the Construction Schedule and it can be demonstrated that progress on one or more controlling operations has been adversely affected by the Department's failure to comply with the requirements of this section).

(b) Construction Project Scheduling. Prepare a complete Schedule that adheres to and incorporates all contract time requirements, shows work being completed on or before the Required Completion Date, meets specified Milestone Date(s), and is in compliance with all contractual requirements. For Design/Build or Partial Design/Build Projects, include design activities associated with the Design/Build elements as well as the review and approval durations as specified in the contract provisions.

The Representative may require that the Contractor attend a scheduling conference for the purpose of reviewing this specification and the applicable portions of Section 689 that pertain to the scheduling format indicated for the project (i.e., Narrative, CPM, or Resource Loaded CPM). This scheduling conference may be held in conjunction with the Preconstruction Conference. Be prepared to discuss the concepts and logic to be used in sequencing work activities for development of the construction Schedule.

Acceptance of the Contractor's Schedule or any revision(s) thereto, by the Department, will not constitute the Department's approval of or agreement with the sequence of operations, the durations of activities, the adequacy or propriety of resources, the identity of controlling operations, nor the feasibility or any other characteristics of the Schedule or its revisions.

Show the sequence and interdependence of activities for completion of all work. Consider and make appropriate scheduling and operational allowances, including but not limited to, seasonal weather conditions and ambient temperatures, permitting requirements, plant establishment periods, traffic signal testing periods, Intelligent Transportation System equipment-related testing periods, pavement marking retro-reflectivity testing, Maintenance and Protection of Traffic restriction periods, and asphalt pavement restriction periods.

Incorporate in the Schedule coordination with all entities (subcontractors, utilities, railroads, etc.) and adjacent or private contracts that could impact the Schedule. Utility coordination as specified in the contract documents must be

interdependently specified within the Construction Schedule. All Utility entities will be incorporated into the Construction Schedule to define the interdependencies with all Construction Activities. In addition to construction activities, include in the Schedule, the procurement, fabrication, and delivery of critical or special materials and equipment, and indicate relationships between activities.

Schedule updates are required at minimum on a monthly basis.

1. Construction Scheduling Coordinator. Have the individual responsible for supervising the work, as specified in Section 105.05(a), serve as the Construction Scheduling Coordinator or be responsible for and oversee all activities of the Construction Scheduling Coordinator.

2. Project Control Meetings. Project control meetings will be held on an as needed basis, as directed. During project control meetings, the Representative and the Contractor's superintendent will conduct a site visit and jointly review project progress. Submit, 2 working days before each project control meeting, a written report, in an acceptable format, that includes the following:

- Progress of project design and construction activities.
- Impacts on the current Schedule.
- Planned progress for the next 2 weeks.
- Other Schedule-related information, as required.

3. Submittals. Prioritize and schedule submissions to allow sufficient time for Department review. Make submissions at least 21 calendar days before information is needed for purchasing, fabricating material, or obtaining equipment, unless otherwise indicated or directed. The 21-calendar day review period will begin on the date the Representative receives the submission. Any delays caused by incomplete submissions, including drawings and designs, will be the responsibility of the Contractor.

4. Adjustment of Required Completion Date or Specified Milestone Date(s). If a request for a time extension is approved or a time reduction processed, the Department will use the changed Required Completion Date and/or Milestone Date(s) for the purpose of monitoring progress, assigning resources, authorizing additional and/or extra work, processing contract adjustments associated with incentive/disincentive clauses, and assessing liquidated damages. Contractor imposed dates in the Schedule; other than the Required Completion Date, specified Milestone Date(s), and/or any contractually specified sequences; will not be binding on the Department.

5. Recovery. If the latest completion time for any work on the current Schedule results in a controlling activity being delayed 14 days or more beyond the Required Completion Date or any specified Milestone Date(s), as adjusted, the Representative may require the Contractor to submit a written description of the plan to recover all lost time and maintain the Required Completion Date or specified Milestone Date(s) including affected activities (with explanations for delays or duration variance from the original accepted baseline). If required, submit the written recovery plan within 7 calendar days of notification by the Representative.

If the order of project operations is changed to the extent that the Contractor is no longer following the accepted Schedule, the Representative may require that a recovery schedule be submitted. The revision to the schedule must include the Asta Powerproject (.pp) recovery schedule, a narrative recovery plan including what has changed and an explanation as to why it has changed, and a Portable Document Format (PDF) of the recovery schedule, submitted through the PennDOT Project Collaboration Center (PPCC). If the recovery plan and/or recovery schedule is not received within 14 calendar days from the date of the request by the Representative, the District Executive may withhold current estimate payments until the required information has been submitted and accepted.

6. Updates. Submit updates to the Schedule monthly on or before the date agreed to by the Department, unless otherwise specified. If any Update is not received within 7 calendar days from the agreed upon date, the District Executive may withhold current estimate payments until all requested schedule updates are received and accepted.

(c) PennDOT Project Collaboration Center (PPCC**).** Submit all project-related documentation, as required or indicated, using PPCC. Coordinate with the Department to obtain access for necessary parties to PPCC. The Department's standard file format is PDF. The Department may require documentation to be submitted in other

compatible electronic file formats.

108.04 LIMITATION OF OPERATIONS—

(a) Maintenance of Traffic. Conduct the work in a manner and sequence that assures minimal interference to traffic.

(b) Completion of Sections of Project. Complete any designated section or sections of the project as indicated; as specified; or when directed, in writing, as specified in Section 107.15.

The Contractor will be relieved of responsibility for further physical work and maintenance only for work items within the section of the project which are satisfactorily completed at the time of, or subsequent to, opening of the section to traffic. The Contractor's responsibility for further physical work and maintenance remains for work items within the section of the project which are not satisfactorily completed at the time of, or subsequent to, opening of the section to traffic.

Release of Contractor responsibility is further contingent on the following:

- a final inspection of the section has been made as specified in Section 110.08(a);
- the Contractor's obligation under the contract to replace defective work or material is not relieved;
- the Contractor's responsibility for repairing any damage to satisfactorily completed work items within the section, which occurs due to construction operations, is not relieved; and
- any work done by the Department, on a designated section of the project that may have been satisfactorily completed, as provided, does not waive the rights of either party to the entire contract.

(c) Maintenance of Existing Vegetation. In order to maintain natural vegetation in all undisturbed areas, do not cross these areas with construction equipment or make any other use of these areas, except at allowed locations.

108.05 CHARACTER OF WORKERS; METHODS AND EQUIPMENT—

(a) General. Employ at all times sufficient labor and equipment for performing the work, as specified in Section 108.03.

(b) Competence of Workers. Employ only competent and efficient superintendents, forepersons, clerks, timekeepers, equipment operators, laborers, mechanics, or artisans for every kind of work. Whenever, in the Representative's opinion, any person is unfit to perform the task, does the work contrary to instructions, or exhibits improper conduct, discharge the person immediately and do not employ the person again on the project without written permission of the Representative. Failure to remove such person, as ordered, or failure to furnish suitable and sufficient personnel for the proper completion of the work, after being ordered to correct the deficiency, may result in suspension of the work, by written notice from the District Executive, until such orders are followed.

If the superintendent or representative on the project fails to cooperate with the Department's authorized representatives in any way, the District Executive will give a written order for dismissal and replacement of that superintendent or representative.

(c) Equipment. Furnish the type, condition, and quantity of equipment that meets the qualifications necessary for the proper execution of the work within the specified contract time. Maintain the equipment in good condition, subject to acceptance, before and during use in connection with the project. If special equipment, not normally used in highway construction, is required to be used, comply with Section 108.05(c)2.

1. Alternate Method and/or Equipment. If the contract specifies that construction be performed by the use of certain methods and equipment, use such methods or equipment, unless others are authorized. To use a method or type of equipment other than those specified, request authority to do so. Provide the request in writing and include a full description of the methods and equipment proposed to be used, with an explanation of the reasons for desiring to make the change. If acceptance is given, it will be on condition that construction work is performed in conformity with contract requirements. If, after trial use of the substituted methods of equipment, it is determined that the work produced does not conform to the contract requirements, discontinue the use of the substitute method or equipment.

Complete the remaining construction with the specified methods and equipment. Remove the deficient work and replace it with work of specified quality, or take such other corrective action, as directed. No change will be made in the basis of payment for the construction items involved, nor in contract time, as a result of authorizing a change in methods or equipment under these provisions.

2. Test of New Special Equipment. A vendor or manufacturer of equipment not currently used may submit the necessary technical data concerning the item to the LTS. If the item warrants further investigation, the LTS may grant permission to the vendor to contact a contractor for the experimental use of the equipment on an appropriate project under construction. The experimental operation will be observed by representatives of the LTS and the District Executive's office, to obtain data necessary to substantiate a final recommendation to the Department.

3. Roller Requirements. Provide rollers, of the type(s) specified for the various items of construction, complying with the following:

3.a Three-wheel power rollers, with an unballasted load of not less than 300 pounds per linear inch of tread of rear wheels, having a manufacturer's certified metal weight of not less than 10 tons.

3.b Tandem power-driven rollers, with a ballasted load of not less than 330 pounds per linear inch of tread of drive roll, having a manufacturer's certified metal weight of not less than 10 tons.

3.c Tandem power-driven rollers, with a load of not less than 120 pounds per linear inch of tread of drive roll, having a manufacturer's certified metal weight of either not less than 5 tons or more than 8 tons or either not less than 8 tons or more than 10 tons.

3.d Self-propelled trench-type rollers, with a minimum trench roller factor (RF_t) of 2.0 using the following equation:

$$RF_t = (F_c*(f*A)^2)/(W_d*650)$$

where,
RF_t = Trench roller factor (dim)
F_c = Maximum centrifugal force (lb)
f = Minimum vibration frequency (Hz)
A = Maximum vibration amplitude (in)
W_d = Drum width (in)

Trench-type rollers may be hand operated or remotely controlled. Use trench rollers capable of being operated in both static and vibratory modes. Roller drums must have alternating rows of raised pads across the entire drum width and be equipped with scraper bars at each drum to assist in removal of soil from between the pads. Smooth steel drums are prohibited.

Supply manufacturer’s technical data, measured data, and the serial number for the specific trench roller being used to the Representative before beginning compaction operations. Verify that the roller meets the minimum requirements. Equipment that does not meet the minimum requirements will be rejected. Operate equipment in accordance with manufacturer’s recommendations and at a frequency and amplitude to provide the minimum required RF_t.

3.e Pneumatic-tire rollers, used to compact base courses, may be either single or multiple-axle type and may be equipped with pneumatic tires of equal size and diameter on any one axle. Uniformly inflate tires so that air pressure does not vary more than 5 pounds per square inch. Use rollers of sufficient weight and dimensions that, when loaded, will cause the pneumatic tire wheels to exert a ground pressure of not less than 300 pounds per inch of width of tread, as measured on a hard surface.

3.f Pneumatic-tire rollers, used to compact hot asphalt mixtures of a self-propelled type. Use rollers having not less than seven wheels mounting smooth tread pneumatic tires, not less than 7 1/2 inch by 15 inch size, each tire capable of exerting an average contact pressure through a range from 60 pounds per square inch to 95 pounds per square inch. Use rollers with wheels equally spaced along both axles and so arranged that those on one axle track midway between those of the other, with the wheels on one or both axles arranged to oscillate in pairs or to be

individually sprung.

Use rollers equipped with power steering and fluid drive or a torque converter, capable of turning or reversing on the hot material without surface scuffing or displacement, and provided with means of wetting and cleaning the tires during operation, to prevent adhesion of hot asphalt mixture to the tires.

Make provision for checking tire pressures during operation. Keep the tires uniformly inflated at the designated pressure and with the difference in pressure between any two tires not to exceed 5 pounds per square inch.

In operation, adjust the tire pressure and wheel load, as required, to provide an average contact pressure of from 60 pounds per square inch to 95 pounds per square inch over the surface, to conform to the requirements of both the particular application and the material being compacted.

Equip the roller with means of adjusting the wheel load by ballasting and provide tires with a ply-rating that supports the maximum operating wheel load, at the specified maximum contact pressure.

Furnish copies of the roller manufacturer's charts or tabulations, showing the contact areas and average contact pressures for the full range of both tire inflation pressures and tire loadings for each type and size of compactor tire furnished. Also, furnish copies of the calibration table or chart for the ballast box, showing both the volume of the box in cubic feet, for at least each 3-inch increment of depth, and the empty or tare weight of the roller.

3.g Padfoot rollers with a minimum pad contact pressure of 160 pounds per square inch, a flat pad contact surface with a minimum pad contact area of 15 square inches, and a minimum pad projection of 3.0 inches from the surface of the drum. Calculate pad contact pressure by dividing the static roller weight by the product of the maximum number of pads sighting across the roller drum and the pad contact area.

Use padfoot rollers capable of being operated in both static and vibratory modes. Roller drums must have alternating rows of raised pads across the entire drum width and be equipped with a scraper bar(s) to assist in removal of soil from between the pads.

Supply manufacturer’s technical data, measured data, and the serial number for the specific padfoot roller being used to the Representative before beginning compaction operations. Verify that the roller meets the minimum requirements. Padfoot rollers that do not meet the minimum requirements will be rejected.

3.h Smooth drum tandem vibratory rollers of a self-propelled type, with the necessary frequency and amplitude to achieve required density without objectionable undulations, material pickup, or other surface defects. Use a vibrator drive that automatically stops when the roller changes direction or stops.

3.i Smooth single-drum vibratory rollers of a self-propelled type, with a minimum drum width (W_d) of 48 inches and a minimum vibratory roller factor (RF_y) of 2.0 using the following equation:

$$RF_v = (F_c*(f*A)^2)/(W_d*1{,}000)$$

where,
RF_v = Vibratory roller factor (dim)
F_c = Maximum centrifugal force (lb)
f = Minimum vibration frequency (Hz)
A = Maximum vibration amplitude (in)
W_d = Drum width (in)

The vibratory rollers must be capable of achieving the required density without objectionable undulations, material pickup, or other surface defects. Use a vibrator drive that automatically stops when the roller changes direction or stops.

4. Other Compaction Equipment. Permission may be given for the use of other types of impact vibratory, and/or compaction equipment designed for, and capable of accomplishing, compaction. Specific minimum requirements for various types of lightweight and/or hand-operated compaction equipment are provided below.

Supply manufacturer’s technical data, measured data, and the serial number for the specific compactor being used to the Representative before beginning compaction operations. Verify that the compaction equipment meets the minimum requirements. Equipment that does not meet the minimum requirements will be rejected.

4.a Hand operated impact rammer (jumping jack) with a minimum required impact rammer factor (RF_i) of 2.0 using the following equation:

$RF_i = (w_o*(f*A)^2)/(W_p*L_p*400)$

where,
RF_i = Impact rammer factor (dim)
w_o = Operating weight (lb)
f = Percussion rate or frequency (Hz)
A = Rammer stroke or amplitude (in)
W_p = Rammer plate width (in)
L_p = Rammer plate length (in)

The rammer plate length and width must be reported as the actual dimensions of the plate. Verify that the plate dimensions reported on the manufacturer's technical data sheet are correct for the actual impact rammer being used. Use rammer plates constructed of steel. Plastic, rubber, or wood rammer plates are prohibited. Operate equipment in accordance with manufacturer's recommendations and at a percussion rate and stroke to provide the minimum required RF_i.

4.b Hand operated vibratory plate compactor with a minimum required plate factor (PF_v) of 2.0 using the following equation:

$PF_v = (F_c*(f*A)^2)/(A_p*100)$

where,
PF_v = Vibratory plate factor (dim)
F_c = Maximum centrifugal force (lb)
f = Minimum vibration frequency (Hz)
A = Maximum vibration amplitude (in)
A_p = Effective plate area (in^2)

The effective plate area must be reported as the actual area of the bottom surface of the plate in contact with the ground when placed on a firm surface. Verify the effective plate area in the presence of the Representative. Use vibratory plates constructed of steel. Plastic, rubber, or wood plates are prohibited. Operate equipment in accordance with manufacturer's recommendations and at a frequency and amplitude to provide the minimum required RF_v.

5. Material Transfer Vehicle (MTV). For RPS pavements or when specified in a special provision, provide a Material Transfer Vehicle (MTV) to be used as an intermediate and separate motorized, self-propelled unit between the haul vehicle and the asphalt paver as follows:

- Provide adequate covers of sufficient size to protect the material in the MTV, under all conditions.
- Capable of transferring the material from the haul vehicle to the paver hopper at a uniform and continuous rate to allow the continuous movement of the paver.
- Equipped with remixing augers for remixing the asphalt material before transferring to the paver hopper.
- Free of petroleum oils, solvents, or other material, which adversely affect asphalt concrete.

In addition, equip the asphalt paver with a manufactured hopper insert to provide a mass flow of material directly to the slat conveyors of the paver. Deliver mixture through the MTV at the correct laying temperature as specified in Section 413.2(e) Table A or Section 413.2(e) Table A, and free from lumps of chilled material.

6. Cranes. Crane operators must hold a valid Crane Operator's license for the Commonwealth for the size and type of crane to be used. Before performing work with a crane, submit a copy of the operator's license to the Representative. In addition, one on-site meeting must be held with the crane operator(s) to discuss safety and crane type(s), size(s), location(s) and movements. For projects that require an erection plan or pre-erection meeting or both, ensure that the crane operators are in attendance at the meeting and invite the Structure Control Engineer to the

meeting. If the crane operator cannot attend the meeting, a representative from the crane company must be in attendance. Remediate possible mat shifts and correct possible conflicts observed with the operation.

108.06 TIME EXTENSIONS AND REDUCTIONS—

(a) Time Extensions. An extension of the Required Completion Date and/or a specified Milestone Date(s) may be granted by the Department as a result of any of the events or occurrences identified herein. If an event or occurrence qualifies for an extension of contract time, and the extension is supported by the Construction Schedule after the impact of the event or occurrence is incorporated, submit an official time extension request to the Representative early enough so that it can be evaluated and decided upon by the Department in time to avoid any constructive acceleration of the work, but no later than 30 calendar days after the "termination" of the event or occurrence, as specified herein. Submit time extension requests electronically, using ECMS. Include a combined PDF of the Supporting Schedules with each request, at no additional cost to the Department. The Supporting Schedules are to include: a pre-impact schedule, which is the accepted schedule in place prior to the impact, and a post-impact schedule, which shows the impact of the specific event or occurrence on the Required Completion Date and/or specified Milestone Date(s) on the accepted schedule in place at the time of the event or occurrence. Along with submitting the combined PDF of the Supporting Schedules in ECMS, the electronic Asta Powerproject (.pp) files are to be submitted to the Representative outside of ECMS (via the PPCC). The Representative will respond to all time extension requests within 14 calendar days of receipt. Time extension requests that are not submitted within the specified time and/or do not include all of the required supporting information, including Supporting Schedules, will not be approved. If, after reviewing the Contractor's initial time extension request, the Representative determines that the supporting information provided is incomplete or inadequate, notification of the deficiency will be sent to the Contractor. Complete or revise the time extension request, as indicated, and resubmit within 10 calendar days of receipt of the Representative's notification. Revised time extension requests that are not resubmitted within the specified time will not be approved. If a time extension request is disapproved by the Department, liquidated damages may be chargeable.

The following events or occurrences may qualify for an extension of the Required Completion Date and/or a specified Milestone Date(s):

- A Notice to Proceed is issued indicating that the actual Notice to Proceed Date will be after the anticipated Notice to Proceed Date in the proposal, through no fault of the Contractor. A time extension will only be granted for such an occurrence if it is requested by the Contractor within 30 calendar days after the date of Department acceptance of the initial Construction Schedule.

- Progress on one or more controlling operations is adversely affected by impacts from Utility Infrastructure and Utility Adjustments as specified in Section 105.06. Submit a time extension request within 30 calendar days after the date all utility infrastructure and utility adjustments impacting the Contractor's operations are completed.

- Satisfactory project completion requires work in greater quantities than those indicated in the contract, and progress on one or more controlling operations is adversely affected by the item plan quantity overruns. Submit a time extension request within 30 calendar days after the date the overrun quantity of work under the applicable item(s) is completed.

- The District Executive, in writing, authorizes the elimination of an item(s) of work or a reduction in quantity for an item(s) of work, and progress on one or more controlling operations is adversely affected by the elimination(s)/reductions(s). Submit a time extension request within 30 calendar days after the date of receipt of the District Executive's initial, itemized, written authorization for the work item elimination(s)/quantity reduction(s).

- The District Executive, in writing, authorizes additional and/or extra work, which affects progress on one or more controlling operations. Submit a time extension request within 30 calendar days after the date the prices to be paid for all authorized additional work and/or extra work at a negotiated price are agreed upon and, when applicable, accepted by the Department, or, if authorized extra work is to be paid on a force account basis, within 30 calendar days after the date the force account work is completed.

- A strike or labor dispute that causes, despite all reasonable efforts by the Contractor to avoid it, a shutdown of the entire project or of one or more controlling operations, as specified in Section 108.10. Submit a time extension request within 30 calendar days after the date the strike or labor dispute ends.

- Progress on one or more controlling operations is adversely affected by the delayed action or failure to act of an agency other than the Department that is not the fault of the Contractor, all of which will be determined by the Representative. Submit a time extension request within 30 calendar days after the date all issues involving the agency's delay or failure are resolved.

- Progress on one or more controlling operations is adversely affected by an act or omission of the Department that is not the fault of the Contractor, all of which will be determined by the Representative. Submit a time extension request within 30 calendar days after the date all issues involving the Department's act or omission are resolved.

Events or occurrences that do not qualify for an extension of the Required Completion Date and/or a specified Milestone Date(s) include, but are not limited to, weather delays, the removal and replacement of defective work, and the reseeding of areas where specified growth coverage and/or germination time requirements have not been met.

Weather-related events warranting an emergency declaration by the Federal Government or by the Government of the Commonwealth of Pennsylvania may qualify for an extension of contract time provided it can be clearly established that the delay to the project for which a time extension is sought is not, in fact, the responsibility of the Contractor, and that the Contractor has taken all necessary precautions to protect the project from damage, as required. Furthermore, the Secretary of Transportation, or an authorized delegate, must determine, following an emergency declaration, that the emergency conditions had a direct adverse impact on one or more active construction projects. Finally, for a given project to qualify, the accepted Schedule in place at the time of the weather-related event giving rise to the emergency declaration must show work on one or more controlling operations occurring during the period in which the weather-related event took place.

1. Dispute Resolution. If a request for an extension of the Required Completion Date and/or a specified Milestone Date(s), supported by documentation prepared using the appropriate scheduling tool, is not approved by the Department or is approved for a number of days that is less than the number of days originally requested, and the Contractor wishes to dispute the Department's decision, submit a written request for a re-evaluation of the time extension request, to the District Executive, within 7 calendar days after the date the Department takes action on the request within ECMS. Notification of the District Executive's final determination regarding the time extension request will be provided within 7 calendar days of receipt of the Contractor's written, re-evaluation request.

(b) Time Reductions. A reduction of contract time affecting the Required Completion Date and/or a specified Milestone Date(s) may be processed by the Department as a result of any of the events or occurrences identified herein. On a case-by-case basis, before any reduction of contract time is processed in response to a qualifying event or occurrence, the Department, in consultation with the Contractor, will assess whether such an action is warranted (i.e. necessary for proper and equitable administration of the contract and supported by the Construction Schedule after the impact of the event or occurrence is incorporated). If a qualified event or occurrence is found to warrant a reduction of contract time, an official time reduction will be prepared, by the Representative, within 30 calendar days after the "termination "of the event or occurrence, as specified herein. Reductions of contract time will be processed electronically, using ECMS, and a combined PDF of the Supporting Schedules will be included as a support for the number of reduction days. The Supporting Schedules will be prepared by the Contractor, at no additional cost to the Department, and include: the accepted schedule in place at the time of the impact, and impact of the specific event or occurrence on the Required Completion Date and/or specified Milestone Date(s) using the accepted Schedule in place at the time of the event or occurrence. Notification of the Representative's processing of a time reduction will be sent to the Contractor. Within 10 calendar days of receipt of this notification, use ECMS to provide the requested disposition information (i.e. indicate agreement or disagreement with the Department's decision to reduce contract time and comment on the action). However, failure to provide the requested information within the specified time will not prevent the Representative from completing the contract time reduction. Along with submitting the combined PDF of the Supporting Schedules in ECMS, the electronic Asta Powerproject (.pp) files should also be submitted to the Representative outside of ECMS (via PPCC).

The following events or occurrences qualify for and may warrant a reduction in contract time affecting the Required Completion Date and/or a specified Milestone Date(s):

- A Notice to Proceed is issued indicating that the actual Notice to Proceed Date will be before the anticipated Notice to Proceed Date in the proposal. A time reduction, if warranted, will be processed within 30 calendar days after the date of Department acceptance of the initial Construction Schedule.

- Satisfactory project completion requires work in lesser quantities than those indicated in the contract, and progress on one or more controlling operations is favorably affected by the item plan quantity underruns. A time reduction, if warranted, will be processed within 30 calendar days after the date all work under the applicable contract item(s) is completed.

- The District Executive, in writing, authorizes the elimination of an item(s) of work or a reduction in quantity for an item(s) of work, and progress on one or more controlling operations is favorably affected by the elimination(s)/reduction(s). A time reduction, if warranted, will be processed within 30 calendar days after the date of submission of the District Executive's initial, itemized, written authorization for the work item elimination(s) / quantity reduction(s).

- The Contractor submits an initial Construction Schedule that shows the Required Completion Date and/or a specified Milestone Date(s) will be earlier than the date(s) indicated in the contract. A time reduction will be processed within 30 calendar days after the date of the Department acceptance of the initial Construction Schedule.

- Progress on one or more controlling operations is favorably affected by an act of the Department. A time reduction, if warranted, will be processed within 30 calendar days after the date notification of the Department's act is submitted to the Contractor.

1. Dispute Resolution. If a reduction of contract time affecting the Required Completion Date and/or a specified Milestone Date(s), supported by documentation prepared using the appropriate scheduling tool, is processed by the Department despite the Contractor's objections or is processed for a number of days that is more than the number of days originally indicated, and the Contractor wishes to dispute the Department's action, submit a written request for a re-evaluation of the reduction of contract time, to the District Executive, within 7 calendar days after the date the District Executive, or a delegate, approved the time reduction within ECMS. Notification of the District Executive's final determination will be provided within 7 calendar days of receipt of the Contractor's written, re-evaluation request.

108.07 LIQUIDATED DAMAGES—

(a) Construction Engineering Liquidated Damages. For each day that any physical work remains uncompleted after the Required Completion Date, the sum per day specified in the following schedule, unless otherwise stated in the proposal, will be deducted from money due or to become due. This deduction will not be as a penalty, but as Construction Engineering Liquidated Damages.

Original Contract Amount		**Schedule of Daily Charges For Construction Engineering Liquidated Damages**
From More Than	To and Including	Per Calendar Day
$ 0	$ 400,000	$ 885
400,000	1,000,000	1,675
1,000,000	5,000,000	2,440
5,000,000	10,000,000	3,755
10,000,000	15,000,000	5,240
15,000,000		6,220

In the event the Contractor is declared in default, as specified in Section 108.08, Construction Engineering Liquidated Damages will be charged as provided by this section. If the total amount chargeable as Construction Engineering Liquidated Damages exceeds the amount payable to the Contractor or the surety, the excess is to be paid to the State by the Contractor or the surety.

(b) Road Users Liquidated Damages. When indicated in the proposal, Road Users Liquidated Damages will be

charged for each day that the roadway is not opened to unrestricted traffic after the specified Milestone Date. The sum per day will be deducted from money due or to become due. This deduction will not be as a penalty, but as Road Users Liquidated Damages.

In the event the contractor is declared in default, as specified in Section 108.08, Road Users Liquidated Damages will be charged in the amount indicated. If the total amount chargeable as Road Users Liquidated Damages exceeds the amount payable to the Contractor or the surety, the excess is to be paid to the State by the Contractor or the surety.

(c) Work Zone Liquidated Damages. A sum of no less than $1,000 per 24 hour period will be charged as work zone liquidated damages for failure to comply with Maintenance and Protection of Traffic requirements and drawings or other contract traffic control requirements. This deduction will not be as a penalty, but as work zone liquidated damages.

(d) Erosion and Sedimentation Control (E&S) Noncompliance Liquidated Damages. Begin work to correct any noncompliance with Section 107.28 (Erosion and Sediment Pollution Control Plans and Permits) within 24 hours of notification by the Representative of the noncompliance. At the time of notification, the Representative will provide the Contractor with a copy of the visual site-inspection report or the report from DEP or their designee or other regulatory agency that identifies the noncompliance.

A sum of $1,500 per 24-hour period will be charged as E&S noncompliance liquidated damages for failure to begin work within 24 hours of notification of noncompliance and for each subsequent 24-hour period until E&S compliance is attained. This deduction will not be as a penalty, but as E&S noncompliance liquidated damages.

The liquidated damages specified in this section are in addition to, and not in derogation of, the contractor's obligation set forth in Section 107.01 to indemnify the State and its representatives against any claim or liability arising from or based on the violation of any law, ordinance, regulation, order, or decree, including violations by Contractor employees, as well as any other obligation that the contractor may have to indemnify or hold the State and its representative harmless.

108.08 DEFAULT AND TERMINATION OF CONTRACT—in the following paragraphs, the word “Contractor” also means the surety, in case of default, and completion of the contract by the surety.

(a) Delay, Neglect, or Default. The Contractor may be declared in default for the following reasons:

- failure to begin work within the time specified in the Notice to Proceed;
- failure to perform the work with sufficient labor, equipment, or material to ensure the completion of the specified work according to the contract terms;
- unsatisfactory performance of the work;
- failure or refusal to remove material, or to repair or remove and replace any work, rejected as defective or unsatisfactory;
- discontinuing work without approval;
- failure to resume work, which has been discontinued, within a reasonable time after notice to do so;
- insolvency or bankruptcy;
- commission of any act of bankruptcy or insolvency;
- making assignment for the benefit of creditors;
- failure or refusal within 10 days after written notice by the Secretary, to make payment or show cause why payment should not be made, of any amounts due for material furnished, labor supplied or performed, for equipment rentals, or for utility services rendered, as covered by the Payment Bond;

- failure to protect, to repair, or to make good any damage or injury to property, as specified in Section 107.12; and
- not performing work in an acceptable manner for any cause.

The Secretary, upon written notice from the District Executive or upon other proof satisfactory to the Secretary, and after having given written notice to the Contractor and the surety of such delay, neglect, or default on the part of the Contractor, will have power and authority, without violating the contract to:

- declare the Contractor in default;
- take the completion of the work out of the hands of the Contractor;
- appropriate or use any or all material and equipment of the Contractor assembled for the project;
- enter into a contract or contracts for the completion of the work, according to the contract; or
- use such other methods that will be expedient for the completion of the contract in a satisfactory manner.

(b) Completion by Surety. The Secretary may elect to take the performance of the work from the Contractor. The Secretary may at that time notify and require the surety to complete the contract according to its terms. Also, require the surety to render within 3 months from the completion certificate date, but before payment on the final certificate, a detailed statement of the costs of the completion of the work, including receipts and disbursements of all funds received and paid on account. However, the responsibility of the surety extends only to the limit of the bond amount.

(c) Completion by Department Forces. The Secretary may elect to take the performance of the work from the Contractor and fulfill the contract with Department forces. At that time and in the State's name, the Secretary may take all right, title and interest in and to the equipment and material owned by the Contractor and assembled for use in the execution of the contract, and may use them for completion.

(d) Settlement of Contract. If the contract completion by any of the methods specified results in financial loss to the State, the Secretary may dispose of any of the remaining equipment and material taken over as specified in Section 108.08(a) or (c), without further legal process and in the manner that may be considered in the State's best interests. Any equipment or material not required for completion or recoupment of loss, or for legal charges against the contract, or any balance remaining from the disposition of material and equipment after deducting losses by the State, or any legal charges against the contract, will be turned over to the party legally or equitably entitled to them.

In the event the contract is completed by Department forces, all proper costs and legal charges incurred by the Department in connection with the contract will be deducted from money due or to become due to the Contractor. The Department will credit the Contractor with the amount realized from the disposal of equipment or material.

If legal charges against the contract and the expense incurred by the Department in connection with contract completion by any of the methods specified, less the credits herein provided for, exceed the sum which would have been payable under the contract for the completed work, the Contractor or the surety are liable to the State for the excess amount.

If such legal charges and expenses are less than the contract value of the completed work, the difference will be paid to the Contractor or such difference may be paid to the surety, in an amount not exceeding the total amount which has been paid by the surety on its obligations under the Performance Bond and the Payment Bond. In this event, the surety is required to furnish evidence satisfactory to the Secretary that such payments have been made and that any balance remaining after payment to the surety will be paid to the Contractor.

(e) Termination Clause. The State may, by written notice, with the approval of the FHWA where applicable, terminate the contract or any portion because of any of the following conditions:

- the Contractor is prevented from proceeding with the construction contract as a direct result of a President's Executive Order with respect to the occurrence of war or in the interest of national defense;

- the State or the Contractor is prevented from proceeding with the construction contract as direct result of an Order of a Court of competent jurisdiction;

- funds necessary for the project completion become unavailable;

- for the Department's convenience, the Department has determined that such termination will be in the State's best interest; or

- all of the work of any controlling operation is delayed for more than 90 consecutive calendar days, for any cause beyond the responsibility of the Contractor. The Secretary may enter into an Agreement with the Contractor or may terminate the contract by written notice to the Contractor. If an agreement is entered into, it will be executed by the Contractor and the Secretary, approved by the Surety and the Chief Counsel, the General Counsel or the Attorney General, or their designees.

When the contract, or any portion is terminated before completion of all items of contract work, payment will be made for each unit of work fully completed at the contract unit price and payment for each partially completed unit of work will be as mutually agreed or at the percentage of the contract unit price that the cost of the partially completed unit is of a fully completed unit with a maximum allowable of 100%. No claim for lost profits or damages of any kind will be allowed for the termination.

Acceptable material, obtained by the Contractor for the work, will be purchased from the Contractor at actual cost, as shown by receipted bills and actual cost records, at such points of delivery as may be designated.

Termination of any portion of the contract does not relieve the Contractor of responsibilities for the completed work, nor will it relieve the surety of its obligation for any claim arising out of the performance of the work.

108.09 NONCOMPLIANCE BY THE CONTRACTOR—In addition to the elective measures the Secretary may take for violation of the contract, as specified in Section 108.08, the Secretary will also have the discretionary right to take any or all of the following actions if the Contractor fails, neglects, or refuses to comply with the requirements specified in Sections 105.03, 107.12, 107.16(c), 110.03(d), or 901:

- The Secretary may shut down the work until the requirements of the violated section are met. In this event, no remission will be made in contract time for the period for which the work is shut down.

- The Secretary may withhold payment of estimates for work completed until the requirements of the violated section are met.

- The Secretary may enter upon the project and perform all work necessary to conform to the requirements of the section violated, then deduct the cost from money due or to become due to the Contractor or the surety. If the Contractor fails to comply with the requirements specified in Sections 107.12 and 107.16(c), the Secretary will not proceed until 48 hours after written notice to the Contractor and the surety that the Secretary will take such action.

- The Secretary has the right to enter upon the project and repair or replace public or private property which has been damaged in violation of Section 107.12, to estimate the amount of such damage, and to deduct the amount from money due or to become due to the Contractor or the surety. When money is deducted as provided, the Secretary will settle with the property owner and secure a written statement, releasing the State and the Contractor from further responsibility for such damage.

108.10 STRIKES OR LABOR DISPUTES—Time extensions will be considered appropriate in the event of a strike or labor dispute which causes, despite all reasonable efforts of the contractor to avoid it, a shutdown of the entire project or of one or more controlling operations, whether the strike or labor dispute involves a union bargaining with the Contractor, a subcontractor, the Department, or third parties. In no event, however, will the Contractor be entitled to any delay costs for labor, material, equipment, or related expenses such as overhead or administrative costs, profit, etc., resulting from the strike or labor dispute, regardless of whether the strike or labor dispute involves a union bargaining with the Contractor, a subcontractor, the Department, or third parties affecting a controlling operation.

SECTION 109—MEASUREMENT OF QUANTITIES

109.01 MEASUREMENT—

(a) Units of Measure. Work performed under this contract will be measured in the following units shown in the Measurement and Payment sections of the Specifications and in the Design Items in the proposal, unless otherwise specified:

- **Lump Sum.** Not measured. Indicates complete construction of the item of work, as specified.
- **Each.** Measured by the number of individual items of work completed.
- **Linear Foot.** Measured parallel to the longitudinal base or foundation upon which items are placed, or along the longitudinal surface of the item.
- (**M. Linear Feet.** 1,000 Linear Feet, to the nearest 0.01 M. feet.)
- **Vertical Foot.** Measured vertically to the nearest 0.1 foot, with a minimum vertical measurement of 1 foot, at each unit.
- **Square Foot, Square Yard.** Measured by a two-dimensional area method on the surface of the item.
- **Cubic Yard.** Measured by a three-dimensional volume method.
- **Acre.** Measured by a two-dimensional area method on the surface to the nearest 0.1 acre**.**
- **Pound.** Measured by actual item net weight (avoirdupois).
- **Ton.** Measured by actual item net weight in short tons consisting of 2,000 pounds, avoirdupois.
- **Gallon.** Measured by actual item liquid volume.
- **M. Gallon.** Measured by actual item liquid volume consisting of 1,000 gallons, to the nearest 0.1 M. gallon.
- (**Foot Board Measure.** Measurement by a three-dimensional method of the actual item lumber board foot.)
- (**M. Feet Board Measure.** 1,000 feet board, to the nearest 0.01 M. feet board.)
- **Set.** Measured as an item unit set, consisting of two or more parts together, as specified.
- **Bag.** Measured as an item unit bag.
- (**Bushel.** Measured by actual item dry measure consisting of 32 quarts.)

(b) General. Measurement will be according to the system of weights and measures recognized by the United States Bureau of Standards. Method of measurement and computation of quantities will conform to generally recognized engineering and construction practice. Computer generated or electronic digital measuring and computing devices are acceptable methods.

A station, when used as a definition or term of measurement, will be 100 linear feet, horizontal measurement.

When required, weigh material on accurate, acceptable scales, using competent, qualified personnel at locations designated. When material is shipped by rail, the car weight may be accepted, if only the actual weight of material is measured. However, car weights will not be acceptable, for material passed through mixing plants. Weigh empty trucks used to haul material measured by weight daily, as directed. Mark each truck with a distinct, legible identification. Trucks may be selected at random and weighed, as directed, to verify the weight of material by weighing the truck empty and loaded on other acceptable scales.

Use acceptable vehicles to haul material to be measured by volume at the delivery point. Use acceptable vehicles of any size or type, provided the actual body contents can be readily and accurately determined. Load vehicles to at least their water level capacity. Level the loads at the delivery point.

If requested, material measured by the cubic yard may be weighed and converted to tons, if approved in writing by the District Executive. Factors to be used for conversion from weight measurement to volume measurement or weight measurement to area measurement will be determined by the Representative and agreed to by the Contractor before using this method of measurement.

Measure asphalt material by the gallon or ton, as indicated. Measure volumes at 60F or correct to volume at 60F, using ASTM D 1250 for asphalts or ASTM D 633 for tars. Net certified scale weights, or weights based on certified volumes for rail shipments, will be used as a measurement basis. Weights will be subject to correction when asphalt material has been lost from the car or by the distributor, wasted, or otherwise not incorporated in the work. If asphalt materials are shipped by truck, the net certified weight or volume, subject to correction for loss or foaming, may be used for computing quantities.

SECTION 110—PAYMENT

110.01 GENERAL—Payment for items of work performed under this contract will be made at the contract price per unit of measure, as specified in Section 109.01 for the item complete in place, or portions thereof. Unless otherwise specified, the contract unit price will cover all costs for materials, labor, and equipment:

- specified, described, or identified in each section of the specifications (including the special provisions and plans);
- identified in each section of the specifications (including the special provisions and plans) as "as required" or "as directed;" or
- allowed under the specifications (including the special provisions and plans) and for which payment is not expressly provided.

In addition to the above, the contract price includes all other costs incurred in performing work on the project (e.g., home office overhead) and all profit. The contract price is accepted as payment in full for all risk, loss, damage, or expense of every kind arising out of the nature of the work or the performance as specified in Section 107.20.

Work specified as "incidental" in the Measurement and Payment section of the specification for a contract item is to be considered as an additional obligation to the other work required for the item(s). This incidental work is not payable directly, but is to be considered included in the contract price for the item(s) of work specified.

Removal and replacement of defective work, as specified in Section 105.12, will not be paid by the Department.

No payment will be made for work in excess of that indicated, shown, or specified, unless otherwise accepted in writing by the Secretary.

Removal of material found in excavation areas and accepted for use, as specified in Section 106.04, will be paid for at the contract unit price for the class of excavation in which it is found. Payment will also be made for the contract bid item in which the excavated material is used.

Work, material, or labor specified for an item will not be measured or paid for again under any other indicated pay items.

110.02 DIFFERING SITE CONDITIONS, SUSPENSIONS OF WORK, AND SIGNIFICANT CHANGES IN THE CHARACTER OF WORK—

(a) General. If differing site conditions, changes in quantities, or alterations of the construction drawings will significantly increase or decrease the cost of performing the work directly affected, perform such work only when authorized in writing, as specified in Section 110.03(a). Payment for such work will be made as specified in Section 110.03.

(b) Differing Site Conditions. During the progress of the work, if subsurface or latent physical conditions, differing materially from those indicated, are encountered at the site, or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work, are encountered at the site, the party discovering such conditions is responsible for promptly notifying the other party, in writing, of the specific differing conditions, before the site is disturbed and before the affected work is performed.

Upon written notification, the Representative will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding loss of anticipated profits, will be made as specified in Section 110.02(a). The Representative will notify the Contractor of the determination whether or not an adjustment of the contract is warranted.

No contract adjustment that results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

No contract adjustment will be allowed under this section for any effects caused on unchanged work.

(c) Suspensions of Work Ordered by the Representative. If the performance of all or any portion of the work is suspended or delayed by the Representative in writing, as specified in Section 107.16(c), for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes

that additional compensation and/or contract time is due as a result of such suspension or delay, submit to the Representative, in writing, a request for adjustment within 7 calendar days of receipt of the notice to resume work. Set forth the reasons, and support for such adjustment, in the request.

Upon receipt, the Representative will evaluate the Contractor's request. If the Representative agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors, and not caused by weather, the Representative will make an adjustment, excluding profit, as specified in Section 110.03 and Section 108.06, as applicable. The Representative will notify the Contractor of the determination whether or not an adjustment of the contract is warranted.

No contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed.

No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded as specified in Section 107.16(c).

(d) Required Changes in the Scope of Work. The Department reserves the right to make, in writing, at any time, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations in the work will neither invalidate the contract or release the surety, and the Contractor agrees to perform the work as changed or altered.

If alterations in the work or changes in quantities do not significantly change the character of the work to be performed under the contract, the work will be paid for at the original contract unit price.

If alterations in the work or changes in quantities significantly change the character of the work under the contract, whether such alterations or changes are in themselves significant changes to the character of the work or by affecting other work cause such other work to become significantly different in character**,** an adjustment, excluding loss of anticipated profits, will be made as specified in Section 110.03. The basis for the adjustment will be agreed upon before the performance of the work. If a basis cannot be agreed upon, the work will be paid for as extra work as specified in Section 110.03.

The term “significant change in character” applies only to the following circumstances:

- If the work as altered differs materially in kind or nature from that involved or included in the original proposed construction, or

- If any major item of work as defined in Section 101 is increased to in excess of 125% or decreased to below 75% of the original contract quantity. Any allowance for an increase in quantity applies only to that portion in excess of 125% of the original contract item quantity or, in case of a decrease below 75%**,** to the actual quantity of work performed.

When a contract item experiences a significant change in character as a result of a decrease to below 75% of the original contract quantity, the actual quantity of work performed may be paid at an adjusted price, as agreed upon with the Contractor and as approved; however, total compensation will not exceed the contract item’s original value. Item value is defined as the original contract quantity multiplied by the contract unit price.

(e) Adjustment of Lump Sum Items. The original contract price for a lump sum item, where quantities and unit prices for component items are designated on a component item schedule submitted as specified in Section 103.01(a), will be adjusted only if differing site conditions, as specified in Section 110.02(b), or changes directed by the Representative will significantly increase or decrease the cost of performing the work. If the Representative determines that conditions materially differ and cause an increase or decrease in the cost or time for performance of the work, or if increases or decreases in quantities are required due to a change directed by the Representative, adjusted payment will be made as specified in Section 110.03.

110.03 ADDITIONAL WORK, EXTRA WORK, AND EXTRA WORK ON A FORCE ACCOUNT BASIS—

(a) General. Work as specified in Sections 104.02 and 104.03 will be paid, if authorized in writing by the District Executive, as additional work, extra work, or extra work on a force account basis. Compensation will be limited to the work authorized in writing and actually performed. Work performed before written authorization will be at the Contractor's risk.

A work order identifying the work to be done and the price to be paid therefore will be processed before or during

the performance of the work. To avoid interrupting the project, written authorization to perform work under this section will be in the form of a letter or other writing from the District Executive, or the Inspector-in-Charge, in writing to the Contractor when confirming an oral authorization of the District Executive, issued within a reasonable length of time.

If the work is to be paid as additional work, the District Executive's writing will refer to the contract price for that work.

If the work is to be paid as extra work and:

- is such that a reasonable price therefore can be negotiated, and
- is such that force account records, if necessary, can be kept by the Department,

the District Executive's writing will authorize commencement of work as extra work. Within 10 calendar days of such authorization, submit a price for the extra work with back-up data to the District Executive for transmittal to the Representative. Pending approval of the price, force account records will be kept as stated below. If the price is accepted, the work will be paid only at the negotiated price, which will not be renegotiated once submitted for acceptance.

If the work is to be paid as extra work and:

- the Contractor and District Executive cannot agree on a tentative price, therefore, and
- the work is such that force account records cannot be kept by the Department,

the District Executive's writing will contain a firm, binding price determined by the District Executive to be fair and equitable for the work to be performed.

If the District Executive and Contractor cannot agree on a tentative price for the extra work and if the work is such that force account records can be kept by the Department, the District Executive's writing will state that such work is to be paid on a force account basis. Force account records will be kept as stated below.

Payment for additional work, extra work, and extra work on a force account basis is accepted as payment in full for all profit and for all equipment, labor, material, field overhead, home office and general administrative expenses, and every other expense incurred as a result of the additional or extra work. No claims for additional compensation of any kind arising out of or relating to such work can be asserted against the Department with the Board of Claims.

(b) Additional Work. This includes only the following:

- work of the type already provided by the contract, and
- work for which there is a contract price.

Perform all such work only when authorized in writing by the District Executive, as stated in Section 110.03(a).

All additional work will be paid at the contract price and in the same manner as if it had been included in the original contract.

(c) Extra Work. This includes only the following:

- work arising from changes specified in Section 110.02 that result in a significant increase or decrease in the cost of performing that work, or
- work, having no quantity and/or price included in the contract, which is determined by the District Executive to be necessary or desirable to complete the project.

Perform all such work only when authorized in writing by the District Executive, as stated in Section 110.03(a). All extra work will be paid only as stated in Section 110.03(a).

(d) Force Account Work. Perform extra work on a force account basis only when directed in writing by the District Executive, as stated in Section 110.03(a).

Upon receipt of written authorization to perform force account work, schedule a meeting with the Representative to discuss any concerns regarding the work itself, as well as expectations regarding reimbursement for the associated costs. Topics of discussion at this meeting should include, but are not limited to, the availability of needed materials or equipment; expectations regarding reimbursement for off-site labor, "show up" time, travel time, and/or paid non-working holidays; payment of standby time for owned equipment; the need to rent equipment; the need for consumables and whether they will be purchased or taken from stock; and the availability of needed subcontractors and the incurring of costs for overnight travel.

The Department will keep records of extra work done on a force account basis. Compare force account records with those kept by the Department, at the end of each day or as directed, to ensure accuracy and obtain concurrence. Report any unresolved disagreements with such records to the Representative. Failure to review the Department's records or to report disagreements with such records will create a presumption that the Department's records are complete and accurate.

Payment for extra work performed on a force account basis will be made, as specified herein, upon completion of the work. Progress payments will be made only when an itemized estimated force account of cost is provided, in writing, within 10 working days after receipt of the Department's written authorization to perform the extra work on a force account basis.

1. Labor. Wages of forepersons; equipment operators; and skilled, semiskilled, and common laborers directly assigned to the specific operation or directly involved in the off-site handling, loading, and transportation of material, equipment, and/or purchased consumables needed specifically for the force account work will be reimbursed, as direct labor, at the actual wage rate and fringe benefit rate paid, for each hour that such employees are engaged in the performance of authorized work and, if directed, overtime as provided for in existing laws, regulations collective bargaining agreements, or other employment contracts generally applicable to the classes of labor employed in the work. The workforce utilized and hours paid for off-site handling, loading, and transportation must be mutually agreed upon as being fair and reasonable given the nature and scope of the force account work.

Additionally, if a labor crew assigned to the force account operation arrives on the job site and is not permitted to perform work of any kind (i.e. contract work, Additional Work, or Extra Work) due to circumstances beyond its control, payment of "show up" time as provided for in an existing collective bargaining agreement or employment contract will be reimbursed as direct labor at the actual wage rate and fringe benefit rate paid. Reimbursement for the payment of reasonable travel time from a central meeting location to the site of the force account work and/or for non-working paid holidays may be made at the actual wage rate and fringe benefit rate paid if it is mutually agreed that such costs are unavoidable and being incurred for the convenience of the Department. Additionally, with regard to reimbursement for non-working paid holidays, the Contractor must show that the payment is required by existing laws, regulations, collective bargaining agreements or other employment contracts, or being made in accordance with an established, written company policy, and that any prerequisite or post requisite work hours were earned completely in the performance of the force account work.

Finally, if a worker in a given labor classification is engaged in the performance of work not of the type typically performed by individuals in that classification, and there is an OSHA requirement for specific Personal Protective Equipment (PPE) to be used by individuals performing such work, the cost of the required PPE will be reimbursed as purchased consumables as specified in Section 110.03(d)5.a.

Indirect labor costs will be paid, without markup, as a percentage of the total base labor cost, as supported by certified payroll records and, when required, a fringe benefit letter. The total base labor cost will be the total amount paid directly to the force account workforce based on the actual wage rate paid each individual worker, which is to include that portion of the worker's fringe benefit rate also paid directly, if any. Any amount paid on behalf of the members of the force account workforce as tax exempt fringe benefits will not be included in the indirect labor cost computation. Allowable indirect labor costs include the following:

- Social Security Tax at the percentage legally required;
- Medicare Tax at the percentage legally required;
- Unemployment Taxes at the estimated effective rate computed as specified below;
- Workers' Compensation Insurance at the rate computed as specified below; and
- Liability Insurance at the current, policy period rate used to account for the cost of applicable Liability Insurance provided as specified in Sections 103.05 and 107.14. Update the liability rate annually in

ECMS prior to the start of each new policy period. The Liability Insurance rate entered into ECMS is to be accompanied by a certification attesting to the fact that the rate being charged for Liability Insurance for force account work does not exceed the applicable, current policy period rate used when determining unit prices for bidding purposes during the policy period. Maintain appropriate records needed to verify the certification for audit purposes, including bid documents, records of all payments, rate computations, and policy statements, in accordance with the provisions of Section 112.C

Contractors and subcontractors are to compute their company's estimated effective rate for unemployment taxes for the current calendar year by dividing total, company-wide, Pennsylvania and Federal Unemployment Tax payments for the prior calendar year by the total wages and salaries reported for applicable employees for the same period. The tax payment, wage, and salary amounts used to compute the estimated effective rate are to be consistent with the information reported on Pennsylvania Unemployment Compensation tax forms filed with the Department of Labor and Industry and on Federal Unemployment Tax returns filed with the Internal Revenue Service. Each employer reports its state and federal unemployment tax payments under a unique account or identification number representing the company and all employees for whom unemployment taxes must be paid. The gross wages and unemployment tax contribution reported on PA Form UC-2 under the employer's PA UC account number, along with the total payments to all employees and FUTA tax liability reported on Form 940 under the company's Employer Identification Number (EIN), are considered company-wide amounts representing all applicable employees for the purpose of computing the company's estimated effective rate for unemployment taxes. A company's estimated effective rate for unemployment taxes is to be updated after April 15 of each calendar year based on the prior calendar year's reported total wages and salaries and total tax payments.

Contractors and subcontractors are to compute their company's Workers' Compensation Insurance rate based on an average of applicable policy premium costs; amounts paid or credited for deductibles, loss claims, and retrospective adjustments; and actual payroll basis over the last five, consecutive, complete policy periods. The average of the policy premium amount established by the insurance carrier during its end-of-policy period, premium adjustment audit for each of the last five, consecutive, complete policy periods is to be added to the average of the total amount paid during the last five, consecutive, complete policy periods for deductibles and/or to settle loss claims, and the average of the total amount paid to or credited by an insurance carrier (current or prior) during the last five, consecutive, complete policy periods as retrospective adjustments to policies in effect during prior policy periods, dividing by the average of the applicable Payroll Basis for the last five, consecutive, complete policy periods, and multiplying the result by 100. The term "policy periods" as used herein is defined as the period of time covered by the last five, consecutive Workers' Compensation Insurance policies for which an end-of-policy period, premium adjustment audit was completed. When determining the policy premium amount for each year and its associated Payroll Basis, only the portion of each that is attributable to the company's field or project-based workforce need be included. The portion of each that is attributable to the company's clerical or sales workforce may be excluded. Additionally, any premium amount and associated Payroll Basis that is attributable to a company workforce employed in a state other than PA may be excluded. As support for the Worker's Compensation Insurance rate being charged, provide a copy of the last five, consecutive, end-of-policy period Audit Adjustment statements prepared by the insurance carrier and ensure each statement indicates the Payroll Basis upon which the adjusted premium was based. Additionally, provide a schedule (i.e. spreadsheet) of applicable deductible and claim payments made during the last five, consecutive, complete policy periods and include, at a minimum, the amount, payment date, and invoice number for each payment. Finally, provide a schedule of applicable payments made and credits received during the last five, consecutive, complete policy periods as retrospective adjustments and include, at a minimum, the amount, the payment/credit date, and the policy period to which each adjustment is applicable. If a company involved in the performance of force account work has not been in business long enough to compute its Workers' Compensation Insurance rate based on an average of five, consecutive, complete policy periods of cost data, compute the company's Workers' Compensation Insurance rate based on average cost data from all available, consecutive, complete policy periods.

Contractors and subcontractors will be required to enter their company's estimated effective rate for unemployment taxes into ECMS after April 15th of each calendar year. The rate will be effective for a one year period ending on April 15th of the subsequent calendar year. Additionally, Contractors and subcontractors will be required to enter and their computed Workers' Compensation Insurance and Liability Insurance rates into ECMS, along with the applicable expiration date for each type of coverage, prior to the start of each new insurance policy period. Supporting documentation demonstrating that the Workers' Compensation Insurance rate entered into ECMS was computed as specified above will be required, as will the required Liability Insurance rate certification. The coverage expiration date information will be tracked by ECMS and used to prompt the Contractor or subcontractor to update its rate information as existing policy periods expire.

2. Material. An item or product purchased specifically for the force account work that becomes a permanent part of the completed work will be considered a material for reimbursement purposes. The cost of material used will be reimbursable, including applicable sales tax and transportation costs charged by the material supplier.

3. Equipment. Reasonable rental rates for equipment, including trucks and machinery, mutually considered necessary, will be allowed, computed as follows:

3.a Owned Equipment. The term "owned equipment", as used herein, applies to equipment (including trucks and machinery) that the Contractor is required to provide for the proper execution of the original contract work, as specified in Section 108.05(c), whether such equipment is actually owned by the Contractor, is leased (rented), or has been obtained in some other manner.

For any owned equipment used in the performance of force account work, a rental rate will be determined using data obtained from the Rental Rate Blue Book (aka. EquipmentWatch Cost Recovery), which is published by EquipmentWatch, a division of Penton, Inc. Blue Book published data considered "current" as of the first day that work is performed on a specific force account is the data that will remain applicable throughout the performance of such work even if Blue Book data for an applicable piece of owned equipment is updated during that time. Outdated Blue Book data will be voided by the Department annually, as of a specific date, and no longer accepted thereafter.

The Department utilizes the Engineering and Construction Management System (ECMS) to keep electronic records of force account work. To enable the Department to electronically account for owned equipment utilized by Contractors and subcontractors in the performance of force account work within ECMS, the following actions must be taken:

- Purchase a subscription to all necessary volumes of the Blue Book, in electronic format, based on the various ages of the pieces in the Contractor's equipment inventory for Department projects,

- Utilize the All Saved Models tool available to subscribers to create a Department project equipment inventory,

- From the equipment included in the All Saved Models inventory, create an equipment Group,

- Use the Group Manager tool to select the applicable equipment Group and generate a Basic Fleet Report (i.e. the report that lists the ID, subtype, manufacturer, model, year, serial number, and configuration, as applicable, for each piece of equipment in the Group),

- Using the available "CSV" button, export the Basic Fleet Report to a spreadsheet and save the spreadsheet in a .csv (Comma Separated Values) file format. Note: Do not use the available "PDF" button to export the Basic Fleet Report as ECMS will not allow a spreadsheet saved in .pdf format to be imported.

- At this point, if the Contractor or subcontractor's owned equipment inventory includes any pieces that are not listed in the Blue Book, such equipment must be added to the spreadsheet. When adding equipment with no Blue Book listing to the spreadsheet, care should be taken to ensure that applicable information relating to ID, subtype, manufacturer, model, year, serial number, and configuration, as it is entered, is consistent with the existing column headings.

- Log in to ECMS and import the .csv file using the "Import Equipment" hyperlink found on the "Contractor Portal" screen.

At a minimum, the equipment Group imported to ECMS must include all of the owned equipment that will be used to perform the authorized force account work on a given project. However, to avoid having to repeat the above import procedure for future force account work on the same project or for force account work on other projects, the Contractor may elect to import a spreadsheet file that lists all of the equipment assigned to a given project or its entire Department project, owned equipment inventory. The ECMS equipment Group import procedure may be repeated at any time (e.g. to import new pieces added to the inventory or to import a piece that was missed in a prior import).

An hourly rental rate for owned equipment will be computed by dividing the Blue Book monthly rate by 176. To this rate, the Blue Book area adjustment percentage for Pennsylvania and the age adjustment percentage for the

model year of the piece of equipment will be applied. Blue Book city-level regional adjustment factors will not be used in computing an hourly rental rate for owned equipment.

An allowance will be made for operating costs by adding, to the above adjusted hourly rate, the Blue Book estimated operating cost per hour, for each hour that the owned equipment is actually in operation on the force account work.

If a piece of owned equipment is required at the work site on a standby basis, but is not operating, compensation, if any, will be at 50% of the adjusted hourly rate, exclusive of operating costs.

Payment for standby time will not be made on any day a piece of owned equipment is operated the entire work day. For a standard 8-hour work day, when equipment operates less than 8 hours, payment for standby time will be limited to the number of hours that, when added to the operating time for that day, equals 8 hours. For work days that exceed 8 hours, when equipment operates less than 10 hours, payment for standby time will be limited to the number of hours that, when added to the operating time for that day, equals 10. When force account work extends into one or more full weeks, in any 1-week period payment for standby time will be limited to the number of hours that, when added to the operating time for that week, equals 40 hours, regardless of the number of hours per day or days per week the Contractor works (i.e. overtime, multiple shifts, etc.). Payment for standby time will not be made on days the Contractor elects not to work or days not normally a work day. Standby time will not be paid if equipment is awaiting repair, while repairs are being made, or for maintenance or servicing of equipment. Standby time will not be paid for equipment not on the job site (i.e. while equipment is awaiting transport or being transported to the job site).

With the exception of owned equipment used for maintenance and protection of traffic, owned equipment used on a 24-hour basis will be reimbursed at a daily rental rate, which will be determined by dividing the Blue Book monthly rate by 22. Owned equipment used for maintenance and protection of traffic on a 24-hour basis will be reimbursed at the Blue Book daily rate. Applicable adjustment percentages from the Blue Book will be applied.

Where owned equipment utilized in the performance of force account work is not listed in the Blue Book, a rental rate will be determined based on the sale price for such equipment at the time of purchase, if the equipment is actually owned, or the applicable lease agreement. In these cases, for equipment that is actually owned, the monthly rate will be computed as 6% of the sale price, and the total hourly rate determined by dividing the monthly rate by 160, when the equipment is operating, and by 352, when the equipment is required at the work site on a standby basis, but not operating, with no adjustment percentages applied. For equipment that is leased, an hourly rental rate will be determined by prorating the lease cost. Additionally, if not included in the lease cost, an allowance will be made for operating costs by adding, to the hourly rental rate, the Blue Book estimated operating cost per hour for an equivalent piece of equipment for each hour the equipment is actually in operation on the force account work. The equivalence of the piece of equipment in the Blue Book listing to the piece of equipment actually used must be mutually agreed upon.

With the exception of owned equipment used for maintenance and protection of traffic, owned equipment used on a 24-hour basis, with no listing in the Blue Book will be reimbursed at a daily rental rate, which will be computed as 6% of the sale price for the equipment at the time of purchase divided by 22, with no adjustment percentages applied. Owned equipment used for maintenance and protection of traffic on a 24-hour basis with no listing in the Blue Book will be reimbursed at a daily rental rate, which will be computed as 15% of the sale price for the equipment at the time of purchase divided by 22, with no adjustment percentages applied. If, instead of being purchased, the equipment was actually fabricated by the owner, the "sale price" used to determine the daily rental rate will be the owner's total, documented, fabrication cost. If equipment used on a 24-hour basis with no listing in the Blue Book is leased, whether or not the equipment is used for maintenance and protection of traffic, the daily rental rate will be determined by prorating the lease cost.

The rates established above include the cost of fuel; oil; lubrication; supplies; necessary attachments; repairs; overhaul and maintenance of any kind; storage; all costs of moving equipment on to and away from the work site, except as specified below; and all incidentals.

If a piece of owned equipment, not already on or near the project site, is needed specifically for the force account work, the cost of moving the equipment on to and away from the work site will be reimbursed, provided the equipment will not be used immediately thereafter in the performance of original contract work.

The Department will not approve any Contractor requests for reimbursement of owned equipment costs incurred in the performance of force account work in excess of those outlined above unless such costs were mutually agreed upon, in writing, based on an acceptable cost breakdown prepared by the Contractor.

3.b Rented Equipment. If a piece of equipment needed for the force account work is not of the type required to be provided by the Contractor for the proper execution of the original contract work, or if the piece of equipment needed is "owned" but not currently available, and the equipment can be obtained by rental, discuss the need to rent the equipment with the Representative and obtain approval of the rental source and the rate to be paid before renting

the equipment for the force account work. The Department will not provide reimbursement for equipment rented without the prior knowledge and approval of the Representative.

The Contractor will be reimbursed the actual invoiced cost for rented equipment, plus the cost of transporting the equipment to and from the work site, provided transportation is not included in the rental cost and the rented equipment will not be used immediately thereafter in the performance of original contract work. An allowance will be made for operating costs by adding, to the rental cost, the Blue Book estimated operating cost per hour for each hour the rented equipment is actually in operation on the force account work. If the rented equipment has no listing in the Blue Book, the Blue Book estimated operating cost per hour for an equivalent piece of equipment will be allowed, as mutually agreed upon.

Transportation charges for each piece of rented equipment, to and from the site of the force account work, will be paid provided:

- Return charges do not exceed the delivery charges,
- Haul rates do not exceed the established rates of licensed haulers, and
- Charges are restricted to those units of equipment not readily available and not on or near the project.

Equipment that is rented or leased from an entity that is a division, affiliate, or subsidiary of, or that is in any other way related to, the Contractor or its parent company will be considered owned equipment for reimbursement purposes and subject to the provisions of Section 110.03(d)3.a.

4. Services by Others. Specialized construction analyses, engineering services, and work not considered subcontract work requiring prequalification will be considered services by others for reimbursement purposes. Additionally, when required exclusively for the force account work, as directed, the securing of permits, bonds, and specialized insurance coverage, of a type not already required by the contract, will be considered a service by others. The Contractor will be reimbursed the actual invoiced cost of each service by others; including allowable permit fees, bond premiums, and insurance premiums; plus 5% to cover administration and all other costs. The markup on service by others costs will be limited to 5% only, regardless of whether the service was arranged by the Contractor or a subcontractor performing any or all of the force account work. The overhead and profit allowances specified in Section 110.03(d)7 are not applicable to service by others costs.

5. Consumables. An item needed specifically for the force account work that does not become a permanent part of the completed work, the useful life of which is either fully or partially expended in the performance of the work, will be considered a consumable for reimbursement purposes. Reimbursement for consumable items will be determined as follows:

5.a Purchased Consumables. If a consumable item needed for the force account work is purchased (new), as evidenced by a supporting invoice, and the item's useful life is completely expended in the performance of the work, as mutually agreed upon by the Representative and the Contractor, the full cost of the item will be reimbursed, including applicable sales tax and transportation costs. Otherwise, that portion of the item's useful life expended in the performance of the force account work will be determined, as mutually agreed upon by the Representative and the Contractor, and reimbursement made at a prorated cost. In such cases, the purchase price of the item plus applicable sales tax will be prorated, with applicable transportation costs being reimbursed in full.

5.b Consumables Taken From Stock. If one or more of the items shown in Table A is needed for the force account work and is not purchased (new) but rather obtained from the Contractor's existing inventory of used consumables, the item will be considered as being taken from stock. Given the fact that the usage history of these items cannot always be accurately assessed by the Department, reimbursement will be made based on the percentage of value and payment frequency specified in Table A. When utilizing Table A to compute reimbursement for a consumable taken from stock, item value will be established based on a supporting invoice. The supporting invoice must show the purchase of the item (new or used), from a vendor regularly engaged in the sale of such items. Reimbursement based on the percentage of value in Table A includes the cost of off-site handling and loading the consumable (e.g. at the Contractor's yard). Applicable transportation costs to the project site (i.e. labor and equipment costs) will be reimbursed separately. All consumables taken from stock remain the Contractor's property upon completion of the force account work. No additional payment will be made for a consumable taken from stock if the

Contractor elects to leave the item in place for its own convenience. No payment will be made for a consumable taken from stock if the Contractor is unable to furnish a supporting invoice meeting the above requirements.

TABLE A

Consumable Item	Unit of Measure	% of Value Reimbursed	Payment Frequency
Structural Steel – Plate	LB	1%	Monthly*
Metal Bridge Overhang Brackets	Each	1%	Monthly*
Temporary Concrete Barrier	LF	1%	Monthly*
Steel Sheet Piling	LB	1%	Monthly*
Structural Steel – Falsework	LB	1%	Monthly*
Wood – Structural Timber	Board Foot	33%	One Time
Wood – Dimensional Lumber	Board Foot		
Plywood	Sheet		
Concrete Forms – Metal	SF	1%	Monthly*
Concrete Forms – Laminated			
Concrete Curing Blankets	Each	25%	One Time

*For each 1-month period or portion thereof.

6. Subcontracting. If any or all of the force account work is to be performed by an approved subcontractor, the work must be considered subcontract work requiring prequalification and the Contractor's need to subcontract the work must be approved. Payment for work performed by a subcontractor, will be determined based on a complete statement of applicable material, labor, and equipment costs, computed as specified herein, plus applicable markups for overhead and profit.

If a subcontractor's workforce must be in overnight travel status while performing force account work, any costs incurred for hotel rooms, per diem, subsistence, travel allowance, or any other similar expense may be reimbursed, provided it is mutually agreed that such costs are unavoidable and being incurred for the convenience of the Department. Overnight travel costs, when agreed to, will be reimbursed as service by others, as specified in Section 110.03(d)4.

7. Overhead and Profit. Except for work considered to be service by others, as specified in Section 110.03(d)4, to cover all administration, general and project superintendence, other overhead, bonds, insurance, anticipated profit, and use of small tools and equipment for which no rental is allowed (i.e. tools and/or equipment having a sale price at the time of purchase of $1,000 or less), 15% will be added to the total material cost, 30% will be added to the total direct labor cost, and 5% will be added to the total cost of equipment rented as specified in Section 110.03(d)3.b, and the total cost of consumables provided as specified in Section 110.03(d)5. If applicable, in addition to the above markups, 5% will be added to the total cost of any force account work performed as approved subcontract work as specified in Section 110.03(d)6.

8. Statements. Upon completion of force account work, prepare an itemized statement of the cost of the work, in the form of a properly completed ECMS Actual Force Account record, detailed as follows:

- Name, classification, work dates, daily hours, total hours, base pay rate, fringe benefit rate, total pay rate and extension for each foreperson; equipment operator; and skilled, semi-skilled, and common laborer;

- Description (year, make, model, axel configuration, capacity, horsepower, etc.), Blue Book edition reference, use dates, daily hours, total hours, rental rates (operating and standby) and extension for each piece of owned equipment and/or description, rental cost, transportation costs (if separate), and extension for each piece of rented equipment;

- Description, quantity, unit of measure, unit price and extension for all materials, applicable sales tax, and transportation costs charged by the material supplier;
- Name, description, quantity, unit price, and extension for all consumables;
- Name, description, and amount for all services by others; and
- Rates paid for liability insurance, workers' compensation insurance, and unemployment taxes.

Statements of labor costs are to be supported by certified payroll records. If certified payroll records do not indicate the fringe benefit rate being paid, furnish a notarized statement, on company letterhead paper, listing the total fringe benefit rate for each applicable labor classification, showing how the total rate is proportioned and distributed, and identifying the portion of the rate, if any, that is being paid directly to individual workers, which would be subject to payroll taxes and therefore considered part of the base labor cost. If a salaried working foreman is involved in the force account work and the Contractor elects not to include that individual on certified payroll records, furnish an affidavit certifying that the individual's combined salary and benefit package is equivalent to or exceeds the wage and fringe benefit rates being charged.

Statements of material costs (including sales tax and transportation costs), rented equipment costs, consumables costs, and service by others costs are to be supported and accompanied by invoices, receipts, or canceled checks.

If materials used in the force account work are not specifically purchased for the work but are taken from the Contractor's stock or provided by entities that are divisions, affiliates, subsidiaries or in any other way related to the Contractor or its parent company, and a supporting invoice, receipt, or canceled check cannot be provided, furnish an affidavit certifying that the materials were obtained as described above, that the quantity claimed was actually used, and that the price and transportation costs claimed were actually incurred.

If the Contractor fails to furnish the required itemized statement of the cost of force account work, detailed as specified, within 90 calendar days after completion of the force account work, final payment for the work will be made based on the daily force account records kept by the Department. In such cases, since the Department will be unable to verify the prices paid for materials, rented equipment, consumables, and services by others due to the Contractor's failure to provide supporting invoices, receipts, or canceled checks, the total cost of unsupported material, rented equipment, consumables, and/or services by others will be fully discounted and not included in the final payment amount.

When the required itemized statement of the cost of the force account work, detailed as specified, is furnished within 90 calendar days after completion of the force account work, the Department will review the submission and notify the Contractor, in writing, within 14 calendar days, regarding all corrections that must be made and all outstanding support documentation that must be provided. Make all necessary corrections, obtain all missing support documentation, and resubmit the itemized statement within 14 calendar days of the date of the Department's written notification. If the Contractor fails to furnish a properly completed and fully supported statement of the cost of force account work within the 14-calendar day period, final payment for the work will be made based on the Contractor's original submission and the daily force account records kept by the Department. In such cases, the total cost of any material, rented equipment, consumables, and/or services by others for which a supporting invoice, receipt, or canceled check has not been furnished will be fully discounted and not included in the final payment amount.

Extension(s) of either of the above 14-calendar day periods will be made only by mutual written consent of the parties to the contract provided such written consent is given before the expiration of the applicable 14-day period.

If the amount already paid to the Contractor via progress payments exceeds the final payment amount computed after discounting unsupported material, rented equipment, consumables, and/or service by others costs, the overpayment amount will be recouped through the processing of a negative Force Account Adjustment.

The Contractor's failure to submit all required supporting invoices, receipts, or canceled checks, releases and forever discharges the Department from any claims relating to the act of discounting the cost of unsupported material, rented equipment, and/or services by others before making final payment for force account work.

(e) Disputes. Notwithstanding the provisions specified in Section 105.01, in the event of a disagreement with the District Executive as to whether work is:

- original contract work or additional work,
- original contract work or extra work, or

- additional work or extra work,

notify the Inspector-in-Charge immediately of such disagreement and confirm the disagreement in writing to the District Executive within 10 calendar days. Upon notification to the Inspector-in-Charge of such disagreement, records will be kept daily of all labor, equipment, and materials used from that day forward in the disputed work. Keep and maintain such daily records in the field. Claim no extra costs of any kind for work performed before notifying the Inspector-in-Charge of disagreements with the District Executive's decision. On each Monday, compare records of the previous week's work with those kept by the Department and review for accuracy. Report to the District Executive within 10 calendar days of each review all disagreements with such records or to report disagreements with such records. Refusal or repeated failure to meet to review the Department's records or to report disagreements with such records will create an irrebuttable presumption in favor of the Department that its records are accurate.

Disputes concerning all such work will be resolved by the District Executive and payment will be made on the basis determined by him.

In the event of a disagreement with the decision of the District Executive, comply with provisions specified in Section 105.01 concerning due notice in writing of an intent to file a claim and send a copy of the written notice to the District Executive within the time frame allowed by that section. If written notice is not submitted to the District Executive within 10 calendar days of receipt of the District Executive's decision, daily records of labor, equipment and materials will no longer be kept by the Department and no claim for additional compensation of any kind arising from or relating to the disputed work or the decision of the District Executive can be filed with the Board of Claims.

If due notice in writing is submitted to the District Executive and Deputy Secretary for Highway Administration within the 10 calendar-day period, continue to keep and review daily records, as provided above, until completion of the disputed work.

With the exception of those specific daily records or portions thereof on which written disagreements were filed with District Executive as provided above, any claim for damages filed with the Board of Claims arising out of or relating to the disputed work or the decision of the Secretary can be measured at the hearing solely by the aforementioned daily records kept by the Department.

110.04 PRICE ADJUSTMENT OF ASPHALT MATERIALS—These requirements provide for a price adjustment, in the form of a payment to the Contractor or a rebate to the Department, for fluctuations in the cost of asphalt cement used in the asphalt materials placed as part of the construction work specified in the following Sections:

313	360[b]	420	471	489[e]	656[d]
316	410	450	480[c]	496	657[d]
341[a]	412	460	481	651[d]	
342[a]	413	461	482	653[d]	
344[b]	419	470[c]	483	654[d]	

Publication 447 – Approved products for Lower Volume Local Roads

MS-0310-0011[b]	MS-0310-0032[b,c]	MS-0350-0018[a]
MS-0310-0021[b]	MS-0310-0051[b]	MS-0360-0019[b]
MS-0310-0022[b]	MS-0311-0001[b]	MS-0370-0040[a]
MS-0310-0031[b,c]	MS-0340-0005[a]	

Applicable contract items include any modified standard or nonstandard item where the character of the work to be performed is considered placement of one or more of the asphalt materials specified in these Sections.

[a] Price adjustments, when applicable, will be computed based on the Asphalt Material item quantity (gallon) only, as paid on current estimates.

[b] When measured and paid for on a square yard basis, the tonnage of material placed will be determined from delivery tickets and the asphalt tonnage computed as specified Section 110.04(b)4.a. The tonnage of material wasted, if any, will be agreed upon with the Contractor and deducted.

[c] When measured and paid for on a Material Used Basis, price adjustments, when applicable, will be computed based on the Asphalt Material item quantity (gallon) only, as paid on current estimates.

[d] Price adjustments, when applicable, will be computed as specified for the type of asphalt material used in the type of paved shoulder placed. Excludes shoulder backfill items.

[e] Price adjustments, when applicable, will be computed based on the tonnage of asphalt cement used in the ultra-thin bonded wearing course only (i.e., excluding the asphalt cement used in the emulsified asphalt membrane).

(a) General. These price adjustment provisions apply only to projects where more than 100 tons of asphalt cement, including asphalt cement residue contained in emulsions or cut backs, will be used in the asphalt materials specified or indicated for placement.

The Department posts monthly index prices for asphalt cement (PG 64S-22) using price data obtained, on the last Wednesday of the preceding month, from a survey of producers who do business in Pennsylvania. Data provided by producers serving the eastern portion of the state is averaged to compute the index price for Zone 1 (Districts 3-0, 4-0, 5-0, 6-0, and 8-0). Data provided by producers serving the western portion of the state is averaged to compute the index price for Zone 3 (Districts 1-0, 10-0, 11-0, and 12-0). The index price for Zone 2 (Districts 2-0 and 9-0) is computed as the average of the index prices for Zone 1 and Zone 3.

The price index IB, will be the index price posted by the Department, determined as specified above, for the month in which the project is advertised.

The price index at the time of placement, IP, will be the index price posted by the Department, determined as specified above, for the month during which the applicable material is placed.

(b) Price Adjustment Criteria and Conditions. The following criteria and conditions will be considered in determining a price adjustment for asphalt materials:

1. No Price Adjustment. When the ratio IP/IB falls within the range of 0.90 to 1.10, no price adjustment will be made for any asphalt material placed during the relevant month.

2. Price Rebate. When the ratio IP/IB is calculated to be less than 0.90, the Department will receive an automatic price rebate determined according to the following formula:

$$P.R. = (0.90 - IP/IB)\ (Q)\ (IB)$$

where:

P.R.	=	Price Rebate
IP	=	Price Index for the last Wednesday of the month preceding the month in which the material is placed (One-Month Price Adjustment Period)
IB	=	Price Index
Q	=	Quantity tons of Asphalt in Mixture placed

3. Price Increase. When the ratio IP/IB is calculated to be greater than 1.10, the Contractor will receive a price increase determined according to the following formula:

$$P.I. = (IP/IB - 1.10)\ (Q)\ (IB)$$

where:

P.I.	=	Price Increase
IP	=	Price Index for the last Wednesday of the month preceding the month in which the material is placed (One-Month Price Adjustment Period)
IB	=	Price Index
Q	=	Quantity tons of Asphalt in Mixture Placed

4. Equivalent Tonnage.

4.a Ton Basis. For asphalt mixtures containing performance-graded (PG) asphalt binder or emulsified asphalt, which are measured and paid for on a ton basis; including Superpave HMA base, binder, and wearing courses; flexible

base replacements, asphalt treated permeable base courses; stone matrix HMA wearing courses; asphalt wearing courses, FJ-1, FJ-1C, FB-2, and FB-1; asphalt binder courses, FB-2 and FB-1; manual asphalt patching; and polymer-modified emulsified asphalt paving systems (micro-surfacing), type RF; the equivalent tonnage is computed as follows:

$$\begin{matrix}\textit{Asphalt}\\ \textit{Tonnage in}\\ \textit{Asphalt Mixture}\end{matrix} = \left(\begin{matrix}\textit{Asphalt Mixture}\\ \textit{Tonnage Placed}\end{matrix}\right) \times \left(\begin{matrix}\textit{Percent}\\ \textit{Asphalt}\\ \textit{by Weight*}\end{matrix}\right)$$

* If the asphalt mixture contains performance-graded (PG) asphalt binder, the Percent Asphalt will be obtained from the approved JMF (Form TR-448A, Job Mix Formula Report) for the asphalt mixture placed. The Percent Asphalt will be the "Virgin AC%" listed on the applicable JMF. If the asphalt mixture contains emulsified asphalt, the Percent Asphalt will be computed using the approved mix design for the type of asphalt mixture placed and Bulletin 25. The Percent Asphalt will be the percent emulsion in the asphalt mixture, as listed on the applicable mix design, multiplied by the minimum asphalt percent by weight for the class of emulsified asphalt used, as specified in Bulletin 25.

4.b Square Yard Basis. For asphalt mixtures containing performance-graded (PG) asphalt binder only (i.e. not including emulsified asphalt or cut-back asphalt), which are measured and paid for on a square yard basis; including Superpave WMA base, binder, and wearing courses; flexible base replacements, aggregate- asphalt base courses; stone matrix WMA wearing courses; asphalt wearing courses, FJ-1, FJ-1C, FB-2, and FB-1; asphalt binder courses, FB-2 and FB-1; and paved shoulders, types 1-F, 1-SP, 6-F, 6-SP, and 7; the equivalent tonnage is computed as follows:

Asphalt Mixture Tonnage Placed = (0.000375) (A) (D) (d)

where:

A = Surface Area (square yards)
D = Design Depth (inches)
d = Design Density* (pounds per cubic feet)

$$\left(\begin{matrix}\textit{Asphalt}\\ \textit{Tonnage in}\\ \textit{Asphalt Mixture}\end{matrix}\right) = \left(\begin{matrix}\textit{Asphalt Mixture}\\ \textit{Tonnage Placed}\end{matrix}\right) \times \left(\begin{matrix}\textit{Percent}\\ \textit{Asphalt}\\ \textit{by Weight**}\end{matrix}\right)$$

* The Design Density will be obtained from the approved JMF (Form TR-448A, Job Mix Formula Report) for the asphalt mixture placed. The Design Density will be the "N_{des} Density" listed on the applicable JMF. If necessary, the Design Density (i.e. N_{des} Density) obtained from Form TR-448A will be converted to the proper units by multiplying by the density of water, 62.4 pounds per cubic foot.

** The Percent Asphalt will be obtained from the approved JMF (Form TR-448A, Job Mix Formula Report) for the asphalt mixture placed. The Percent Asphalt will be the "Virgin AC%" listed on the applicable JMF.

4.c Gallons per Square Yard Basis. For asphalt coatings or mixtures measured and paid for on a square yard basis, where asphalt material (i.e. performance-graded asphalt binder, emulsified asphalt, or cut-back asphalt) is used or applied on a gallons per square yard basis; including asphalt tack coats, asphalt prime coats, asphalt seal coats, asphalt surface treatments, slurry seals, and polymer-modified emulsified asphalt paving systems (micro surfacing); the equivalent tonnage is computed as follows:

Asphalt Tonnage = (0.004164) (A) (a) (g)

where:

A = Surface Area (square yards)
a = Actual Residue Application Rate* (gallons per square yard)
g = Specific Gravity of Asphalt Material**

* For asphalt tack coats, asphalt prime coats, asphalt seal coats, and asphalt surface treatments, the Actual Residue Application Rate will be the rate of application of the emulsified asphalt, cut-back asphalt, or performance-graded (PG) asphalt binder, as applicable, in gallons per square yard, as determined in the field according to PTM No. 747; multiplied by 100% if PG asphalt binder is used, or by the minimum asphalt percent by weight for the class of emulsified asphalt or cut-back asphalt used, as specified in Bulletin 25. For asphalt seal coats and asphalt surface treatments using pre-coated aggregate, the Actual Residue Application Rate for the asphalt precoating material will be the design rate of application of the coarse aggregate, in pounds per square yard; multiplied by the average of the minimum and maximum residual asphalt binder percent by weight for the type of asphalt precoating material used, as specified in Section 471.2(d); multiplied by 100% if PG asphalt binder is used, or by the minimum asphalt percent by weight for the class of emulsified asphalt or cut-back asphalt used, as specified in Bulletin 25; divided by the weight of water, 8.328 pounds per gallon. For slurry seals, the Actual Residue Application Rate will be the average of the minimum and maximum rate of application for the type of slurry seal constructed, in pounds per square yard, as specified in Section 482.2(e); multiplied by the percent emulsion in the asphalt mixture, as listed on the applicable mix design; multiplied by the minimum asphalt percent by weight for the class of emulsified asphalt used, as specified in Bulletin 25; divided by the weight of water, 8.328 pounds per gallon. For polymer-modified emulsified asphalt paving systems (micro-surfacing), the Actual Residue Application Rate will be the average of the yield value for the asphalt mixture calculated at the end of each day's application, in pounds per square yard; multiplied by the percent emulsion in the asphalt mixture, as listed on the applicable mix design; multiplied by the minimum asphalt percent by weight for the emulsified asphalt, as specified in Bulletin 25; divided by the weight of water, 8.328 pounds per gallon.

** The Specific Gravity of Asphalt Material will be obtained from the bill of lading provided with each shipment of asphalt material delivered to the project. If asphalt material from multiple shipments is placed or applied during the same one-month period, and the specific gravity reported on the bills of lading varies from one shipment to another, the Specific Gravity of Asphalt Material will be the average of the specific gravities reported on each applicable bill of lading.

4.d Gallon Basis. For asphalt coatings or mixtures where the asphalt material (i.e. performance graded asphalt binder, emulsified asphalt, or cut-back asphalt) used or applied is measured and paid for on a gallon basis; including asphalt tack coats, asphalt prime coats, and asphalt material for cold recycled asphalt base courses, asphalt wearing courses FB-1, asphalt binder courses FB-1, asphalt seal coats and asphalt surface treatments; the equivalent tonnage is computed as follows:

Asphalt Tonnage = (0.004164) (V) (g) (p)

where:

V = Volume of Asphalt Material (gallons)
g = Specific Gravity of Asphalt Material*
p = % Asphalt**

* The Specific Gravity of Asphalt Material will be obtained from the bill of lading provided with each shipment of asphalt material delivered to the project. If asphalt material from multiple shipments is used, placed or applied during the same one-month period, and the specific gravity reported on the bills of lading varies from one shipment to another, the Specific Gravity of Asphalt Material will be the average of the specific gravities reported on each applicable bill of lading.

** For other than performance-graded (PG) asphalt binder (% Asphalt = 100%), the % Asphalt will be the minimum asphalt percent by weight for the class of emulsified asphalt or cut-back asphalt used, as specified in Bulletin 25.

5. Expiration of Contract Time. If asphalt materials or mixtures are placed after expiration of contract time and liquidated damages are chargeable, the value for IP used to compute the price adjustment will be either the price index at the time of actual placement or the price index at the time contract time expired, whichever is less.

6. Approval. Should the price index at time of placement, IP, indicate an increase of 50% or more over the price index, IB, do not furnish asphalt material for the project without prior written approval.

7. Payment/Rebate. The price adjustment will be paid, or rebated, upon approval of a work order to be prepared after completion of all work. Cumulative price adjustments amounting to less than $500 will be disregarded. Upon written request by the Contractor, partial payments may be made, before total completion, when the unpaid accrued price increase exceeds $10,000 or once every 12 months.

8. Inspection of Records. The Department, through the Office of Inspector General, reserves the right to inspect the records of the prime contractor and its subcontractors and material suppliers to ascertain actual pricing and cost information for the asphalt cement used in the asphalt materials incorporated in the work.

9. Extra Work. If applicable items of work, as specified herein, are added to the contract as extra work, as specified in Section 110.03, no price adjustment will be made for fluctuations in the cost of asphalt cement used in any asphalt materials placed in the performance of the extra work, unless otherwise approved. The current price for asphalt cement is to be used when preparing required backup data for extra work to be performed at a negotiated price. For extra work performed on a force account basis, reimbursement for material costs along with the specified overhead and profit markup will be considered to include full compensation for the current cost of asphalt cement.

110.05 CURRENT ESTIMATE PAYMENTS—Current estimate payments will be processed based upon assessments made by the Department as work is satisfactorily completed. Processing of estimate payments will begin on the first estimate date established following the Notice to Proceed Date or indicated in the special provisions. No estimate payments will be processed before the Notice to Proceed Date. Current estimate payments exceeding $1,000 will be processed by the Department at semimonthly intervals, or more frequently, as work progresses. Current estimate payments amounting to less than $1,000 may be processed monthly. Final payments amounting to between -$10 and +$10 will be disregarded. Partial payments do not bind the Department to the acceptance of any material furnished or work performed.

Within 7 calendar days of the receipt of current estimate and final payments from the Department, pay all subcontractors their earned share of the payments, including all retainage, provided the terms and conditions of the applicable subcontract or purchase agreement have been reasonably met.

110.06 MATERIAL STORED OR ON HAND—

(a) Stored Material. The Representative may authorize payment for certain material, using form CS-110, before its incorporation into the work. Upon the Contractor's written request and the Representative's written approval, the Contractor may be paid 100% of the cost of the material, less the pro-rata share of the retainage, if any; provided the quantity of stored material does not exceed the total estimated quantity required to complete the project, the cost is at least $1,000 but does not exceed 90% of the contract price of the applicable contract item or component item, and the accumulative costs do not exceed 25% of the current contract amount. The cost of the material is that amount to be paid by the Contractor as evidenced by invoices. Fabricated structural steel that is to receive a protective coating may be approved for prepayment at 75% of the contract price of the applicable contract item or component item, before application of the coating, provided the structure has been fully fabricated and preassembly of field connections has been made.

Payment for stored material will not be authorized until the material has been delivered to the project site or an approved location in the vicinity of the project, is inspected by the Representative to ensure the material is in a satisfactory condition and of sufficient quantity, is stored in an approved manner, and conforms to the requirements specified in this Section and Section 106.03. Identify stored material by project designation and set apart from other materials. Material to be stored less than 30 days is not eligible for prepayment. In determining eligibility for prepayment, the beginning date for evaluating whether the required 30-day minimum storage period will be met will be the date the material is delivered to the project or approved storage location, or the date the invoice is submitted to the Department, whichever is the latter. Material originally determined to be ineligible for prepayment due to the minimum storage period requirement, that is then stored for more than 30 days, is eligible for prepayment on the next estimate, provided the invoice has been submitted to the Department. If the Representative determines, because of required fabrication at an off-site location, that it is not feasible or practicable to store material in the vicinity of the project, the material may be stored at an approved location, which is not in the vicinity of the project, at the Contractor’s expense.

With the exception of structural steel to be incorporated into fabricated structural steel components for main bridge members, as specified in Section 110.06(a)1., only end product manufactured material or fully fabricated products

that are awaiting installation and/or incorporation into the finished work are eligible for prepayment. Ingredients of a finished product are not eligible for prepayment. Aggregates, cements, and other bulk material are not eligible for prepayment. Beams containing precast components or secondary precast elements detailed on the structure component item schedule or both are eligible for prepayment. Living or perishable plant materials are not eligible for prepayment before planting.

Assume full control and responsibility for the protection of the stored material from the elements and against loss or damage by any cause. In the event any stored material becomes lost, stolen, impaired, or damaged while stored, the monetary value of the lost, stolen, impaired, or damaged material as may have been paid for in a current estimate will be deducted from a subsequent estimate. Retain the title to the prepaid material until issuance of the acceptance certificate.

Payment for acceptable stored material will be made on current estimates against the applicable contract item. The amount paid will be proportionately recouped as the material is incorporated into the work. The cost of surplus stored material previously paid on a current estimate but not ultimately incorporated in the final measured work will not be included in the final payment. Surplus stored material is the property of the Contractor. Remove surplus material from the project and dispose of in a satisfactory manner.

Pay the material provider the amount due, as shown on the invoices within 7 calendar days of receipt of payment from the Department. Provide evidence of payment upon request. Failure to make invoice payments as specified will cause the appropriate monies to be deducted from future estimates and will cause the disapproval of further prepayment requests.

1. Prepayment for Structural Steel. Structural steel to be incorporated into fabricated structural steel components for main bridge members may be approved for payment up to 60% of the contract price of the applicable contract item or component item; provided the quantity, cost, delivery, inspection, and storage requirements of Section 110.06(a) are met. The cost of the structural steel is that amount to be paid by the Fabricator as evidenced by invoices. Invoices for approved structural steel are to include the material quantity and Department project identification (i.e. ECMS number, SR & Section, and county), and must be accompanied by certification, as specified in Section 106.03(b)3., and proof of payment (e.g. a copy of a canceled check or receipt, or a certified letter from the structural steel supplier acknowledging receipt of payment).

Payment for approved structural steel will be made on current estimates against the applicable contract item. The amount paid will be proportionately recouped as the fabricated structural steel components are incorporated into the work. Pay the Fabricator the amount due, as shown on the invoices, within 7 calendar days of receipt of payment from the Department. When payment is made, the structural steel becomes the property of the Department. Have the Fabricator furnish a transfer of ownership document within 7 calendar days of receipt of payment and promptly submit the documentation to the Department.

Only approved structural steel to be incorporated into fabricated structural steel components for main bridge members is eligible for prepayment. Handling, transportation, and storage of structural steel materials including, but not limited to, any storage site rental, security, and weather protection, are to be borne by the Contractor and included in the contract price for the applicable contract item.

(b) Erected Steel. Partial payment for structural steel required for bridge construction will include not over 97% of the total estimated weight of structural steel in a span erected and completely and permanently bolted, riveted, or welded. The total estimated weight of structural steel will be included in partial payments after painting has been satisfactorily completed.

110.07 VALUE ENGINEERING—Upon approval of a value engineering proposal, as specified in Section 104.04, a two-part, lump sum Value Engineering payment will be made in an amount equal to one-half of the actual net cost savings associated with the proposal. Actual net cost savings is defined as the cost difference between the original contract work and the actual cost of the new work.

Compensation will be made only for proposals pertaining to contracts in effect with the submitting Contractor at the time of submission.

An initial contract work order or contract adjustment will be processed to provide payment for one-half of the lump sum value engineering payment, based on the estimated net cost savings as identified in the approved value engineering proposal. Upon completion of all items of work included as part of the value engineering proposal, a final, lump sum payment will be made by processing a follow-up contract work order or contract adjustment. The final, lump sum payment amount will be determined by computing the actual net cost savings associated with the value

engineering proposal, based on actual item quantities, taking one-half of the actual net cost savings, and deducting the amount paid under the initial contract work order or contract adjustment.

110.08 FINAL INSPECTION, ACCEPTANCE, AND FINAL PAYMENT—

(a) Final Inspection. When the project is substantially complete, make arrangements for a mutual final inspection. Substantial completion is the date when at least 90% of the contract work has been completed and the project can be used, occupied, or operated for its intended use.

At the time of final inspection, the Representative, along with the Contractor, will establish the following:

- The date of final inspection;
- The list of all physical work items, by stations and in detail, requiring completion and/or correction; and
- A list of all certificates or documents requiring submission, completion, and/or correction.

As established during the final inspection, perform work as necessary for required correction or completion of all physical work items, and complete, correct, and submit all outstanding certificates and documents.

The Contractor will be relieved of responsibility for further physical work and maintenance only for work items which are satisfactorily completed at the time of, or subsequent to, the final inspection. The Contractor's responsibility for further physical work, maintenance, and third-party liability remains for work items, which are not satisfactorily completed at the time of, or subsequent to, the final inspection. When all physical work has been satisfactorily completed according to the requirements of the contract, the Representative will establish the Date of Physical Work Completion.

Upon receipt and verification, the Representative will establish the date that all required certificates and/or documents are satisfactorily furnished.

When all physical work has been satisfactorily completed and all contractually required certificates and documents have been properly furnished, the date of project acceptance will be established.

If any substantial project section has been completed in advance of the whole, a final inspection will be made of that section and the Contractor will be relieved of responsibility for further physical work and maintenance on the section of the project as specified in Section 108.04(b). The final inspection will be conducted as specified for the entire project; except, the date of project acceptance will not be established nor will an acceptance certificate be issued.

(b) Acceptance Certificate. Upon completion of the requirements as specified in Section 110.08(a), an acceptance certificate will be issued, establishing the date on which the project has been satisfactorily completed and certifying that the project is accepted as of that date.

(c) Final Settlement Certificate Computations. The Representative will compute the entire amount of each contract work item performed and its contract value. The Representative will notify the Contractor of the amount for each item, including additions to and deductions from the contract quantity for each item of work, all other legal and equitable additions and deductions to be made, amounts previously paid, and the net amount of the final settlement certificate computations. The Representative will request written acceptance of, or exception to, these final settlement certificate computations within 10 days of the notification. Failure to follow the following procedures will waive the right to file a claim.

1. Within 10 days from the date the final settlement certificate computations or revised computations are submitted, notify the Representative, in writing, of acceptance or exceptions.

1.a If accepted, or upon failure to accept or take exception within the specified time, the Director, BOPD will certify to the Secretary, in the final settlement certificate, the entire amount of each work item performed, its contract value, all legal and equitable additions and deductions, and the amounts previously paid. The Secretary will certify to the State Treasurer the amount due in final payment and contract settlement. Under these circumstances, all claims are considered waived by the Contractor.

The Department will forward a copy of the final settlement certificate, setting forth the final settlement date. Copies will also be forwarded to the surety and other appropriate interested agencies. The date the Secretary notifies the Contractor of the final settlement certificate computations, or revised computations, will be the date of contract

completion.

1.b If not acceptable, notify the District Executive, in writing, of all exceptions. The District Executive will give notification of the acceptance or rejection of the exceptions. The Contractor or surety has the right to appeal, within 10 days of the rejection, to the Chief, HDD. Notification will then be sent, in writing, from the Chief, HDD stating that the claim has been approved or rejected. Where the claim does not involve any disputes specified in Section 105.01, the "date that the claim accrued," for purposes of filing claims before the Board of Claims, will be the date notification in writing is sent from the District Executive, of the rejection of the claim. In the event of an appeal within 10 days, as provided, the date will be the first notification following the claim rejection by the Chief, HDD.

2. During final settlement certificate computations, if the Department determines that the net total amount to be received is actually a negative amount, then prompt reimbursement to the Department for the total amount overpaid is required. In the event of failure to reimburse the Department, the Secretary will take legal measures to secure the amount due. The Department may, in addition, remove the Contractor from its list of approved pre-qualified contractors, according to regulations.

(d) Final Settlement of Contract. Final contract settlement will occur when the Secretary certifies to the State Treasurer the amount due in final payment and contract settlement, after making all legal and equitable additions and deductions, including amounts previously paid, according to the contract terms, the terms of written or approved work orders, and the terms of an award, if any, of the Board of Claims. The Department will forward a copy of the final settlement certificate, setting forth the final settlement date. Copies will also be forwarded to the surety and other appropriate interested agencies.

(e) Final Settlement Certificate on Related Contracts. Where work has been done for a political subdivision of the State or other agency, by means of approved related contract or contracts under the specifications and Department supervision, the Secretary will forward a copy of the acceptance certificate to the proper authorities. The final settlement certificate in such cases will be certified to the proper authorities for payment, after approval by the Secretary or authorized representative, instead of to the State Treasurer, as provided for work done for the State.

110.09 RELEASE OF FINAL PAYMENTS—The Secretary will authorize interest payments on the final payment due, at the rate of 6% per annum, beginning 30 calendar days after the date of physical work completion and running until the date when payment is made. If payment for an item or items is withheld due to a lack of required information from the Contractor, interest charges for the item or items will not begin to accrue until 30 days after the date the Representative receives the information required for payment. For projects financed with bonds, interest will be payable at the rate of interest of the bond issue or at the rate of 10% per annum, whichever is less.

Foreign corporations and their sureties will not be discharged from liability on the bond, nor the bond surrendered, until the corporation files the following with the Department:

- a certificate, from the Department of Revenue, proving the payment in full of all bonus taxes, penalties, and interest; and

- a certificate, from the Bureau of Employment and Unemployment Compensation of the Department of Labor and Industry, as required by the Act of June 10, 1947, P.L. 493 (8 P.S. 23).

110.10 EVALUATION, DISPOSITION, AND ADJUSTED PAYMENT OF LOW STRENGTH CEMENT CONCRETE—The following outlines procedures for the evaluation, disposition, and adjusted payment of low strength cement concrete. Use the Concrete Specification Flowchart, Section 110.10(e), as a visual guide to these procedures.

(a) General. Low strength, cast-in-place cement concrete will be evaluated using the compressive strength of concrete cylinder or concrete core test specimens. The requirements of this specification do not apply to concrete construction performed as specified in Section 506.

(b) Definitions.

- **F'(28-day).** 28-day minimum mix design concrete compressive strength (pounds per square inch), as specified in Section 704, Table A.

- **F'(c).** 28-day structural design concrete compressive strength (pounds per square inch), as specified in Section 704, Table A.

- **F'(28-cyl).** 28-day concrete compressive strength (pounds per square inch) of acceptance cylinders representing a specific concrete lot. Determined as the average of the compressive strength testing of two cylinders molded from the same sample.

- **F'(56-cyl).** When specified for bridge decks only, 56-day concrete compressive strength (pounds per square inch) of acceptance cylinders and QC cylinders representing a specific concrete lot. Determined as the average of each set of compressive strength testing of two cylinders molded from the same sample. The lower of the two averages will be used in the calculation of payment.

- **F'(cores).** 28-day concrete compressive strength (pounds per square inch) of concrete test cores representing a specific concrete non-bridge deck lot. Determined as the average of the compressive strength tests of the cores and calculated according to PTM No. 606.

- **F'(cs).** Minimum acceptable concrete compressive strength (pounds per square inch), as specified in Section 110.10, Table B.

- **CUP.** Contract Unit Price of in-place concrete as shown in the Bid Items or, for lump sum structure items, the Component Item Schedule. This value represents the cost of the in-place concrete only and does not include the cost of reinforcing steel. The cost of stay-in-place formwork and other incidental items is to be included in the contract unit price.

- **LOT.** Lot size (cubic yards).

TABLE B
Minimum Concrete Compressive Strength Requirements

Class of Concrete	Use	Minimum F'(cs) (psi)
AAAP	Bridge Deck	3,500
AAA	Other	3,500
AA	Paving	3,000
H.E.S.	Paving	3,000
AA	Structures and Misc.	3,000
A		2,500
C		2,000
H.E.S.		3,000

(c) Evaluation, Disposition, and Payment of Low Strength Cement Concrete Using Acceptance Cylinders. If F'(28-cyl), representing a specific concrete lot, fails to meet the F'(28-day) for the specified class of concrete, the concrete may be considered deficient. Disposition of the low strength concrete will be determined as follows:

1. F'(28-cyl) ≥ F'(c). If F'(28-cyl) is greater than or equal to F'(c), and the corresponding QC test result is greater than or equal to F'(c), the concrete lot may be accepted at an adjusted payment. The adjusted payment will be calculated as specified in Section 110.10(d)2 with F'(cores)=F'(28-cyl).

As an alternative, within 2 working days of notification of deficient F'(28-cyl), request permission of the Representative, in writing, to extract concrete cores from the deficient lot of concrete. If this alternative is permitted,

the procedures specified in Section 110.10(d) for extracting and evaluating the core specimens will be followed. When coring is approved, final disposition of the low strength cement concrete will be determined based solely on the compressive strength of core specimens, F'(cores). The acceptance cylinder strength will no longer be used.

2. F'(cyl) < F'(c).

2.a Non-Bridge Deck Lots. Extract core specimens from the deficient lot of concrete. Notification to core will be given by the Representative within 2 working days after receiving acceptance cylinder test results. Use the procedures specified in Section 110.10(d) for extracting and evaluating the core specimens.

2.b Bridge Deck Lots. Conduct compressive strength testing at 56-days. If F'(56-cyl) > F'(c) the lot will be accepted at full payment. If F'(56-cyl) < F'(c), the adjusted payment will be calculated as specified in Section 110.10(d)2. using F'(56-cyl) for F'(cores).

(d) Evaluation, Disposition, and Payment of Low Strength Cement Concrete Using Concrete Core Specimens. Core locations will be randomly selected within the deficient lot of concrete according to PTM No. 1. Obtain cores, under the direction and supervision of the Representative, within 1 week of notification, at no additional cost to the Department.

Obtain five cores from the deficient lot of concrete.

Obtain cores according to PTM No. 606, except as follows:

Obtain 4-inch diameter cores, which are free of reinforcing steel. A pachometer will be used to locate the reinforcing steel. If 4-inch diameter cores free of reinforcing steel cannot be obtained, smaller diameter cores may be allowed provided the core diameter is at least three times the nominal maximum size of the coarse aggregate used in the concrete mix, but not less than 2 inches.

Deliver cores immediately to the Representative. Cores will be delivered to the LTS within 3 working days. Cores will be prepared for testing according to PTM No. 606 and compressive strength testing will be conducted according to PTM No. 604.

The compressive strength test results of the core specimens will be evaluated to determine material acceptance and adjusted payment. Disposition of the low strength concrete will be determined as follows:

1. Acceptance. Material acceptance for the lot of low strength cement concrete will be determined using the minimum F'(cs) value for the specified class of concrete, as specified in Section 110.10(b), Table B and the average of the compressive strength test results of the core specimens, F'(cores) or F'(56-cyl) when applicable.

- If F'(cores) meet the minimum compressive strength listed in Table C, the lot of low strength cement concrete will be considered acceptable. Adjusted payment will be computed as specified in Section 110.10(d)2.

- If F'(cores) does not meet the minimum compressive strength listed in Table C, the lot of low strength cement concrete will be considered deficient. Remove and replace deficient lot of concrete, at no additional cost to the Department, unless otherwise directed, in writing, by the District Executive. Remove and replace reinforcement steel damaged as a result of the concrete removal process, and not conforming to requirements specified in Sections 709 and 1002, at no additional cost to the Department.

Under certain specific circumstances, the District Executive may approve allowing deficient concrete to remain in place. This approval may be granted only if all of the following conditions are met:

- The Contractor must request, in writing, that the lot of deficient concrete remain in place.

- An engineering analysis of the deficient concrete is performed at no expense to the Department.

- Adjusted Payment for the lot of deficient concrete left in place will be exactly 5% of the contract unit price (CUP) of the contract item.

- The Contractor provides a signed document waiving the right to pursue a claim as a result of the reduced payment for the lot of concrete.

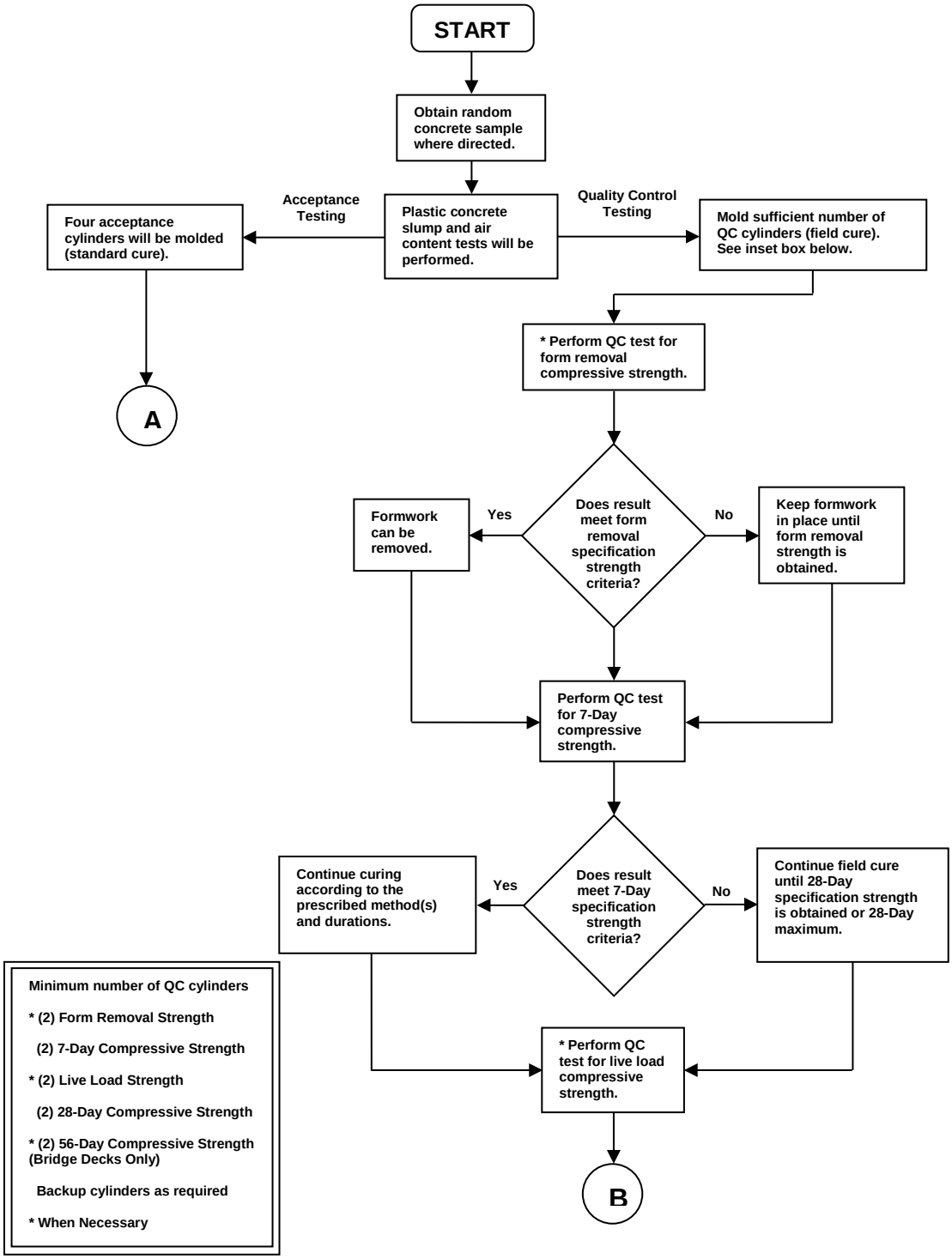
2. Payment. Adjusted payment for lot of low strength cement concrete will be computed using the Payment Factors specified in Table C. The applicable Payment Factor will be determined using the F'(c) value for the specified class of concrete, as specified in Section 704, Table A; the Minimum F'(cs) value of the specified class of concrete, as specified in Section 110.10(b), Table B including a 100 pounds per square inch, and the average of the compressive strength test results of the core specimens, F'(cores).

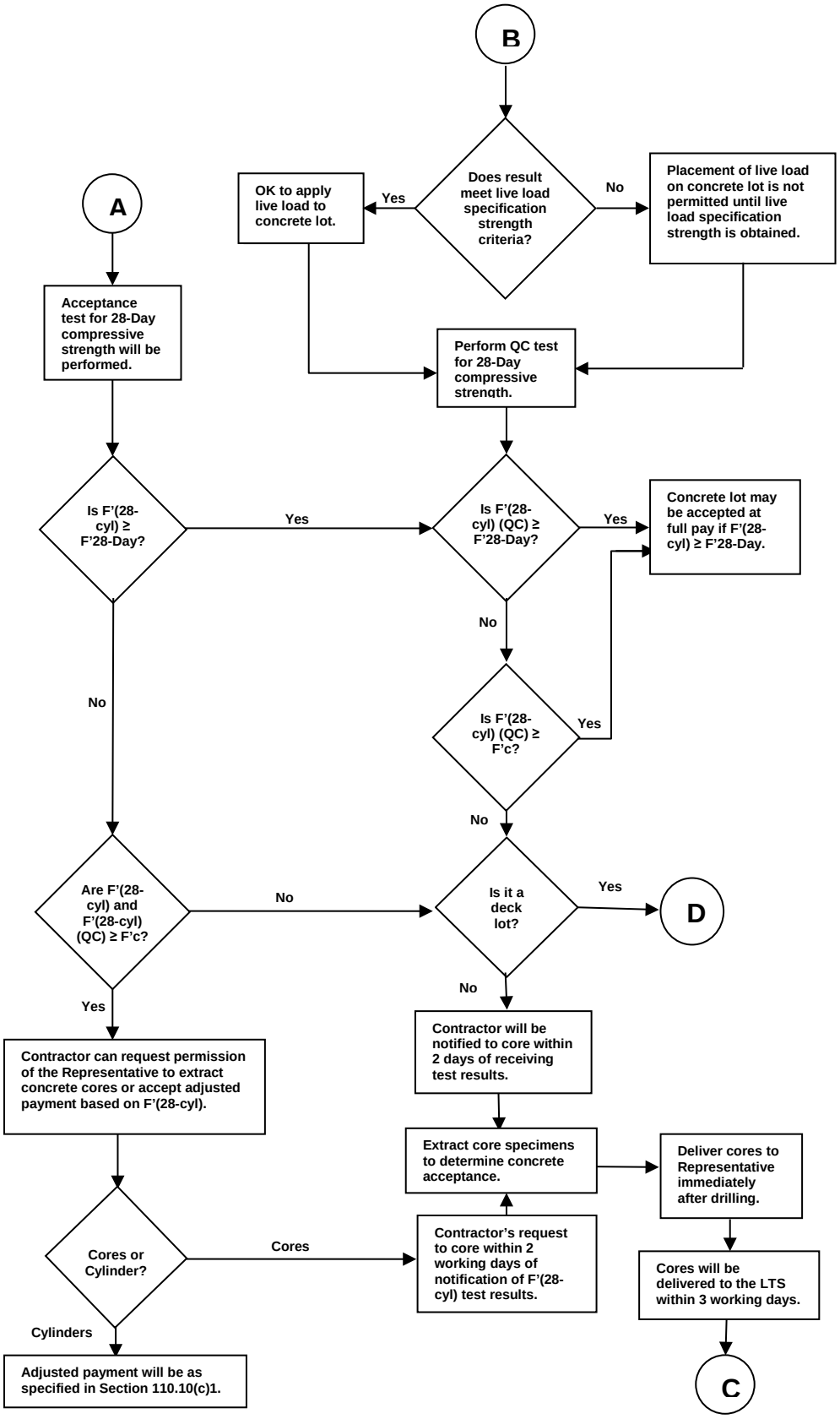
Adjusted Payment = A x CUP x LOT

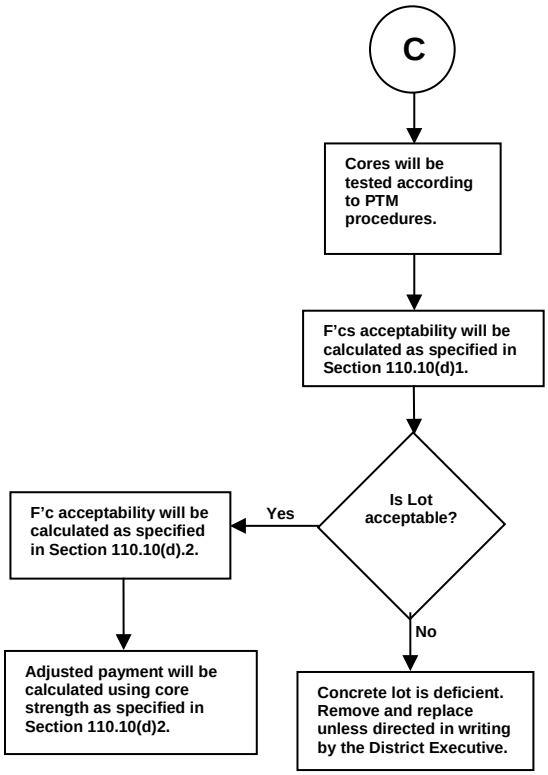
TABLE C
Low Strength Concrete Payment Factors, A

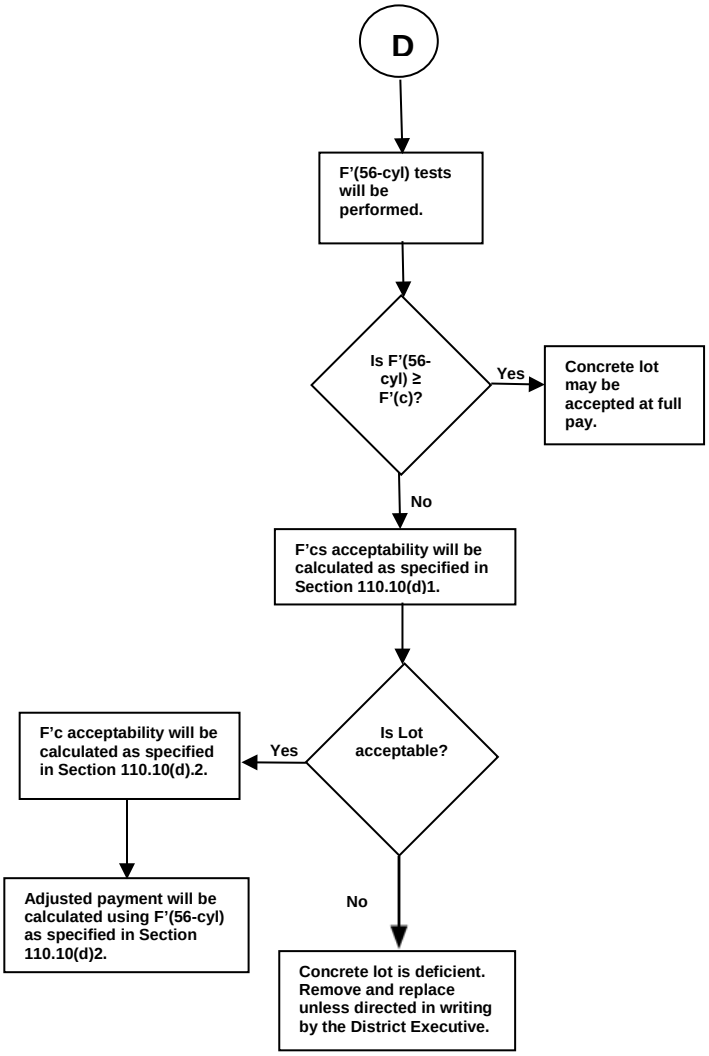
Average of Compressive Strength Test Results of Core Specimens, F'(cores)*	**Payment Factor, A**
≥ F'c	1.00
≥ F'(cs) + 400	0.99
≥ F'(cs) + 300	0.98
≥ F'(cs) + 200	0.96
≥ F'(cs) + 100	0.92

(e) Concrete Specification Flowchart.




B
Does result meet live load specification strength criteria?
Yes
OK to apply live load to concrete lot.
No
Placement of live load on concrete lot is not permitted until live load specification strength is obtained.
A
Acceptance test for 28-Day compressive strength will be performed.
Perform QC test for 28-Day compressive strength.
Is F'(28-cyl) ≥ F'28-Day?
Yes
Is F'(28-cyl) (QC) ≥ F'28-Day?
Yes
Concrete lot may be accepted at full pay if F'(28-cyl) ≥ F'28-Day.
No
Is F'(28-cyl) (QC) ≥ F'c?
Yes
No
No
Are F'(28-cyl) and F'(28-cyl) (QC) ≥ F'c?
No
Is it a deck lot?
Yes
D
No
Yes
Contractor will be notified to core within 2 days of receiving test results.
Contractor can request permission of the Representative to extract concrete cores or accept adjusted payment based on F'(28-cyl).
Extract core specimens to determine concrete acceptance.
Deliver cores to Representative immediately after drilling.
Cores or Cylinder?
Cores
Contractor's request to core within 2 working days of notification of F'(28-cyl) test results.
Cores will be delivered to the LTS within 3 working days.
Cylinders
Adjusted payment will be as specified in Section 110.10(c)1.
C


C
Cores will be tested according to PTM procedures.
F'cs acceptability will be calculated as specified in Section 110.10(d)1.
Is Lot acceptable?
Yes
F'c acceptability will be calculated as specified in Section 110.10(d).2.
Adjusted payment will be calculated using core strength as specified in Section 110.10(d)2.
No
Concrete lot is deficient. Remove and replace unless directed in writing by the District Executive.


D
F'(56-cyl) tests will be performed.
Is F'(56-cyl) ≥ F'(c)?
Yes
Concrete lot may be accepted at full pay.
No
F'cs acceptability will be calculated as specified in Section 110.10(d)1.
Is Lot acceptable?
Yes
F'c acceptability will be calculated as specified in Section 110.10(d).2.
Adjusted payment will be calculated using F'(56-cyl) as specified in Section 110.10(d)2.
No
Concrete lot is deficient. Remove and replace unless directed in writing by the District Executive.

110.11 EVALUATION, DISPOSITION, AND ADJUSTED PAYMENT OF PRESTRESSED CONCRETE BEAMS—

(a) General. Low strength concrete prestress beams will be evaluated using the compressive strength of concrete cylinder or concrete core test specimens.

(b) Definitions.

- **F'(28-day).** 28-day minimum concrete compressive strength (pounds per square inch), as specified on the approved shop drawings.
- **F'(cyl).** 28-day concrete compressive strength (pounds per square inch), of acceptance cylinders representing a beam. Determined as the average of the compressive strength of two or more cylinders.
- **F'(r).** Minimum concrete compressive strength (pounds per square inch), for transfer of prestress as indicated.
- **F'(cores).** Concrete compressive strength (pounds per square inch) of acceptance cores extracted from a beam. Determined as the average compressive strength of the cores as determined by PTM No. 606.
- **FBP.** Fabricated beam price.

(c) Evaluation, Disposition, and Payment of Low Strength Prestressed Concrete Beams Using Acceptance Cylinders. If F'(cyl), representing a specific beam, fails to meet the F'(28-day) for the specified design, the beam will be considered deficient. If F'(cyl) < F'(r), the beam will be rejected. If F'(cyl) ≥ F'(r), perform structural calculation based on F'(cyl) for the prestressed beam. Calculations must include all the original design considerations and be performed by a Professional Engineer registered in the State. Submit calculations to the BDTD's Structural Materials Section for review by the appropriate Engineering District. These calculations must be submitted within 2 weeks of notification that F'(cyl) was deficient. If the structural calculations show that the beam is not acceptable to the Department, the beam will be rejected. If the structural calculations show that the beam is serviceable in accordance with Section 106.07(c) the beam will be accepted and the adjusted payment will be computed as follows:

$$\text{Adjusted Payment} = [\,(A/B \times 0.50) + 0.50\,] \times FBP$$

where:

$A = F'(cyl) - F'(r)$
$B = F'(28\text{-day}) - F'(r)$

As an alternative, within 2 working days of notification of deficient F'(cyl), request permission of the Chief Structural Materials Engineer, in writing, to extract five concrete cores from the deficient beam. If this alternate is permitted, the procedures specified in Section 110.11(d) for extracting and evaluating the core specimens will be followed. When coring is approved, final disposition of the low strength beam will be determined based solely on the compressive strength of core specimens. The acceptance cylinder strength will no longer be used.

(d) Evaluation, Disposition, and Payment of Low Strength Prestressed Concrete Beams Using Cores. When coring is approved by the Chief Structural Materials Engineer, obtain cores, under the direction and supervision of the Representative or his or her designate, within 1 week of notification, at no additional cost to the Department.

Obtain five cores, one from each fifth of the deficient strength beam, according to PTM No. 606. Obtain cores from the portion of the beam that does not contain prestressing strands. Use a pachometer if necessary to avoid damage to the stirrups or strands. Patch holes left after coring using an approved patching material from a manufacturer listed in Bulletin No. 15 or the approved concrete mix design.

Deliver the cores to the Representative immediately upon drilling. Cores will be delivered to the LTS within 3 working days of obtaining them. No cores will be tested at an age of greater than 50 days. Cores will be prepared for testing according to PTM No. 606 and compressive strength testing will be conducted according to PTM No. 604.

The [F'(core)] and standard deviation(s) of three cores will be determined and the results sent to the supplier of the prestress beam. If F'(core) ≥ F'(28-day), the beam will be accepted at full payment; no structural analysis is required.

If F'(core) falls below F'(r), the beam will be rejected. If s ≥ 1,000 pounds per square inch and [F'(core) – s] < F'(r), the beam will also be rejected. If s < 71,000 pounds per square inch or [F'(core) – s] ≥ F'(r), perform structural calculations based on F'(core) and submit these to the Structural Materials Section as specified in Section 110.11(c). If the structural calculations show that the beam is not acceptable to the Department, the beam will be rejected. If the structural calculations show that the beam is serviceable in accordance with Section 106.07(c) the beam will be accepted at an adjusted payment. The adjusted payment will be calculated using the equation specified in Section 110.11(c), except that F'(core) will be used in place of F'(cyl).

110.12 PRICE ADJUSTMENT FOR DIESEL FUEL COST FLUCTUATIONS

(a) General. These requirements provide for a price adjustment in the form of a payment to the Contractor or a rebate to the Department for fluctuations in the cost of diesel fuel consumed in the performance of applicable construction work. These requirements apply to contract items as grouped by category. Category descriptions and the fuel usage factors which are applicable to each are as follows:

1. Categories.

1.a Category A-Earthwork. Contract items performed under Sections 203*, 204*, and 205, including any modified standard or nonstandard item where the character of the work to be performed is considered earthwork. The sum of the plan quantity for each applicable item in the category must exceed 50,000 cubic yards.

If the sum of the plan quantity for each applicable item in the category exceeds 50,000 cubic yards but is less than or equal to 1,000,000 cubic yards, the earthwork will be considered Small Excavation for adjustment purposes. If the total of the plan quantity for each applicable item in the category exceeds 1,000,000 cubic yards, the earthwork will be considered Large Excavation for adjustment purposes.

*Excluding presplit blasting and cleaning existing ditches.

1.b Category B-Subbase and Aggregate Base Courses. Contract items constructed under Sections 303, 341*, 342*, 344*, 350, 360, and Publication 447 items MS-0370-0005, MS-0370-0020, MS-0370-0030, MS-0370-0035, MS-0370-0040*, and MS-0450-0004 including any modified standard or nonstandard item where the character of the work to be preformed is considered construction of a subbase or aggregate base course. The sum of the plan quantity for each applicable item in the category must exceed 5,000 tons.

*When the coarse aggregate and asphalt material are measured and paid for under separate contract items, price adjustments, when applicable, will be computed based on the coarse aggregate item quantity (ton) only, as paid on current estimates.

1.c Category C-Flexible Bases, Pavements, Pavement Patching, and Shoulders. Contract items constructed under Sections 313 316, 410, 412, 413, 419, 420, 450, 470*, 471*, 480*, 481*, 496, 651, 653, 654**, 656**, 657, and Publication 447 items MS-0310-0011, MS-0310-0021, MS-0310-0022, MS-0310-0031, MS-0310-0032, MS-0310-0051, MS-0311-0001, MS-0340-0005, MS-0350-0018, and MS-0360-0019, including any modified standard or nonstandard item where the character of the work to be performed is considered construction of a flexible base, pavement, pavement patch, or shoulder. The sum of the plan quantity for each applicable item in the category must exceed 5,000 tons.

*When measured and paid for on a Material Used Basis, price adjustments, when applicable, will be computed based on the coarse aggregate item quantity (square yards) only, as paid on current estimates. For seal coats / surface treatments paid on an Area Basis, a depth equal to the maximum allowable size of the type of aggregate used, as specified in Section 703.2, Table C, will be assumed.

**Excluding shoulder backfill.

1.d Category D-Rigid Bases, Pavements, Pavement Patching, and Shoulders. Contract items constructed under Sections 323, 501, 502, 505, 506, 516*, 518*, 519, 520, 529, 530, 540**, 545**, and 658, including any modified standard or nonstandard item where the character of the work to be performed is considered construction of a rigid base, pavement, pavement patch, or shoulder. The sum of the plan quantity for each applicable item in the

category must exceed 10,000 square yards.

*Excluding patching joint, new pavement joint, and subbase material for concrete pavement patching.

**Excluding concrete overlay transition, concrete pavement cores, cement concrete, and surface preparation for concrete overlay.

1.e Category E- Structures. Structure work (i.e. new construction or structure rehabilitation) tabulated on an S-drawing or BPAA-drawing; whether the work is measured and paid for under a lump sum contract item (8xxx-xxxx series) plus one or more associated contract items or under one or more separate contract items; excluding any component item(s) or associated contract item(s) for fabricated structural steel, prestressed concrete bridge beams, bearings, bearing pads, and/or any design-related work such as might be included in a design-build project or when an alternate design structure is bid.

Any contract item tabulated on an S-drawing or BPAA-drawing as being a "Roadway Item" is to be included, as are the following contract items, whether or not tabulated on an S-drawing or BPAA-drawing:

- Removal of Existing Bridge / Culvert / Superstructure;
- Removal of Portion of Existing Bridge / Culvert;
- Painting of Existing Structural Steel (i.e. contract items performed under Sections 1070 and 1071, including any modified standard or nonstandard item where the character of the work to be performed is considered painting of existing structural steel;
- Containment (i.e. contract items within the 9075-xxxx series); and
- Causeway Construction and Removal (i.e. any contract item where the item description includes the word "causeway").

The value of all structure work on the project (i.e. the sum of the value of each applicable component item or contract item in the category) must exceed $1,000,000. Item value is defined as the contract item or component item quantity; as indicated on the S-drawing, BPAA-drawing, or Roadway drawing; multiplied by the contract unit price or component item unit price, as applicable.

1.f Category F-Milling. Contract items constructed under Sections 491 and 492, including any modified standard or nonstandard item where the character of the work to be performed is considered milling. The sum of the plan quantity for each applicable item in the category must exceed 10,000 cubic yards.

2. Diesel Fuel Usage Factors -

Category	Factor	Units
A - Earthwork		
• Small Excavation	0.34	Gallons per cubic yard
• Large Excavation	0.25	Gallons per cubic yard
B - Subbase and Aggregate Base Courses	0.71	Gallons per ton
C- Flexible Bases and Pavements	2.00	Gallons per ton
D-Rigid Bases and Pavements	1.77	Gallons per cubic yard
E - Structures	4.00	Gallons per $ 1,000 of work performed
F - Milling	1.15	Gallons per cubic yard

3. Quantity Conversion Factors -

Category	Conversion	Factor
B	square yard to ton	90 lbs/inch of depth/square yard

B	cubic yard to ton	3,240 lbs/cubic yard
C	square yard to ton	110 lbs/inch of depth/square yard
D	square yard to cubic yard	inches of depth/36
F*	square yard to cubic yard	inches of depth/36

*For variable depth milling, an average milling depth of 2 inches will be assumed. For profile milling, an average milling depth of 1 inch will be assumed.

(b) Index Prices. The Department posts a monthly index price for Ultra Low Sulfur (ULS), No. 2 Diesel Fuel using price data obtained, on the last Wednesday of the preceding month, from the Oil Price Information Service (OPIS), which publishes a weekly report on gasoline and distillate reseller prices for cities in the Eastern U.S. Price data reported for Harrisburg, Philadelphia, and Pittsburgh are averaged together to determine the statewide index price.

The price index, FB, will be the index price posted by the Department, determined as specified above, for the month in which the project is advertised.

The price index at the time of performance, FP, will be the index price posted by the Department, determined as specified above, for the month during which applicable contract work is performed.

(c) Price Adjustment Criteria and Conditions. The following criteria and conditions will be considered in determining a price adjustment for diesel fuel cost fluctuations.

1. No Price Adjustment. When the ratio FP/FB falls within the range of 0.95 to 1.05, no price adjustment will be made for any diesel fuel consumed in construction work performed during the relevant month.

2. Price Rebate. When the ratio FP/FB is calculated to be less than 0.95, the Department will receive an automatic price rebate determined in accordance with the following formula:

$$P.R. = (0.95 - FP/FB)(Q)(FB)(F)$$

where:

P.R. = Price Rebate
FP = Price Index for the month during which the diesel fuel is consumed in the performance of applicable construction work.
FB = Price Index
Q = Quantity of eligible Category items as reported on current Estimates. Item quantities will be converted, as necessary, to agree with the units associated with the applicable Diesel Fuel Usage Factor.
F = Diesel Fuel Usage Factor

3. Price Increase. When the ratio FP/FB is calculated to be greater than 1.05, the Contractor will receive a price increase to be determined in accordance with the following formula:

$$P.I. = (FP/FB - 1.05)(Q)(FB)(F)$$

where:

P.I. = Price Increase
FP = Price Index for month during which the diesel duel is consumed in the performance of applicable construction work.
FB = Price Index
Q = Quantity of eligible Category items as reported on current Estimates. Item quantities will be converted, as necessary, to agree with the units associated with the applicable Diesel Fuel Usage Factor

F = Diesel Fuel Usage Factor

4. Payment/Rebate. The price adjustment will be paid, or rebated, upon approval of a contract adjustment to be prepared on a quarterly basis. Quarterly price adjustments amounting to less than $1,000 will be disregarded.

5. Expiration of Contract Time. When eligible items of work are performed after expiration of contract time and liquidated damages are chargeable the value of FP used to compute the price adjustment will be either the Price Index at the time of actual performance or the Price Index at the time contract time expired, whichever is less.

6. Final Quantities. Upon completion of the work and determination of final pay quantities, a final contract adjustment may be prepared to reconcile any difference between estimated quantities previously paid and the final pay quantities. In this situation, the value for FP used in the price adjustment formula will be the average of all FP' s previously used for computing price adjustments.

7. Inspection of Records. The Department, through the Office of Inspector General, reserves the right to inspect the records of the prime contractor and its subcontractors and material suppliers to ascertain actual pricing and cost information for the diesel fuel used in the performance of applicable items of work.

8. Extra Work. When applicable items of work, as specified herein, are added to the contract as Extra Work, as specified in Section 110.03, no price adjustment will be made for fluctuations in the cost of diesel fuel consumed in the performance of the extra work, unless otherwise approved by the Representative at the time written authorization to perform the extra work is submitted. The current price for diesel fuel is to be used when preparing required backup data for extra work to be performed at a negotiated price. For extra work performed on force account basis, reimbursement for material, equipment, and service by others costs along with specified overhead and profit markups will be considered to include full compensation for the current cost of diesel fuel.

110.13 EVALUATION, DISPOSITION, AND PRICE ADJUSTMENT OF LOW STRENGTH PRECAST CONCRETE PRODUCTS

(a) General. Low strength precast concrete products will be evaluated using the compressive strength of concrete core test specimens. This policy applies to non prestressed precast concrete products where the minimum structural design strength is equal to the 28-day minimum concrete compressive strength. Where precast concrete products are designed with a minimum structural concrete strength less than the 28-day minimum compressive strength, evaluation and disposition will be in accordance with Section 110.10.

(b) Definitions.

- **F'(28-day).** 28-day minimum concrete compressive strength (pounds per square inch), as specified on the Standard Drawings or on the approved shop drawings.

- **F'(cyl).** 28-day concrete compressive strength (pounds per square inch) of acceptance cylinders representing the lot of precast concrete products. Determined as the average of the compressive strength of two or more cylinders.

- **F'(cores).** Concrete compressive strength (pounds per square inch) of acceptance cores extracted from the precast concrete products. Determined as the average compressive strength of all cores from the lot as determined according to PTM No. 606.

- **Lot.** One shifts production and produced from a single mix design at the same water/cement ratio.

(c) Evaluation and Disposition of Low Strength Precast Concrete Products Using Cores. If F'(cyl), representing a specific lot of precast concrete products, fails to meet the F'(28-day) for the specific product, the lot of precast concrete products will be considered deficient.

Request permission from the Chief Structural Materials Engineer, in writing, to extract cores from the deficient lot within 2 working days following testing and determination that F'(cyl) < F' (28-day) Obtain cores under the direction and supervision of the Representative or his or her designate within 2 working days following authorization for coring

and evaluation, at no additional cost to the Department. The Representative will affix their inspection stamp using indelible ink on each core to provide verification and traceability. Deliver cores to the LTS within 3 working days from the date coring and evaluation was approved. Use a pachometer to avoid damage to the reinforcing steel. Patch holes left after coring using the approved concrete mix design or an approved concrete repair material a manufacturer listed in Bulletin 15 that will achieve the minimum concrete design strength. For products with architectural finishes, obtain advance approval for the repair methods and materials from the Department.

Determine the total number of cores required for evaluation of the lot from the cube root of the number of precast concrete products produced for that lot rounded to the nearest whole number. A minimum of five cores are required, regardless of the lot size.

Cores will be obtained and compressive strength testing conducted according to PTM No. 606.

If F'(cores) > F'(28-day), the lot of precast concrete products is considered serviceable in accordance with Section 106.07(c) and will be accepted. If F'(cores) < F'(28-day), the lot is considered deficient and will be rejected.

(d) Price Adjustment and Payment for Low Strength Concrete Acceptance Testing Using Concrete Core Specimens. If a specific lot of precast concrete products is determined to be deficient by failing to meet F'(cyl) > F'(28-day) but is considered serviceable by meeting F'(cores) > F'(28-day), the lot will be accepted and the contract unit price (CUP) will be reduced by 5% for the lot.

110.14 PRICE ADJUSMENT FOR STEEL COST FLUCTUATIONS

These requirements provide for a price adjustment, in the form of a payment to the Contractor or a rebate to the Department, for fluctuations in the cost of the steel used in the applicable materials placed as part of the construction work specified in Sections 620, 621, 948, 1002, 1005, 1050, 1056, 1080, and 1085.

(a) General. These price adjustment provisions apply to items in the contract Schedule of Prices, as specified above, including any modified standard or non-standard item where the work to be performed includes incorporation of one or more of the applicable steel materials specified in the above Sections and addressed herein. Additionally, items in the Component Item Schedule (CIS) for an "as-designed" or alternate design structure, as well as work performed under a design-build contract, will be included when applying the specified price adjustment requirements, provided the work to be performed includes incorporation of one or more of the applicable steel materials specified in the above Sections and addressed herein. Terminal sections, end treatments, transitions, and transition treatments associated with guide rail and metal median barrier work; as well as mechanical splice systems, pile tip reinforcement, high load multi-rotational bearings, shear connectors, and scuppers; will not be subject to the price adjustment criteria and conditions specified herein.

To elect to have these price adjustment provisions apply to one or more of the steel product categories identified herein, when planned for incorporation into a specific project, advance notification must be submitted to the Department. The apparent low bidder is required to submit the Steel Escalation Option form attached to the proposal, via email to steeloptions@pa.gov or fax to 717-265-7208 by 3:00 pm prevailing local time within 7 calendar days after the bid opening. When the seventh calendar day after the bid opening falls on a day PENNDOT offices are closed, submit the Steel Escalation Option form by 3:00 pm prevailing local time on the next business day. If a properly completed Steel Escalation Option form is not provided by the apparent low bidder within the time specified, the Department will consider the option to apply these price adjustment provisions to the project to be declined. Furthermore, if a Steel Escalation Option form, when provided within the specified time, has been completed such that the Department is unable to ascertain the bidder's intention with regard to the inclusion of any one of the applicable steel product categories, the Department will consider the option to apply these price adjustment provisions to that product category to be declined. No further opportunity to elect steel escalation for the project or an individual steel product category will be made available. In the event the apparent low bid is rejected, the next lowest bidder will be notified to submit the Steel Escalation Option form by 3:00 pm prevailing local time within 7 calendar days after notification.

The Department posts a monthly index price for steel ($ per ton) based on data obtained from the U.S. Department of Labor (USDOL), Bureau of Labor Statistics, which publishes monthly Producer Price Index (PPI) values for various commodities. The statewide index price for steel will be based on the PPI value posted by USDOL for "Semi-finished

Steel Mill Products" (Series ID: WPU101702). The Department will post its monthly index price for steel after the USDOL lists the PPI value on which it is based as final.

The "base / benchmark" index price, SB, will be the steel index price posted by the Department, determined as specified above, for the month in which project letting occurred.

The "invoice" index price, SI, will be the steel index price posted by the Department, determined as specified above, for the month in which applicable steel material is invoiced.

Steel material will be considered invoiced as of the date when an invoice from the steel mill providing the necessary raw material is sent to the Contractor or to a subcontractor, fabricator, manufacturer, or supplier. The steel price adjustment provisions specified herein are not applicable to raw steel material having a mill invoice date that precedes the project letting date. On a quarterly basis, provide documentation of the invoice date for applicable steel material incorporated into the work during the prior 3-month period. Documentation is to be in the form of a tabulation that lists all material invoiced during the period, in chronological order by invoice date; the quantity invoiced; and the applicable contract item(s) and corresponding project location(s) where the invoiced quantity or portion thereof was incorporated, along with copies of supporting invoices. Have a representative of the Contractor, authorized to make such statements, certify that the information provided in the tabulation is complete and accurate and may be relied upon by the Department.

Failure to provide the required tabulation within 10 calendar days of the end of each, applicable 3-month period will result in the Department computing a price adjustment (rebate or increase) using a value for SI that results in the greatest possible price rebate or least possible price increase based on the monthly index prices posted by the Department, to date, since work on the project began.

(b) Price Adjustment Criteria and Conditions. The following criteria and conditions will be considered in determining a price adjustment for steel cost fluctuations.

1. No Price Adjustment. When the ratio SI/SB falls within the range of 0.95 to 1.05, no price adjustment will be made for applicable steel material having an invoice date that falls within the month for which the SI index price was posted.

2. Price Rebate. When the ratio SI/SB is calculated to be less than 0.95, the Department will receive an automatic price rebate, for applicable steel material having an invoice date that falls within the month for which the SI index price was posted, to be determined in accordance with the following formula:

P.R. = (0.95 - SI / SB) (SB) (ST)

where:

P.R. = Price Rebate

SI = Index price for the month in which applicable steel material is invoiced.

SB = Index price for the month in which project letting occurred.

ST = Quantity (tons) of applicable steel material incorporated into the work during the applicable 3-month period.*

*Computed based on the quantity paid, under applicable contract items, on current estimates processed during the 3-month period addressed in the tabulation provided by the Contractor. Not to exceed the total tonnage of applicable steel material invoiced during the month for which the SI index price was posted, as shown on the Contractor's tabulation.

3. Price Increase. When the ratio SI/SB is calculated to be greater than 1.05, the Contractor will receive a price increase, for applicable steel material having an invoice date that falls within the month for which the SI index price was posted, to be determined in accordance with the following formula:

P.I. = (SI / SB - 1.05) (SB) (ST)

where:

P.I. = Price Increase

SI = Index price for the month in which applicable steel material is invoiced.

SB = Index price for the month in which project letting occurred.

ST = Quantity (tons) of applicable steel material incorporated into the work during the applicable 3-month period.*

* Computed based on the quantity paid, under applicable contract items, on current estimates processed during the 3-month period addressed in the tabulation provided by the Contractor. Not to exceed the total tonnage of applicable steel material invoiced during the month for which the SI index price was posted, as shown on the Contractor's tabulation.

4. Equivalent Tonnage. For applicable steel material furnished under a separate contract item, under a design-bid-build contract, or under a design-build contract the equivalent steel tonnage will be computed as indicate in the following sections.

For design-build contracts, provide an itemized breakdown of the applicable steel materials addressed herein incorporated into the work and indicate the quantity of each actually installed. Indicated quantities should be based on field measurements or take-offs from the approved plans or shop drawings and be equivalent to those used to compute payments made against the Lump Sum construction item on current estimates.

4.a Guide Rail and Metal Median Barrier. For applicable guide rail and metal median barrier components (i.e. rail elements, posts, and rubbing rail) furnished under separate contract items or as part of a single contract item for guide rail / metal median barrier complete in place, the equivalent steel tonnage is computed as follows:

4.a.1 Guide Rail or Median Barrier Rail Element (Weak Post or Strong Post).

Steel Tonnage (ST) = 7.84 (Q) / 2000

where:

Q = Quantity (linear feet) of weak post or strong post guide rail element paid on current estimates processed during the applicable 3-month period

4.a.2. Type 2W Posts.

Steel Tonnage (ST) = 8.67 (L) (Q) / 2000

where:

L = Length of each post (feet) as required by the Standard Drawings or as specified

Q = Quantity (each) of Type 2W posts paid on current estimates processed during the applicable 3-month period.

4.a.3 Type 2S Posts.

Steel Tonnage (ST) = 9.17 (L) (Q) / 2000

where:

L = Length of each post (feet) as required by the Standard Drawings or as specified

Q = Quantity (each) of Type 2S posts paid on current estimates processed during the applicable 3-month period

4.a.4 Rubbing Rail.

Steel Tonnage (ST) = 8.56 (Q) / 2000

where:

Q = Quantity (linear feet) of rubbing rail paid on current estimates processed during the applicable 3-month period

4.b Reinforcement Bars. For applicable reinforcement bars furnished under a separate contract item, as a component item associated with an alternate design structure, or as a component item associated with a design-build contract, the equivalent steel tonnage is computed as follows:

Steel Tonnage (ST) = (Q) / 2000

where:

Q = Quantity (pounds) of reinforcement bars paid on current estimates processed during the applicable 3-month period.

4.c Piles. For applicable steel beam bearing piles, cast-in-place concrete bearing piles, cast-in-place concrete piles, and steel pipe piles, furnished under a separate contract item, as a component item associated with an alternate design structure, or as a component item associated with a design-build contract, the equivalent tonnage is computed as follows:

4.c.1 Steel H-Piles.

Steel Tonnage (ST) = (UW) (Q) / 2000

where:

UW= Unit Weight of the Steel Beam* (pounds per foot)

Q = Quantity (linear feet) of steel piles paid on current estimates processed during the applicable 3-month period.

* The unit weight of steel will be the second of the two numbers associated with the size designation for the beam as cited in the item description (i.e. If the item description is "Steel Beam Bearing Piles, HP12x74", the unit weight of the steel is 74 pounds per foot).

4.c.2 Cast-in-Place Concrete Piles.

Steel Tonnage (ST) = 2.80 (D) (Q) / 2000

where:

D = Diameter of the steel shell (inches)*

Q = Quantity (linear feet) of cast-in-place concrete piles paid on current estimates processed during the applicable 3-month period.

* From the approved structure Plans or field measurements. For cylindrical shells of varying diameter, a weighted average diameter will be used, computed based on the number of shells of each diameter actually installed. For tapered shells, an average diameter will be used, computed as the average of the shell diameters at the butt end and at the tip.

4.c.3 Pipe Piles.

Steel Tonnage (ST) = 6.70 (D) (Q) / 2000

where:

D = Diameter of the steel pipe (inches)*

Q = Quantity (linear feet) of pipe piles paid on current estimates processed during the applicable 3-month period.

* From the approved structure Plans or field measurements.

4.d Steel Sign Structure. For applicable steel sign structures constructed under a separate contract item, the equivalent tonnage is computed as follows:

Steel Tonnage (ST) = (Q) / 2000

where:

Q = Quantity (pounds) of steel in each sign structure, or portion thereof, paid on current estimates processed during the applicable 3-month period.*

*Not to exceed the estimated weight of each sign structure as indicated on the structure Plans.

4.e Fabricated Structural Steel. For applicable fabricated structural steel; furnished under a separate contract item, as a component item associated with an "as-designed" or alternate design structure, or as a component item associated with a design-build contract; the equivalent tonnage is computed as follows:

Steel Tonnage (ST) = (Q) / 2000

where:

Q = Quantity (pounds) of fabricated structural steel girders, rolled beams, angle, and plate paid on current estimates processed during the applicable 3-month period.

4.f Precast Reinforced Concrete Box Culverts and Prestressed Concrete Bridge Beams. For applicable precast reinforced concrete box culvert segments and prestressed concrete bridge beams; furnished under a separate contract item, as a component item associated with an "as-designed" or alternate design structure, or as a component item associated with a design-build contract; the equivalent tonnage is computed as follows:

Steel Tonnage (ST) = (UW)(Q)/2000

where:

UW= Unit Weight (pounds per foot) of reinforcing steel in a box culvert segment or of reinforcing steel and prestressing strands in a prestressed bridge beam.*

Q = Quantity (linear feet) of precast reinforced concrete box culvert segments and prestressed concrete bridge beams paid on current estimates processed during the applicable 3-month period.

* Submit documentation indicating the weight (pounds) of reinforcing steel included in and the length (feet) of each box culvert segment, and the weight (pounds) of mild reinforcing steel and prestressing strands included in and the length (feet) of each prestressed bridge beam. UW will be computed as the average of the unit weight of steel (i.e. weight of steel divided by length) in each box culvert segment, or as the average of the unit weight of steel (i.e. weight of steel divided by length) in each prestressed bridge beam. Documentation must be submitted at the time required shop drawings are submitted for approval.

5. Payment/Rebate. The price adjustment will be paid, or rebated, upon approval of a contract adjustment to be prepared on a quarterly basis as applicable work is completed. Cumulative quarterly price adjustments amounting to less than $1,000 will be disregarded.

6. Expiration of Contract Time. When eligible materials are purchased after expiration of contract time and liquidated damages are chargeable, the value for SI used to compute the price adjustment will be either the index price for the month in which applicable steel material is invoiced or the index price at the time contract time expired, whichever is less.

7. Final Quantities. Upon completion of the work and determination of final pay quantities, a final contract adjustment may be prepared to reconcile any difference between estimated quantities previously paid and the final quantities. In this situation, the value for SI used in the price adjustment formula will be the average of all SI values previously used for computing price adjustments.

8. Inspection of Records. The Department, through the Office of Inspector General, reserves the right to inspect the records of the prime contractor and its subcontractors and material fabricators and suppliers to ascertain actual invoicing dates and quantity information for the steel material used in the performance of applicable items of work.

9. Extra Work. When applicable items of work, as specified herein, are added to the contract as Extra Work, as specified in Section 110.03, no price adjustment will be made for fluctuations in the cost of the steel used in manufacturing the materials placed during performance of the extra work. The current price for steel is to be used when preparing required backup data for extra work to be performed at a negotiated price. For extra work performed on a force account basis, reimbursement of actual material costs, along with the specified overhead and profit markup, will be considered to include full compensation for the current cost of steel.

SECTION 111—DELAY CLAIMS

111.01 COMPENSABLE DELAYS—The Department is responsible for delay damages arising only from delays created by its negligent acts or omissions and from Utility Infrastructure and Utility Adjustment delays as specified in Section 105.06. Unless otherwise specified, assume the risk of damages from all other causes of delay.

111.02 GENERAL CONDITIONS CONCERNING DELAY CLAIMS—Because of the nature and extent of damages arising out of work that has been delayed; of the need for the Department to be made aware of potential delay claims promptly after the cause or causes of delay have arisen so that record-keeping can begin; and of the parties' intent to have all such claims as fully documented as possible, strict adherence to the provisions of this section is an essential condition precedent to filing a delay claim with the Board of Claims. The following items of damage cannot be included in any delay claim against the Department:

- profit;
- loss of profit;
- labor inefficiencies;
- home office overhead, including but not limited to costs of any kind for home office personnel; and
- consequential damages, including but not limited to loss of bonding capacity, loss of bidding opportunities, and insolvency.

111.03 NOTIFICATION OF DELAY CLAIM—Notwithstanding the provisions specified in Section 105.01, within 10 calendar days of any negligent act or omission of the Department or of any Utility Infrastructure or Utility Adjustment delay as specified in Section 105.06, notify the Inspector-in-Charge that operations have been or will be delayed and that a claim for delay damages either is going to or might be filed with the Board of Claims. Confirm such notification in writing to the District Executive within 10 calendar days of such notification to the Inspector-in-Charge.

111.04 PROCEDURES—Upon notifying the Inspector-in-Charge as provided above, keep records, on a daily basis, of all labor, material, equipment, and site overhead expenses for all operations that are affected by the delay. Identify in such daily records each operation and the station or stations thereof affected by the delay. The Department’s forces will also keep daily records of all labor, equipment, material, and site overhead expenses for all operations affected by the delay. On each Monday, compare the previous week's daily records with those kept by the Department and review for accuracy. Report to the District Executive, within 10 calendar days of each such review, all disagreements with such records. Refusal or failure to meet to review the Department's records or to report disagreements with such records will create an irrebuttable presumption in favor of the Department that its records are accurate. Make no claim for delay costs of any kind allegedly incurred, before notifying the Inspector-in-Charge that operations have been delayed.

On a weekly basis, prepare and submit to the Inspector-in-Charge written reports containing the following information:

(a) The number of days behind schedule.

(b) An identification of all operations that have been, or are to be delayed.

(c) An explanation of how the Department's negligent act or omission or the Utility Infrastructure or Utility Adjustment as specified in Section 105.06 delayed each operation, and an estimation of how much time is required to complete the project.

(d) An itemization of all extra costs being incurred, including:

- An explanation as to how those extra costs, including site overhead costs, relate to the delay and how they are being calculated and measured;
- An identification of all project employees for whom costs are being compiled; and
- An identification of the manufacturer's numbers for all items of equipment for which costs are being compiled.

Upon completion of the project, submit to the Inspector-in-Charge and the District Executive copies of a report containing the following information:

- An itemization and explanation of the measurement and basis of all extra costs being sought, including all reports certified by an accountant;
- A description of the operations that were delayed, including all reports by scheduling experts or other consultants, if any;
- All actions taken by the Contractor to minimize the delay and to minimize the delay costs incurred;
- An as-built chart, CPM scheme, or other diagram, depicting in graphic form how the operations were adversely affected; and,
- For delays related to Utility Infrastructure and Utility Adjustments, an explanation of why the delay was unforeseen based on the contract documents and a careful pre-bid examination of the project site, or of any waste or borrow sites designated in the proposal.

The District Executive will review the submission and any reports prepared by the Inspector-in-Charge. If, in the opinion of the District Executive, the Department is not liable for any delay, a written decision will be issued. Comply with the provisions of Section 105.01 if the District Executive's decision is disputed.

If the District Executive determines that the Department delayed operations, a review of the damages claimed will be made and a written decision will be issued. Comply with the provisions of Section 105.01 if the District Executive's decision is disputed. For operation delayed by a Utility Infrastructure or Utility Adjustment as specified in Section 105.06, concurrence of the district Executive’s decision by the Director of Project Delivery is also required.

Only expenses for extra labor, material, equipment, and site overhead will be considered by the Department. Ten percent will be added to these costs to cover allocable home office overhead. Likewise, in the event a delay claim is filed with the Board of Claims, only the foregoing expenses may be claimed.

When computing additional equipment expenses, do not use, in any way, the Rental Rate Blue Book for Construction Equipment or any other rental rate book. For equipment that is owned, use actual records kept in the usual course of business, and compute increased ownership expenses pursuant to Generally Accepted Accounting Principles (GAAP). For equipment that is rented or leased, use the rental agreement or actual invoices to compute increased rental expenses. Equipment that is rented or leased from an entity that is a division, affiliate, or subsidiary of, or that is in any other way related to, the Contractor or its parent company, will be considered owned equipment.

SECTION 112—PROJECT RECORDS

112.01 SCOPE—This section pertains to all project records that were used to prepare and compute the bid; to prepare all schedules used on the project; to record the progress of work on the project; and to record, compute and/or analyze all costs incurred on the project, including those used in the preparation or presentation of claims to the Department or the Board of Claims.

112.02 DEFINITION—Charts, graphs, cross-sections, plans, photographs, schedules, reports, accounting statements, accounting ledgers, balance sheets, bid sheets, take-off sheets, cost estimates, cost records, payroll records, financial documents, notes, memoranda, correspondence, and all other records, whether typewritten, handwritten, computerized, microfilmed, photographed, or recorded, that were prepared by or received by the Contractor.

112.03 RETENTION PERIOD—Retain the aforementioned project records for a period of 3 years from the date of receipt of final payment with the following exception:

- If any litigation, claim, or audit is started before the expiration of the 3-year period, retain the records until all litigations, claims, or audit findings involving the records have been resolved.

112.04 INSPECTION—Upon written notice by the Representative or an authorized agent acting on behalf of the Department, make available all requested project records for inspection and copying by Department personnel or those authorized to act on its behalf. Make such records available at a reasonable time and place.

Refusal or repeated failure to present requested project records for inspection or copying may be considered grounds for declaring the Contractor in default and may be considered against prequalification for work on future projects.

Exempt from this section are all project records, which under the Pennsylvania Rules of Civil Procedure, are deemed confidential and, therefore, exempt from discovery.

112.05 RELEASE OF ELECTRONIC VERSION OF PROJECT PLAN FILES--After executing the Contract the Department may, if requested in writing, provide the existing available electronic version of the project plan files (the Commonwealth of Pennsylvania's (Commonwealth's) Intellectual Property) to the Contractor subject to the terms and conditions of this specification.

The Department's Project Manager will determine the content of the electronic files to be released.

The Department does not warrant or guarantee the information and data in the electronic version of the project plan files as a substitute for the sound engineering judgment of the Contractor.

Do not assume any proprietary rights to or interest in the Commonwealth's Intellectual Property. Hold, maintain, and protect the Commonwealth's Intellectual Property in the strictest confidence. Do not transfer any translated or converted form of the information or data in any manner without written permission of the Department.

Do not copy, distribute, sell, rent, sub-license, or lease the Commonwealth's Intellectual Property to any third parties or use the files or any translated or converted form of the files to produce, market, or support Contractor owned products. The provisions set forth in this paragraph are not intended to supplant a Contractor's right to allow access to its sub-contractors.

After payment of the final invoice for work and services provided by the Contractor as part of the Contract, one electronic copy of the information and data contained in the Commonwealth's Intellectual Property or any translated or converted form of its Intellectual Property may be retained for archival purposes only. However, all rights in the Intellectual Property including documents, sketches, drawings, designs, papers, reports, computer programs, data, computer documentation, and other tangible materials authored, prepared and transmitted by the Department constitute and remain the Intellectual Property of the Commonwealth.

The electronic version of the project plan files are provided by the Department, "AS IS," without any covenant, representation or warranty of any kind or nature whatsoever, express or implied. Indemnify and hold harmless the Department, its officials and employees for any injury to the person or property of third parties arising out of the use of or any defect in the Commonwealth's Intellectual Property or any translated or converted form of these files or any

accompanying documentation. All copies of the Commonwealth's Intellectual Property remain the property of the Commonwealth, acting through Department, and any rights involving the copyright law, patent law, trademark law, and trade secret law remain with the Commonwealth. All goodwill remains with the Commonwealth.

SECTION 200
EARTHWORK

SECTION 201—CLEARING AND GRUBBING

201.1 DESCRIPTION—This work is:

- Removal of the first 8 inches of topsoil and organic material.
- Removal of topsoil and organic matter such as trees, stumps, brush, roots, and other vegetation within the limits of grading, including ditches and channels. When indicated, perform tree trimming and selective tree removal outside of the limits of grading as specified in Section 810.
- Removal of objectionable material, rubbish, and junk within the project limits.
- Removal of buildings and structures, fences, walls, guide rail posts, guide rails, signs, direction markers, and other obstructions interfering with the work.
- Disposal of removed material.
- Salvaging, temporarily storing, and delivering of material.
- Obtaining of waste areas for disposal of material as specified in Section 105.14.
- Stockpiling of topsoil mixture as specified in Section 801.
- Chipping and stockpiling wood waste material, if specified in the Special Provisions.

201.3 CONSTRUCTION—Clear and grub before the start of grading operations in an area. The Contractor may remove stumps within excavation areas during grading. Replace suitable material and topsoil that is required on the project and was wasted during clearing and grubbing operations, at no additional cost to the Department.

Do not damage trees or other vegetation beyond the grading limits. Install protective fencing as indicated, as specified in Section 811, before clearing and grubbing operations.

Clear the ground of organic matter within excavation areas. Remove stumps and roots to a depth of at least 2 feet below subgrade or slope surfaces.

Remove organic matter and topsoil within embankment areas to a depth of 8 inches below the existing ground to 20 feet beyond the pavement edges. Beyond 20 feet of the pavement edges and within the embankment area, cut trees and stumps flush with the ground surface. Remove remaining topsoil over 8 inches in depth, when directed, as specified in Section 203. Stockpile removed topsoil as specified in Section 801.

Trees and shrubs along a highway previously opened to traffic belong to the property owner. Surrender all material from the removal of trees and shrubs to the owner of the abutting property. Dispose of the trees and shrubs if the owner refuses to accept the wood.

Transport wood chips to approved stockpile areas that will not interfere with construction operations, obstruct drainage, or cause water pollution.

Dispose of material in an approved waste area, unless otherwise specified in the Special Provisions. Review and comply with all Federal, State and Local regulations governing burning. If burning is allowed, obtain permits and burn in accordance with regulations. Comply with the requirements of the Air Pollution Control Act (Act 245-1972, or as amended), the Solid Waste Management Act (Act 97-1980, or as amended), and the permits specified in Section 107.27(a), whichever are applicable. Do not burn within 40 feet of remaining vegetation. Recondition the sites of fires as specified in Section 105.14.

When an enclosure fence is partly or wholly within the right of way, notify the property owner 30 days in advance of clearing and grubbing operations to allow the owner to make necessary arrangements to restore the enclosure. Upon failure of the property owner to proceed with work required to enclose the property, carefully remove the fence within the right of way and neatly pile material on the owner's property adjacent to the right of way.

201.4 MEASUREMENT AND PAYMENT—Lump Sum

If no item of work is provided in the contract, this work is incidental to the other contract items.

SECTION 202—TOTAL DEMOLITION OR PARTIAL DEMOLITION OF BUILDINGS AND OTHER STRUCTURES

202.1 DESCRIPTION—This work is total or partial demolition of buildings and other structures, as indicated. The following definitions apply:

(a) Total Demolition. This work is the removal of indicated buildings and other structures located wholly within the right of way.

(b) Partial Demolition. This work is the removal of indicated buildings and other structures located partly within the right of way. Demolish and remove only the portion within the right of way, unless the owner of the remaining portion requests and authorizes total demolition in writing.

(c) Refinishing Party Walls. Refinishing of the exposed portion of the party wall, including the party wall foundation.

202.2 MATERIAL—

(a) Cement, Type IS, IP, or II. Section 701

(b) Fine Aggregate, Type A. Section 703.1

(c) Lime. Section 723

(d) Water. Section 720.1

(e) Emulsified Asphalt, Class E-1 or E-2. Section 702

(f) Caulking Compound. Section 705.8

(g) Other Material. Certify as specified in Section 106.03(b)3.

- Metal Mesh Lath, 3.4 pounds per square yard—FSS QQ-L-101a
- Roofing Material, 65 pounds per roll—ASTM D 224
- Insulating Board—ASTM C 578, Types I and II, Grades 2 and 3
- Asphalt Mastic—FSS SS-C-153

202.3 CONSTRUCTION—

(a) General. Confine movements and operations to the existing right-of-way limits. Do not deposit construction material, junk, debris, or rubbish on private property. Do not enter private property without first obtaining the written consent of the property owner or owners, and filing a copy of the consent with the Department.

The Department will obtain the vacation of all buildings or structures to be demolished as expeditiously as possible. The Department does not guarantee that all facilities will be vacated and available in sufficient time to allow systematic operations.

The Department does not assume responsibility for the condition of the various buildings or loss of fixtures, equipment, material, or other objects between submittal of the proposal and actual possession of the buildings.

Remove and dispose of material taken from within the project limits as well as debris and rubbish, except items of personal property belonging to owners or tenants and material required for backfilling. Remove material from the project limits as it accumulates, or as directed. Conduct no sale of material while within the project limits.

Comply with the requirements, outlined in Pennsylvania's Asbestos Occupations Accreditation and Certification Act of 1990 (Acts 194 and 161) as well as Federal National Emission Standard for Hazardous Air Pollutants (NESHAP) regulations, for providing notification to all State and County agencies having regulatory enforcement responsibility for demolition and asbestos abatement projects prior to the start of any such work. Such notification should be made using the "Asbestos Abatement and Demolition/Renovation Notification Form," which may be obtained by contacting the DEP Asbestos Office at (717) 787-9257, or the nearest DEP regional office. The form may also be obtained here.

(b) Safety Regulations. Furnish, erect, and maintain barricades, steady burn lights, flashing warning lights, and warning and "Keep Out" signs where the placing of such protective devices is warranted, or as directed.

Provide, erect, light, and maintain suitable footway shelter platforms, as required by law or as directed.

Control dust resulting from demolition.

Comply with the National Emission Standard for Asbestos, as contained in the Federal Register, Vol. 55, No. 224.

(c) Utility Disconnections. Before starting work, make arrangements with the proper utilities for turning off and disconnecting utilities in connection with demolition operations. Perform the work according to local requirements.

When only a portion of an occupied building is to be demolished, conduct demolition and related operations without interrupting utility service to the remaining portion of the building.

Make permanent reconnections where it is necessary to reconnect facilities to the un-demolished portion of the building.

(d) Demolition. Submit a demolition plan to the Representative at least 2 weeks before beginning demolition. Provide a rodent control plan if directed. Before beginning demolition, pump out and clean wells, cesspools, and outbuildings, within the areas to be cleared, in a sanitary manner. Disinfect all such structures as required by the appropriate health authorities, then backfill to the adjacent ground level.

Do not interfere with functioning wells, cisterns, cesspools, or other ground openings outside the condemned area. Securely and permanently cap well casings. Cut off and cap pipes leading into or out of abandoned wells or wells to be demolished.

Where the uncondemned portion of a property has been abandoned, cover, backfill, or treat wells and other openings that constitute a hazard or dangerous condition. Before proceeding with this work, obtain the consent of the owner or owners in writing.

Leave contiguous buildings in a safe condition. Do not deface, mar, or jeopardize them. Repair damage and restore them as directed.

Remove existing fences and guide rail posts, unless otherwise directed. Do not disturb existing curbs, sidewalks, and street paving unless directed.

Do not use a swinging ball immediately adjacent to any public thoroughfare or in any area where its use may create a public hazard.

Do not set fire to any structure. Burn debris only with written permission of local police or fire authorities and if the burning conforms to State Air Pollution Control Commission regulations. Do not begin burning debris until the Department receives a copy of the written permission.

Ensure that the demolition work is strictly confined within the limits of the indicated temporary construction area without hazard to adjacent properties or to the public.

Do not demolish chimneys common to adjacent properties. Do not disturb these chimneys other than to give them support as necessary for continued stability. Repoint and cap as directed.

Restrict partial demolition to horizontal operations, one floor of each structure at a time. Progressively demolish a structure(s), except for the stripping of fixtures, from top to bottom, one floor at a time. The Contractor may perform bay or sectional-type demolition provided a detailed plan, including the building's structural framework, is submitted and accepted before beginning the work. Progressively demolish bay or sectional-type structures from top to bottom as well. Completely demolish each bay or section before starting operations on any adjacent bay or section. Remove each bay or section in a manner that maintains the integrity and proper support of adjacent bays or sections.

If only a portion of a building is to be demolished, adequately shore, brace, and support the remaining part to maintain the integrity of remaining walls, floors, and roofs and their supporting members. Construct shoring, bracing, and supports to be outside the right of way. Tightly board up and seal the remaining portion of a partially demolished building along the right-of-way line. Construct the new closure and connections to the remaining portion of the building in a satisfactory manner and make them weatherproof. Provide a closure of adequately braced lumber studding placed not more than 16 inches apart, with plywood or equal facing, without holes, tightly and securely nailed to the studding. Cover the plywood facing with two layers of smooth finished roofing material. Overlap the roofing material by not less than 4 inches.

Where demolition involves severance through a cellar or other subsurface opening, immediately erect a 18-inch thick cement masonry wall adjacent to and wholly outside the right of way. Provide a wall extending from 18 inches below the existing cellar floor to the elevation of the top of adjacent cellar walls. Integrally connect the new wall to the existing adjacent walls.

Demolish wall portions above the first floor that are located immediately adjacent to and parallel to any street. Remove walls and foundations, except required party walls as indicated, to an elevation 4 feet below the adjacent sidewalk elevation. Clear partition walls and columns of any nature, in cellars or in other subsurface openings, to their floor elevations.

Fill in and repair holes, breaks, or depressions in remaining walls with brick and cement mortar.

Rough cast repaired areas with cement mortar so that they are left in a safe and weatherproof condition.

Remove floor construction above cellars. Remove basement partitions, furnaces, heating apparatus, piping, fuel tanks, miscellaneous fixtures, and stairways from the demolition area.

Store material suitable for backfill that may be encountered in the demolition, until the walls are down.

(e) Refinishing Party Walls. Where indicated or directed, cap party walls and restore by insulating and plastering to an acceptable finish. Before work, thoroughly clean the party wall of old plaster, sand, and dirt. Rake pit joints in the brickwork to a minimum depth of 1/4 inch, as directed. Water joints and repoint while damp.

1. Insulating Coating. If the wall has an average thickness of less than 6 inches, apply an insulating coating as follows:

- Evenly spread a heavy coating of cold asphalt mastic over the entire wall surface.
- Fit, press in place, and securely bond insulating boards (1-inch by 2-foot by 8-foot stock) to the asphalt mastic.
- Caulk joints between the insulating boards with emulsified asphalt or caulking compound to obtain a uniform and finished appearance.

2. Cement Plaster Coating.

2.a Metal Mesh Lath. Place metal mesh lath against the insulating coating, and securely attach with acceptable devices.

If an insulating coating is not required, securely attach the metal mesh lath directly to the wall, using acceptable devices penetrating the mortar and not the brick. Repair damage to the mortar bond or interior of the wall to the satisfaction of the Representative.

2.b Cement Plaster. Do not plaster until the preceding operations have been inspected and accepted. Do not plaster when the outside air temperature is below 45F. Extend the plaster from the roofline or wall top to the established ground line, or as directed. Provide a total thickness of finished plaster not less than 7/8 inch.

Mix plaster in a suitable mixer with water to obtain a plastic composition. Proportion the mix as follows:

Cement Plaster Scratch and Brown Coats	**Cement Plaster Finish Coat**
Cement—1 bag (94 pounds)	Cement—1 bag (94 pounds)
Lime—1 bag (50 pounds)	Lime—1 bag (50 pounds)
Natural Sand—5 cubic feet	Natural Sand—6 cubic feet

Immediately before scratch coat application, evenly wet the wall surface but do not saturate. Apply a 3/8-inch scratch coat, heavily cross-hatched to integrate with the metal mesh lath.

After the scratch coat dries thoroughly, again, evenly wet the wall surface but do not saturate. Apply a 3/8-inch brown coat.

After the brown coat dries thoroughly, again, evenly wet the wall surface but do not saturate. Apply a 1/8-inch finish coat. Provide color and finish type as directed.

Protect each coat of plaster from sun and wind to prevent rapid drying. Keep each coat moist by sprinkling for at least 3 days after application or as directed. Allow each coat to dry thoroughly before placing the succeeding coat.

Upon completion of the plastering, install suitable matching wood trim along the border of the roof. Paint new wood trim to conform to the trim color of the remainder of the structure or as directed.

(f) Backfilling. Backfill subsurface areas as specified in Section 206.3 and as follows:

Before starting backfilling operations, submit the method of backfill and compaction for review and acceptance.

Furnish additional embankment material for backfilling subsurface areas. Have the quality, nature, and source of any additional embankment material accepted before use. Do not use unsuitable or unstable material in the backfill.

Break-up existing cellar floors and other surface areas to ensure adequate subsurface drainage. Backfill cellars and other subsurface spaces, and grade to the adjacent ground level or as directed.

Clean party wall foundations against which backfill material is to be placed, point brick or block walls with mortar, and waterproof with two coats of emulsified asphalt.

(g) Treatment of Disturbed Areas. Treat disturbed areas resulting from demolition with seeding and soil supplements as specified in Section 804. Use a seeding type as indicated or directed. When directed, mulch as specified in Section 805.

202.4 MEASUREMENT AND PAYMENT—

(a) Demolition. Lump Sum

(b) Refinishing Party Walls. Square Foot

(c) Utility Disconnections/Reconnections. Dollar

If indicated, the Contractor shall pay all expenses resulting from utility disconnections/reconnections, including fees to utility companies or other agencies. The Contractor shall be paid for all fees and work performed as specified in Section 110.03(d)4.

(d) Treatment of Disturbed Areas. Treatment of disturbed areas is incidental to this work.

SECTION 203—CLASS 1, CLASS 1A, CLASS 1B, AND CLASS 1C EXCAVATION

203.1 DESCRIPTION—This work is excavation for roadways, roadway appurtenances, and structures. The four classes of excavation include the following:

(a) Class 1 Excavation.

- Excavation as shown on the Standard Drawings, for roadways, shoulders, ditches, drainage structures, stream channels, grade separation structures, retaining walls, and wingwalls.
- Excavation, as indicated or directed, for benches and for the removal of existing pavements not being rehabilitated.
- Excavation, as indicated or directed, for the removal of unsuitable material having a bottom width of 8 feet or more.
- Excavation, as indicated or directed, to allow for the placement of topsoil.
- Excavation and stockpiling, as indicated or directed, for the removal of topsoil other than the first 8 inches, which are incidental to the clearing and grubbing operations specified in Section 201.
- Removal of unforeseen slides and rock ledges.
- Removal of stone fences, piles of dirt or stones, individual boulders, and any portions of structures above the natural ground, when in excess of 1/2 cubic yard volume.
- Full depth saw cutting of existing pavement to neat lines as indicated.

(b) Class 1A Excavation. Excavation for the removal of unsuitable material below subgrade having a bottom width of less than 8 feet, as indicated or directed. Includes sawcutting of existing pavement as indicated. Includes backfilling as specified in Section 206.

(c) Class 1B Excavation. Excavation for roadway rehabilitation and removal of existing pavement to neat lines. Includes full depth saw cutting or milling of the pavement to neat lines as directed.

(d) Class 1C Excavation. Excavation for the removal and undercutting of unsuitable material below existing subgade having a bottom width of 8 feet or more. Includes backfilling as indicated or as specified in Section 206.

203.3 CONSTRUCTION—

(a) General. During construction, keep the excavation graded to drain, and seal with smooth-wheeled compaction equipment to prevent subgrade from becoming saturated. Seal the surface at the end of the workday in order to prevent conditions from deteriorating before work can proceed. Temporary drainage structures or channels may be required.

(b) Blasting. Drill and blast rock, not removable by other excavating methods, in a manner that completes the excavation to the lines indicated, with the least disturbance to adjacent material, as specified in Section 207.

(c) Removal of Existing Pavements.

1. Under Embankments. Remove existing pavements within 3 feet of the finished grade, scarify the underlying base to a depth of 6 inches and recompact.

2. Outside Embankment Limits. Remove existing pavements outside the limit of embankments as indicated to neat lines. Backfill with suitable material compacted as specified in Section 206.3(b). If specified, use Type C or

better, No. 2A or OGS as specified in Section 703.2.

3. Roadway Rehabilitation. Outline area, cut, and remove existing pavement structure as indicated or directed.

(d) Slopes. Vary the slopes, if directed, depending on the type of material encountered, to obtain satisfactory stability. Remove the material by a method that allows the revised slope lines to be neatly and acceptably trimmed to meet existing conditions.

If a slide occurs, notify the Inspector-in-Charge immediately and cease operations in the slide area until directed to resume.

Remove slide material and bench or flatten slopes, as directed, to obtain the planned width of roadway.

(e) Excavation Beyond Established Slope Lines. Do not remove or excavate any material beyond the slope lines indicated, without written authorization.

(f) Stream Channels. Do not excavate stream channels until directed.

(g) Topsoil. Stockpile topsoil removed from within the excavation or under embankment areas as specified in Section 801, unless otherwise directed. Replace topsoil that is required on the project and wasted during clearing and grubbing operations at no additional cost to the Department.

(h) Bracing and Shoring. Brace and shore sides of the excavation, as necessary. Remove bracing and shoring when no longer required, unless otherwise indicated or directed.

(i) Cofferdams. Drive timber or metal sheeting to form a cofferdam. Brace the sheeting in all directions. Pump or bail to remove water as necessary. Remove sheeting or bracing when no longer required, unless otherwise indicated or directed.

(j) Suitable Material Required for Embankment and Backfill. Haul suitable excavated material for placement in embankment and for backfill. Replace suitable material (Section 206.2(a)2) that is required on the project and wasted during clearing and grubbing operations at no additional cost to the Department.

(k) Unsuitable and Surplus Material. Dispose of unsuitable and surplus material in suitable waste areas obtained as specified in Section 105.14.

(l) Stockpile of Material. Remove and stock pile excavated material in approved areas.

(k) Removal of Temporary Roadway. Deliver the items including rock and stream crossing pipe to a County Maintenance Facility or location approved by the Representative. If delivered to a Department Facility, notify and coordinate with the County Manager for delivery. Materials not claimed by the Department are the Contractor's responsibility for disposal.

203.4 MEASUREMENT AND PAYMENT—Cubic Yard

For the class of excavation indicated and as follows:

(a) Excavation Within Established Slope Lines. Excavation quantities will be determined for payment using the following methods:

1. Plan Quantities. Indicated quantities may be used if the Representative agrees, in writing, that the project has been constructed as indicated and that the indicated quantities may only be used if the borrow section can be isolated.

2. Measured Quantities. If the plans have been altered by construction changes, or if the project involves Borrow Excavation that cannot be isolated, excavation will be measured. Measurement may also be requested, or the Representative may require measurement, if there is disagreement as to the accuracy of the indicated quantities. Cross-sectional measurements will be obtained by field survey or by photogrammetric methods. The original cross-sections will be used as the base cross-sections and the final cross-sections plotted thereon. Additional cross-sections may be

interpolated at intermediate points, where necessary to more accurately determine the quantities. The average end-area method, based on horizontal measurement, will be used to compute quantities. If the Representative or Contractor determines this method produces a considerable error, the Representative will use any other three-dimensional method that will keep the error to a minimum.

Stone fences, piles of stone, and individual surface boulders, in excess of 1/2 cubic yard and not shown on the cross-sections, will be measured by a three-dimensional volume method.

Measure the excavation by acceptable methods involving three-dimensional measurements where it is otherwise impractical to measure material by the cross-sectional method due to the erratic type or location of work.

(b) Excavation Beyond Established Slope Lines. The Department will make payment as specified in Section 205.4(a) when widened excavation is used in place of borrow excavation, as shown on the Standard Drawings and accepted in writing. Excavating offsets for the convenience of drilling is incidental to the Class 1 Excavation.

(c) Stream Channels. Request an inspection of the excavation when excavation of a channel is completed as indicated. Cross-sections will be obtained, and the quantities computed, using the method specified in Section 203.4(a)2 when the excavation is satisfactory. These quantities will be used as the basis for current and final payments.

Clearing and grubbing required to make such measurements is incidental to stream channel excavation.

(d) Slope Changes. The Department will pay for work required to change slopes from the indicated template, when directed, as specified in Section 110.03.

(e) Saw Cutting. Linear Foot.

Saw cutting will be paid, when directed or indicated by the Linear Foot. Removal of pavements to neat lines by a milling method when directed or indicated, will be incidental to the class of excavation.

SECTION 204—CLASS 2, CLASS 3, CLASS 4, AND EXISTING DITCH CLEANING EXCAVATION

204.1 DESCRIPTION—This work is the cleaning of existing ditches and the excavation for ditches, stream channels, culverts, drains, utilities, and structures. The four classes of excavation include the following, as shown on the Standard Drawings or as indicated.

(a) Class 2 Excavation. Excavation for inlet, outlet, and parallel ditches; stream channels; structures removed below the ground surface and not replaced with new structures; spillways; and half-circle pipe.

(b) Class 3 Excavation. Excavation for new grade separation and drainage structures, new retaining walls, abutments, piers, and wingwalls.

(c) Class 4 Excavation. Excavation for pipe culverts; pipe-arches; metal plate pipe; metal plate pipe-arches; standard endwalls for pipe culverts and pipe-arches; utilities; and excavation in excess of the standard depth for pavement base drains, pipe underdrains, subsurface drain outlets, and subgrade drains.

(d) Cleaning Existing Ditches Excavation. Removal and disposal of all soil and organic material in existing ditches.

204.3 CONSTRUCTION—

(a) Foundations. Notify the Representative 2 weeks in advance of excavation for structures so that cross-sections may be obtained. Excavate to a depth that provides a satisfactory foundation, as directed. Do not disturb the foundation area to the extent that it requires removal of additional material to provide a satisfactory bearing. Compact direct load bearing foundation to the original bearing capacity as specified in Section 206.3(b). Do not place concrete or masonry until the foundation area has been accepted.

(b) Drilling and Blasting. Drill and blast to complete the excavation to the required lines, with the least disturbance to remaining material. Do not blast within 5 feet of the foundation bearing elevation. Remove remaining rock to bearing elevation using mechanical means.

(c) Bracing and Shoring. Section 203.3(h)

(d) Cofferdams. Drive timber or metal sheeting to a depth below the bottom of foundation, substantially braced in all directions to form a cofferdam, when required, allowing the foundation area to be pumped reasonably free of water while concrete or masonry is being placed. The Representative may require the cofferdam to be sealed below the foundation with sufficient concrete so that it may be pumped reasonably dry where the foundation area is of sandy or other porous materials. Remove sheeting and bracing when no longer required, unless otherwise indicated or directed.

(e) Backfilling. Backfill spaces excavated for, but not occupied by, structures with acceptable material as specified in Section 206.3(b).

(f) Ditch and Stream Channel Slopes. Trim slopes neatly to the lines indicated. Do not remove or excavate any material beyond lines indicated, without written authorization from the Representative.

(g) Topsoil. Dispose of or utilize topsoil removed in Class 2 Excavation as specified in Section 203.3(g)

(h) Suitable Material Required for Embankment and Backfill. Section 203.3(j)

(i) Unsuitable and Surplus Material. Section 203.3(k)

(j) Cleaning Existing Ditches Excavation. Remove and satisfactorily dispose of all soil and organic matter from within the limits of the existing ditch and side slopes as indicated or directed and as specified in Section 204.3(f).

(k) Excavation for Utility Construction. Excavate trench sufficiently true in alignment to allow the utility facility to be laid in the approximate center of the trench. Excavate unsuitable material to width and depth as directed. Excavate rock six inches below bottom of trench.

204.4 MEASUREMENT AND PAYMENT—

(a) Class 2, Class 3, and Class 4 Excavation. Cubic Yard

Measured, using the methods specified in Section 203.4(a)2, for the class of excavation indicated.

When directed to perform excavation below the indicated structure foundation elevation, the Department will pay for excavation as additional work, as specified in Section 110.03(b), to a maximum depth of 2 feet, and as extra work, as specified in Section 110.03(c), beyond a depth of 2 feet.

When directed to perform excavation in rock below utility trench design elevations, the Department will pay for the excavation and backfill as specified in Section 110.03(c), to a maximum depth of 6 inches. When directed to perform utility trench excavation of unsuitable material, the Department will pay for the excavation as specified in Section 110.03(b).

The Department will not pay for material removed or excavated in advance of obtaining cross-sections, unless written authorization by the Representative is first obtained.

(b) Cleaning Existing Ditches Excavation. Linear Foot

SECTION 205—BORROW EXCAVATION

205.1 DESCRIPTION—This work is the excavation or obtaining embankment material from borrow areas acquired as specified in Section 105.14, or from other sources for construction of embankments or backfills.

Borrow excavation includes Common Borrow Excavation, Foreign Borrow Excavation, Selected Borrow Excavation, and Selected Borrow Excavation for Structure Backfill described as follows:

(a) Common Borrow Excavation. Excavation of suitable material as specified in Section 206.2 from borrow areas that can be measured before and after excavation. Common Borrow Excavation also includes the removal of topsoil from borrow areas and stockpiling as specified in Section 801.

(b) Foreign Borrow Excavation. Excavation of or obtaining satisfactory material as specified in Section 206.2 from sources outside the limits of the project that cannot be measured before and after excavation.

(c) Selected Borrow Excavation. Excavation of or obtaining material used in specific items of work and designated by quality, size, and/or gradation, and if indicated as specified in Section 206.2(a).1.d, Section 703.1, Section 703.2 or Section 850.2(a) from sources outside the limits of the project that cannot be measured before and after excavation.

(d) Selected Borrow Excavation for Structure Backfill. Excavation or obtaining material used for structure backfill as specified in Section 205.2, as shown on the Standard drawings, and as indicated.

205.2 MATERIAL—Supply materials only of the following types for Selected Borrow Excavation for Structure Backfill as indicated:

(a) AASHTO No. 1, No. 2A, No. 3, No. 5 or No. 57 Coarse Aggregate, meeting at least Type C quality requirements and as specified in Section 703.2, Table B and 703.2(c) Table C; R-3 Rock Lining, as specified in Section 850.2(a).

205.3 CONSTRUCTION—

(a) General. If project excavation is insufficient to complete the embankments or backfills, or does not meet the physical requirements, obtain material to complete the work.

Do not use material from borrow excavation until all suitable and available project excavation is used, unless otherwise directed.

If suitable material is available on the project, the Representative may, upon request, authorize in writing the widening of areas adjacent to slopes to obtain a portion or all of the excavation in place of borrow excavation, as shown on the Standard Drawings.

The Contractor may waste suitable material and replace it with common borrow after obtaining written authorization from the District Executive and making satisfactory arrangements for obtaining cross-sections of borrow and waste areas and the satisfactory disposal of the waste material.

Haul material from borrow excavation of other sources for placement in embankment or for backfill.

Restore borrow areas as specified in Section 105.14.

(b) Common Borrow Areas. When common borrow areas are required, obtain from areas as specified in Section 105.14. Clear and grub the borrow site as specified in Section 201, and remove topsoil. Notify the Representative at least 2 weeks before removing any suitable material, to sample, test, and take cross-sections.

(c) Foreign and/or Selected Borrow Excavation. When foreign or selected borrow excavation is required, do not begin operations until the material and placement sequence is accepted in writing and an Erosion and Sediment Pollution Control Plan is accepted by the County Conservation District and/or the DEP and by the Representative, as applicable.

(d) Selected Borrow Excavation for Structure Backfill. Construct structure backfill behind bridge abutments and adjacent to structures with Selected Borrow Excavation, as shown on the Standard Drawings and as specified in Sections 1001.3(q)2.b. Material requirements for structure backfill are shown on the Standard Drawings. Compact with equipment for the material classification and placement condition as specified in Section 206.3(b) and as shown on the Standard Drawings. Do not place rock where deep foundations are to be installed.

205.4 MEASUREMENT AND PAYMENT—

(a) Common Borrow Excavation. Cubic Yard

Measured as specified in Section 203.4(a)2 based on cross-sections of the borrow area. The Department will not pay for material removed before measurements are taken.

Additional material obtained within project limits as specified in Section 205.3(a), used in place of borrow excavation will be measured and paid for as specified in the preceding paragraph. However, the Department will make payment at the lower contract unit price for either Class 1 Excavation or Borrow Excavation of the type indicated.

The Department will not pay for common borrow required to replace suitable excavated material wasted for contractor convenience, error, or oversight.

(b) Foreign Borrow Excavation. Cubic Yard

Measured as compacted material in completed embankments.

(c) Selected Borrow Excavation. For the type indicated, and as follows:

1. Volume Basis. Cubic Yard

Measured in place as compacted material, using the average end-area method.

2. Weight Basis. Ton

(d) Selected Borrow Excavation for Structure Backfill. Cubic Yard.

Measured as compacted material in the completed embankments.

SECTION 206—PLACEMENT AND COMPACTION OF EMBANKMENT AND FILL

206.1 DESCRIPTION—This work is the construction of embankments, fills, and backfills.

206.2 MATERIAL—

(a) Embankment Material. Obtain material for embankment, fill, or backfill construction from the various classes of excavation on the project, including Common Borrow Excavation, Foreign Borrow Excavation, and Selected Borrow Excavation.

1. General. Provide material meeting one of the following material classification requirements. Material of maximum size that can be placed within, and does not interfere with the proper compaction of, compacted 6-inch layers, except as specified and classified as follows:

1.a Soil. Material consisting of earth having 20% or more of the material passing the No. 200 sieve and having a minimum dry density of 95 pounds per cubic foot oven-dried mass determined according to PTM No. 106. Material must have a maximum liquid limit of 65, determined according to AASHTO T 89, and a plasticity index of not less than the liquid limit minus 30, determined according to AASHTO T 90 for soils with liquid limits of 41 to 65.

1.b Granular Material, Type 1. Material consisting of natural or synthetic mineral aggregates having greater than 70% of the material passing the 3/8-inch sieve (less than 30% retained on the 3/8-inch sieve) and less than 20% passing the No. 200 sieve, except for AASHTO No. 8 coarse aggregate and select granular material (2RC).

1.c Granular Material, Type 2. Material consisting of natural or synthetic mineral aggregates having less than or equal to 70% of the material passing the 3/8-inch sieve (greater than or equal 30% retained on the 3/8-inch sieve) and less than 20% passing the No. 200 sieve. Also includes AASHTO Nos. 8 or 57 coarse aggregate, or PennDOT Nos. 2A or OGS coarse aggregate meeting the requirements specified in Section 703.2, select granular material (2RC) meeting the requirements specified in Section 703.3, and structure backfill.

1.d Rock. Includes natural material that cannot be excavated without blasting or using rippers; also boulders, detached stones, and concrete and masonry units of a size that cannot be readily incorporated into compacted 6 -inch layers and having insufficient soil to fill the voids in each layer.

1.e Shale. Includes rock-like material formed by natural consolidation of mud, clay, silt, and fine sand; usually thinly laminated, comparatively soft, and easily split.

1.f Random Material. Includes Type 1 or Type 2 granular material combined with shale, concrete, brick, stone, or masonry units that can readily be incorporated into compacted 6-inch layers.

2. Suitable Material. Provide material meeting the requirements of any of the materials specified in Section 206.2(a)1 and reasonably free of organic matter, coal, carbonaceous materials, or other objectionable matter. Wet, dry, or frozen material may be suitable when dried, wetted, or thawed, respectively.

The Contractor may waste suitable material, including wet or frozen material, after obtaining written authorization. This suitable material is subject to replacement in equivalent volume.

(b) Geotextile. Section 735, Class 4, Type A

206.3 CONSTRUCTION—

(a) General.

1. Prepare the embankment foundation area as specified in Section 201.

Backfill existing depressions in embankment or fill areas, such as gullies, old stream channels, stump holes, and areas of undercutting and topsoil or pavement removal, to the adjacent ground elevation. Backfill with material

indicated. If no specific materials are indicated, backfill with suitable material, unless directed otherwise.

Where undercutting is not directed, proof roll entire embankment or fill foundation with a loaded triaxle dump truck (72,000 pounds GVW). Maintain uniform inflation pressures for all tires on the loaded triaxle between 100 and 110 pounds per square inch. When conducting proof rolling, do not exceed a speed of 1.5 feet per second (1 mile per hour). Any areas displaying permanent deformation (rutting) greater than 1/2 inch are considered unstable. Treat unstable areas by excavating material in the area to a depth of 1 foot. Dry the material and recompact or replace with compacted suitable material of the same type or other material, including Soil, Type 1 granular material, and Type 2 granular material, except having particles no greater than 2 inches in size, as approved by the Representative or as indicated. Perform proof rolling only in the presence of the Representative who will assess and approve or disapprove the stability of the area being investigated. In wet areas or unstable areas, the Representative may waive this requirement if other stabilization or treatment measures are indicated and/or required. The Representative may also waive this requirement in confined areas or in areas too small to be effectively proof rolled with the loaded triaxle dump truck. Proof roll the foundations of small or confined areas using the equipment that will be used to compact the fill in these areas. Treat areas identified by the Representative as unstable as specified above.

Proof rolling of constructed embankments or fills may be required by the Representative at any time during the construction when the constructed embankment or fill appears to be visually unstable. Perform proof rolling and mitigation of unstable areas as described above and at no additional cost to the Department.

Break existing pavements, more than 3 feet below the finished grade, as follows:

- break asphalt pavements to a maximum size of 1 square foot and recompact;
- break concrete pavements to a maximum size of 1 square yard; and
- scarify asphalt, surface-treated roadways to a depth of 6 inches and recompact.

Remove existing pavements, less than or equal to 3 feet below finished subgrade, in their entirety unless specified otherwise.

When constructing embankment or fill on an existing or excavated slope, bench the slope to the width and depth indicated, or as directed.

Where required for installation of transverse drainage, construct embankment as shown on the Standard Drawings.

2. QC Plan. When placing and compacting materials as specified in Sections 206.3(b)1.a and 1.b, prepare a compaction control QC Plan as outlined on Form CS-206 and submit for the Representative's review. A QC Plan is not required when placing and compacting materials as specified in Sections 206.3(b)1.c, 1.d, 1.e, and 1.f, where the compaction criteria is non-movement. QC test methods must be as specified in Section 206.3(a)3. The frequency of the QC testing may be determined by the Contractor, however, at a minimum, the frequency must meet the requirements as indicated in Table A. Use start-up criteria at the commencement of operations until proper control of operations has been demonstrated by passing and repeatable QC test results, as determined by the Representative. A minimum of one start-up frequency cycle must be completed before moving to production QC test frequencies. QC tests cannot be performed at the same location as an acceptance test and cannot be replaced by an acceptance test. Submit the compaction control QC Plan at the Pre-construction conference or at least 14 calendar days before placement and compaction is scheduled to commence. If any changes are needed to the QC Plan throughout the life of the project, submit an addendum to the Representative for review before implementation.

Table A
Minimum QC Test Frequency

Material	Embankment or Fill	Subgrade*	Pipe Backfill
Start-up Frequency	One QC test per lift for each 500 square yards placed; minimum six tests per lift per day. In limited or restricted areas the test rate should not exceed the rate for pipe backfill.	One QC test per lift for each 400 square yards placed; minimum eight tests per lift per day.	For every pipe run conduct one QC test for every 50 cubic yards of pipe backfill; minimum two tests per lift per day.
Production Frequency	One QC test per lift for each - 3,000 square yards placed; minimum three tests per lift per	One QC test per lift for each 1,600 square yards	For every pipe run conduct one QC test for every 200 cubic yards of pipe backfill;

	day. In limited or restricted areas the test rate should not exceed the rate for pipe backfill.	placed; minimum three tests per lift per day.	minimum two tests per lift per day.

*Subgrade consists of the top 3 feet of the material immediately below the pavement section subbase.

3. Moisture, Density, and Acceptance Testing. For materials placed and compacted as specified in Sections 206.3(b)1.a and 1.b, determine the in-place moisture and density in accordance with PTM No. 402 using the direct transmission method. All other materials will be accepted based on a condition of non-movement, as determined by the Representative. Provide a Nuclear Density/Moisture Gauge calibrated according to AASHTO T 310. PTM No. 418 may be used if the gauge is manufactured by Troxler (Note: PTM No. 418 is written for Troxler manufactured gauges while AASHTO T 310 is generic to any nuclear density gauge). Gauges must be calibrated every 12 months. A sheet with the current annual calibration providing the projected monthly decay standard with upper and lower limits must be kept with every gauge. Use Form TR-4276A located in PTM No. 402 for recording daily gauge standardization and for recording the results of all nuclear gauge moisture and density test results.

At locations directed by the Representative, conduct acceptance testing for moisture and density at the frequencies specified in Table B. If the required density of the compacted material is not obtained, promptly rework, reshape, and recompact or remove and replace damaged or unsatisfactory areas and perform an acceptance retests before placement or testing of another area. The extent of the unsatisfactory area is defined by the Representative using one of the following: visual inspection of the site, behavior of the material under the compaction equipment originally used to compact the material, delineation using the acceptance moisture-density gauge, or any combination of the above methods.

When an acceptance retest fails to meet the specified requirements, check standard count of the acceptance test gauge on the reference standard block in accordance with PTM No. 418 or AASHTO T310, as appropriate. If the standard count does not meet requirements established for the gauge from the last annual calibration, or is inconsistent with the daily gauge standardization count, the gauge must be diagnosed and repaired or replaced, as necessary, before work may proceed.

If the acceptance test gauge is determined to be functioning properly, and if the required density of the compacted material, within the specified moisture limits, cannot be obtained, conduct a new moisture-density test on the material, according to PTM No. 106, to determine if the moisture-density relationship of the material has changed. If the moisture-density relationship of the material has changed, the corresponding new target values for moisture and density must be established and used for QC acceptance and verification testing. If moisture-density testing indicates that the original target moisture and density are valid, the Contractor must review their operations, make adjustments within specification requirements, and amend the QC Plan to obtain acceptable results.

Table B
Acceptance Test Frequency

Material	Embankment or Fill	Subgrade*	Pipe Backfill
Frequency	One acceptance test per lift for each 4,000 square yards placed; minimum one test per lift per day. In limited or restricted areas the test rate should not exceed the rate for pipe backfill.	One acceptance test per lift for each 3,000 square yards placed; minimum one test per lift per day.	For every pipe run conduct one acceptance test for every 500 cubic yards of pipe backfill; minimum one test per lift per day.

*Subgrade consists of the top 3 feet of the material immediately below the pavement section subbase.

4. Verification Testing. The Representative will perform verification testing, using an Independent Nuclear Density/Moisture Gauge, on one of the first three acceptance tests and a minimum of one verification test for every 10 acceptance tests performed thereafter. Verification testing will consist of testing for moisture and density as specified in Section 206.3(a)3. The verification testing will take place immediately after the Contractor's Nuclear Density/Moisture Gauge has obtained a passing acceptance test result as specified in Sections 206.3(b)1.a and 1.b. Verification tests will be run at the same location and in the same test hole as the acceptance test. Maintain a distance of at least 30 feet between gauges and from any other radioactive source when performing acceptance and verification testing. Perform testing in an area where influences affecting the gauge performance are minimized, whenever practical. In some instances, the Representative may direct an additional acceptance test based upon availability of verification testing equipment and personnel.

Verification test results will be compared to the associated acceptance test results and will not be used to determine acceptance of the in-place moisture and density. A verification test is considered acceptable if the Independent

Nuclear Density/Moisture Gauge readings are within ±2.0 pounds per cubic foot for wet density (not the dry density) and within ±0.1w for moisture, where w is the moisture content in percent, when compared to the readings obtained by the Contractor's Nuclear Density/Moisture Gauge.

When verification test results do not conform as specified, check the standard count of both the acceptance test gauge and the verification test gauge on their respective reference standard blocks in accordance with PTM No. 418 or AASHTO T 310, as appropriate, before placement and testing of another area. If the standard count for either gauge does not meet requirements established for the gauge from the last annual calibration, or is inconsistent with the daily gauge standardization count, the gauge must be diagnosed and repaired or replaced, as necessary, before work may proceed. AASHTO T 2147 or AASHTO T 265 may be used to help resolve questions concerning proper functioning of gauges when determining moisture.

If both gauges are determined to be functioning properly, the Representative will immediately contact the DME/DMM or District Compaction Supervisor for guidance before the continuation of work. The Representative will record the acceptance test results, the verification test results, and applicable corrective measures on Form TR-4276A.

5. Compaction Control Technician. Provide and assign to the work, during placement and compaction of material, a properly trained and experienced Nuclear Equipment Operator to perform the required QC and acceptance testing. The technician must carry a valid nuclear gauge operator certification during placement and compaction of material.

(b) Placement and Compaction.

1. General. Provide uniform material from the same borrow source for the entire lift being placed, unless otherwise indicated or directed by the Representative. Compact material using the specified equipment appropriate for the material classification and placement condition. Do not operate compaction equipment at a speed exceeding 1.5 feet per second (1 mile per hour) when compacting materials. For compaction equipment other than rollers, as specified in Section 108.05(c)4, operate the equipment over the material to be compacted for a minimum duration of 6 seconds. Use the appropriate target moisture and density for the material being placed for QC, acceptance, and verification testing. Shape layers of the compacted embankment or fill to drain during construction. Fine grade to remove low areas and seal the embankment or fill surface at the end of each work day by rolling with a smooth drum roller to promote continuous positive drainage and reduce water infiltration. No furrows at the edges of embankments or fills that prohibit the free drainage of surface water are allowed.

1.a Soil. Place soil for the full width of the embankment or fill in uniform horizontal layers to achieve a compacted 6-inch depth. Determine the optimum moisture content and maximum dry density according to PTM No. 106. Compact soil with a padfoot roller meeting the requirements specified in Section 108.05(c)3.g. Run all compaction equipment in static mode. Do not use vibratory compaction on soil. A single pass of a smooth drum roller in static mode may be used on soil before compaction with the padfoot roller. Maximum roller speed as specified in Section 206.3(b)1 must not be exceeded. During compaction with a padfoot roller, keep the roller drum clean and free of any soil buildup on the drum surface and between pads. When constructing embankments or fills to top of subgrade elevation with soil, overbuild in elevation and mechanically cut the embankment to final grade. Fine grade the surface to fill any depressions left by the roller pads and to establish the final surface elevation. Compact the subgrade surface with a smooth drum roller in static mode. Finish subgrade as specified in Section 210.

In pipe trenches, locations adjacent to structures, and locations where standard, full scale compaction equipment is prohibited, may cause damage, or is not practical due to space or other constraints, compact soil using equipment as specified in Sections 108.05(c)3.d or 108.05(c)4, as directed by the Representative. Reduce lift thickness to 4-inch compacted depth or as directed by the Representative to achieve the equivalent level of compaction as the full scale compaction equipment. Operate in a manner as to provide the required level of compaction, while producing a dense, stable soil mass that does not rut, push, or shove.

Except for the top 3 feet, compact soil for the full width of embankments or fills to not less than 97% of the maximum dry density. Compact the top 3 feet of soil for the full width of embankments or fills to 100% of the maximum dry density. Determine the in-place dry density of soil according to PTM No. 402, using the direct transmission method. Maintain soil within -3% of optimum and optimum moisture content at the time of compaction. Determine the moisture content according to PTM No. 402. Compact soil to a stable condition so there is no rutting, displacement, or shear wave under compaction equipment. A shear wave is bulging of the soil surface in front of and behind the roller.

1.b Granular Material, Type 1. Place Type 1 granular material for the full width of the embankment or fill in uniform horizontal layers of not more than a compacted 6-inch depth. Compact material adjacent to structures as indicated on the Standard Drawings. Determine the optimum moisture content and maximum dry density according to PTM No. 106. Except for pipe trenches, locations adjacent to structures, and locations where standard, full scale compaction equipment is prohibited, may cause damage, or is not practical due to space or other constraints, compact Type 1 granular material using a smooth drum vibratory roller as specified in Section 108.05(c)3.i. For all other areas except for pipe trenches, use dynamic and/or vibratory equipment as specified in Sections 108.05(c)3.d or 108.05(c)4, as directed by the Representative. Reduce lift thickness to 4-inch compacted depth or as directed by the Representative to achieve the equivalent level of compaction as the full scale compaction equipment.

Except for the top 3 feet, compact Type 1 granular material for the full width of embankments or fills to 97% of the maximum dry density. Compact the top 3 feet of Type 1 granular material for the full width of embankments or fills to 100% of the maximum dry density. As directed by the Representative, determine the in-place dry density of Type 1 granular material according to PTM No. 402 using the direct transmission method. The Representative may allow the back scatter method to be used if the material is too coarse for the direct transmission method to be conducted effectively. Conditions when the backscatter method would be appropriate include when the drive rod cannot be readily driven to the required depth to create the hole necessary to insert the nuclear gauge source rod due to coarse particles impeding or deflecting the drive rod, or when the material is too coarse to create a smooth sided, stable, open hole using the drive rod. Compact Type 1 granular material to a stable condition so there is no rutting, displacement, or shear wave under compaction equipment. A shear wave is bulging of the material surface in front of and behind the compaction equipment.

Maintain Type 1 granular material within ±2% of the optimum moisture content at the time of compaction. Determine moisture content in accordance with PTM No. 402.

1.c Granular Material, Type 2. Place Type 2 granular material for the full width of the embankment or fill in uniform horizontal layers of not more than a compacted 8-inch depth. Compact material adjacent to structures as indicated on the Standard Drawings. Except for pipe trenches, locations adjacent to structures, and locations where standard, full scale compaction equipment is prohibited, may cause damage, or is not practical due to space or other constraints, compact Type 2 granular material using a smooth drum vibratory roller as specified in Section 108.05(c)3.i. For all other areas except pipe trenches, use dynamic and/or vibratory equipment as specified in Sections 108.05(c)3.d or 108.05(c)4. Reduce lift thickness to 4-inch compacted depth or as directed by the Representative to achieve the equivalent level of compaction as the full scale compaction equipment.

Compact Type 2 granular material for the full width of embankments or fills to a condition of non-movement under the compaction equipment. Compaction acceptance will be determined by the Representative. Non-movement under compaction equipment is defined as creating a stable condition of the compacted material. A stable condition occurs when there is no rutting, displacement, or shear wave under compaction equipment. A shear wave is bulging of the material surface in front of and behind the compaction equipment.

Maintain Type 2 granular material in a surface damp condition, but not wet (no excess moisture) at the time of compaction.

1.d Rock. Do not place rock in embankments or fills without acceptance of the planned excavation and embankment or fill operations.

When used to form the base of an embankment or fill, place rock the full cross-section width. Place rock on embankment side slopes, where indicated.

Before placing rock on other types of compacted material, slope the top of the embankment or fill from centerline to the sides, at a rate of approximately 1 inch per foot, and compact the surface.

Place rock in uniform loose layers to a depth not exceeding the approximate average size of the larger rock, but limited to a maximum depth of 36 inches. Remove oversize rock or reduce in size until it can be readily incorporated in a maximum 36-inch layer. Do not dump rock in final position, unless specified, but distribute by blading or dozing; keep voids, pockets, and bridging to a minimum. Place rock so larger pieces are evenly distributed and voids are filled as completely as possible. Compact with a smooth drum vibratory roller as specified in Section 108.05(c)3.i. Compact rock to a condition of non-movement under the compaction equipment. Compaction acceptance will be determined by the Representative.

When rock and finer material are placed adjacent to each other at the same time, place the finer material sufficiently above rock layers to allow for proper compaction of the finer material.

When the embankment or fill is to be constructed with rock, choke the surface of the rock with select granular material (2RC) of sufficient thickness to completely fill all voids in the rock and cover with a Class 4, Type A

geotextile. Place an additional layer of select granular material (2RC) to reach the finished subgrade elevation and to allow fine grading as specified in Section 210.

When transitioning from rock to other types of materials, choke the rock surface with select granular material (2RC) of sufficient thickness to completely fill all voids in the rock. Place a second lift of select granular material (2RC) to a compacted thickness of 6 inches. Only one transition from rock to another type of material is allowed in an embankment or fill section.

1.e Shale. Place shale in maximum 6-inch compacted lifts so larger pieces are evenly distributed and voids are filled as completely as possible. Remove oversize shale or reduce in size until it can be readily incorporated in a maximum 6-inch compacted layer. Compact as specified in Section 206.3(b)1.c.

1.f Random Material. Place and compact random material as specified in Section 206.3(b)1.e.

2. Wet and/or Unstable Foundation Areas. Where the embankment or fill foundation is in water or swamp areas or is saturated or unstable, construct embankment or fill with rock to the indicated elevation or as directed.

3. Existing Embankment or Fill. Existing embankment or fill is defined as material placed and compacted during prior construction not associated with the current project, or material placed and compacted as part of the current project during a prior construction season and has been in place at least one winter season. When an existing embankment or fill requires additional material to bring it to the required elevation, proof roll the entire existing surface as specified in Section 206.3(a), before placement of material.

4. Confined Areas. Do not use rock, shale, random material, or any other material having a maximum size greater than 2 inches or otherwise preventing the material from being placed in a compacted 4-inch layer in confined areas. Place material in uniform horizontal layers of not more than 4 inches in compacted depth in areas where small or hand operated compaction equipment, as specified in Sections 108.05(c)3.d and 108.05(c)4, is required for compaction. Compact material to the density and at the moisture content based on the material type as specified in Sections 206.3(b)1.a, 1.b, and 1.c. Determine the in-place dry density and moisture content based on the material type as specified in Sections 206.3(b)1.a, 1.b, and 1.c.

5. Frozen Material. Do not place or compact frozen material. Do not place embankment or fill material on any material that is frozen. Remove frozen material, if the embankment or fill top freezes, before placing additional material.

6. Wet Material. Before compacting, dry material to within -3% of optimum and the optimum moisture content for soil, ±2% of optimum moisture content for Type 1 granular material, and surface damp for Type 2 granular material. Do not place material on embankment or fill that has become unstable from excessive moisture.

7. Dry Material. Before compacting, moisten material to within -3% of optimum and the optimum moisture content for soil, ±2% of optimum moisture content for Type 1 granular material, and surface damp for Type 2 granular material.

(c) Stability. Assume responsibility for the stability of embankments and fills. Replace material that, in the Representative's judgment, has been damaged or displaced due to the following: carelessness or negligence, natural causes such as storms and floods, shrinkage of material, and all other reasons not attributable to other than movement of the natural ground upon which the material is placed.

Dry, reshape, recompact, and test material for moisture and density requirements if construction equipment causes movement, rutting, or displacement of the material.

206.4 MEASUREMENT AND PAYMENT—

(a) Embankment. When measurement is required, embankment will be measured in its final position as specified in Section 203.4(a)2 by the cubic yard.

Embankment construction is incidental to excavation or borrow excavation except for AASHTO Nos. 8 or 57, or PennDOT Nos. 2A or OGS meeting the requirements specified in Section 703.2 and select granular material (2RC) meeting the requirements specified in Section 703.3.

(b) Select Granular Material (2RC). Ton

(c) Granular Material, Type 2, Aggregates. For fills and backfills incorporating AASHTO Nos. 8 or 57, or PennDOT Nos. 2A or OGS meeting the requirements specified in Section 703.2 or structure backfill, measurement and payment are made according to the work specified.

(d) Geotextile, Class 4, Type A. Section 212.4(c)

SECTION 207—BLASTING FOR ROCK CUT SLOPE EXCAVATION

207.1 DESCRIPTION—This work is excavation of rock using controlled blasting and production blasting to achieve a uniform face in the rock along the plane of the specified excavation back slope. Blasting required for rock cut slopes must be conducted in a safe manner to the line and grade as indicated.

(a) Controlled Blasting. Blasting that use explosives and proper blasting equipment placed in carefully spaced and aligned blastholes to produce a uniform surface in the rock along a specified excavation back slope. Controlled blasting methods include:

1. Presplit Blasting. A controlled blasting method in which the row of blastholes are drilled along the plane of the specified final excavation back slope. Presplitting uses reduced blasthole spacing, diameter, and explosive charges. The initiation of blasting in the presplit blastholes precedes the initiation of the adjacent production blasthole explosives by a delay. The delay decouples the final excavated rock face from the excavation and prevents energy from production blasts from propagating to, and damaging, the final cut face.

2. Trim Blasting. A controlled blasting method that cleanly shears a rock face when there is insufficient burden for production blasting. It is essentially identical to presplit blasting, but without production blast holes.

(b) Production Blasting. Rock fragmentation blasting that typically has more widely spaced blastholes than controlled blastholes. Production blastholes are drilled in a pattern throughout the main excavation area adjacent to the controlled blast row. Production blastholes are detonated in a controlled delay sequence toward an open face or relief produced by blastholes firing on an earlier delay. Production blasting fragments the rock in the area to be excavated, to the size required for removal and placement.

207.2 MATERIALS—

(a) General. Provide non-electric detonators and initiating devices that are not damaged or deteriorated and have not been exposed to weather. Non-electric detonators and initiating devices include, but are not limited to, all explosive materials, initiators, blasting caps, detonating cord, delays and timing devices, and all other materials and devices necessary to perform the work. While electric detonators are not allowed, electronic programmable detonators are permissible for use. Provide copies of the technical data sheets and safety data sheets for all materials to the Department with the Blasting Plan. All blasting caps for any individual shot must come from one manufacturer.

1. Stemming. Coarse Aggregate. Section 703.2.

207.3 CONSTRUCTION—

(a) General. Use controlled and production blasting for excavations in rock when mechanical excavations methods cannot produce a uniform excavated surface at the specified slope angle. Conduct all blasting, explosive handling, and monitoring operations according to the latest OSHA standards, 29 CFR Parts 1926.900 through 1926.914 and Pennsylvania Code, Title 25 Environmental Resources, Article IV – Chapter 77, Chapter 210, Chapter 211, and all local requirements. Maintain a copy of all standards on site including health and safety requirements and make available upon request.

1. All blasting operations must be performed by a blaster licensed in the Commonwealth of Pennsylvania meeting the following qualifications: The blaster must submit to the Department a list containing at least five successfully completed similar projects that, together, demonstrate a minimum of 3 years of experience in surface rock blasting including controlled blasting. Include a brief description of each project, and the name and telephone number of the owner's representative knowledgeable in each project listed. The Department will review and approve

the blaster. Receipt of written approval must be obtained before any blasting operations including drilling of blastholes are initiated. Allow at least 21 calendar days for approval.

2. When blasting is used to excavate rock, use controlled blasting techniques for all portions of any rock cut slope exceeding a vertical height of 10 feet and a slope equal to or steeper than 0.5(H):1(V). The Department may require controlled blasting to form the faces of more gradual slopes or excavations, even if the slopes could be formed by non-blasting methods. Presplit test sections must be conducted to determine the presplit blast pattern and design necessary to achieve the required results. The conditions of each presplit section will be evaluated by the Representative. Revisions to the presplit blast design must be made by the blaster, as necessary, to achieve the required results before drilling can proceed in adjacent presplit sections.

3. Production blasting must be designed to control flyrock, minimize ground vibrations and noise, and result in fragmented, in-situ rock that can be removed, processed, and/or placed as required. The production blasthole must be located and drilled as specified in Section 207.3(g). Prepare the production Blasting Plan so as not to affect the controlled blastholes. Where blasting is adjacent to highways with lane closure restrictions, the volume of rock cannot exceed the Contractor's ability to remove the blasted material from the highway within the established maximum allowable closure time.

The sequence of blasting at any blast is as follows:

- Conduct and submit the Pre-Blast Survey.
- Submit and obtain acceptance of the Blasting Plan.
- Submit and obtain acceptance of the Blasting Safety Plan.
- Before blasting operations, conduct and submit the Water Supply Monitoring Report.
- Notify appropriate entities of blasting schedule (property owners, utilities, traffic, flagging, and police).
- Schedule and conduct the Pre-Blast meeting.
- Obtain Department approval and selection of the test section.
- Drill and conduct test section blasting before the start of any full-scale blasting operations.
- Proceed with full-scale drilling and blasting.
- Submit required Blasting Report including Vibration and Airblast Monitoring Reports.
- Remove rock and scale if required.
- Inspect and evaluate rock face/excavation results (including any required modifications).
- If applicable, submit a modified Blasting Plan for adjacent blasts in that project work area.
- Conduct and submit the Post-Blast Survey.
- Post blasting operations, conduct and submit the Water Supply Monitoring Report.

(b) Pre-Blast Survey. Conduct an Exterior and Interior Pre-Blast Survey on all structures, buildings or utilities within 300 feet of the blasting site, and within 1,000 feet of the blasting site if the blast is designed for a peak particle velocity (PPV) exceeding 0.5 inches per second (confirm by vibration monitoring). If no structure or building is located within these limits, complete a survey on the closest structure or building within 1 mile of the blasting operations. At a minimum, complete one survey as directed on the closest structure or building within 1 mile. The Pre-Blast Survey will serve as proof of the condition of the existing residential and commercial structures prior to blasting. Begin the Pre-Blast Survey no sooner than 6 weeks before the beginning of blasting operations. Submit the completed Pre-Blast Survey at least 1 week before the Pre-Blast meeting.

Complete the Exterior and Interior Pre-Blast Survey using Form TR-42. Alternative forms/reports are acceptable for use provided that they contain the information required on Form TR-42. Include structural observations and descriptions, locating any existing cracks, including length and size. Where significant cracks, structural defects, or damage exists, collect digital images to supplement the written description. Provide a scale and a date stamp on each digital image taken. Digital images must be taken and submitted electronically at a minimum 8-megapixel resolution with the Pre-Blast Survey.

Request, in writing, property access from each property owner to complete a Pre-Blast Survey. If the property owner fails to allow access to the property for the Pre-Blast Survey, notify the Department. If the property owner declines the Pre-Blast Survey, submit a notification letter and Form TR-43 that is signed by the property owner to the Department. If the property owner refuses to sign, the qualified independent blasting consultant must indicate as such and sign the waiver. A copy of the letter and waiver must be kept on file as part of the Pre-Blast Survey Records.

Do not enter any private property without written permission. The Pre-Blast Survey must be conducted by a qualified independent blasting consultant in the presence of the property owner. At the conclusion of the Pre-Blast Survey, the property owner must sign both Exterior and Interior Pre-Blast Survey Forms and be provided a copy. Submit the Exterior and Interior Pre-Blast Survey Forms, including diagrams and digital images, at least 1 week before the Pre-Blast meeting. Notify the respective utility company within a minimum of 7 days before blasting of any utility within 300 feet of the blasting site and within 1,000 feet of the blasting site if the blast is designed for a PPV exceeding 0.5 inches per second. Provide notice in writing at 2 weeks and again 48 hours before blasting begins to all property owners where a Pre-Blast Survey was performed. Inform the residents that blasting signals will be issued according to Title 25 Pa. Code § 211.155to warn of imminent blasting. The Contractor is solely responsible for any damage resulting from blasting.

(c) Blasting Plan. Provide the Representative a Blasting Plan at least 1 week before the Pre-Blast Meeting and before the start of drilling for blasting for each proposed rock cut excavation that requires blasting, and at any time the drilling and blasting operations change. The Blasting Plan will be reviewed by the Department and any concerns will be discussed with the Contractor before acceptance of the Blasting Plan. Do not drill any blast holes until the Blasting Plan is accepted by the Department.

Schedule and attend a pre-blast meeting at least 1 week before any explosives being brought onto the project site to review the following: the Blasting Safety Plan including requirements concerning explosives being brought onto the project site, the restrictions and requirements during the loading of explosives; the sequence of operations before, during, and after each blast; all required traffic control; all inspection procedures of blast zones for misfires, stability, blast material debris clean up; and any other relevant issues. At a minimum, the following must attend the pre-blast meeting: The Representative, the blaster, the Contractor, the qualified independent blasting consultant(s), and other personnel designated necessary by the Representative.

Submittal of the Blasting Plan is for quality control, conformance, and record keeping purposes. Review and acceptance of any Blasting Plan by the Department does not release the Contractor of full responsibility for the accuracy of the plans, safety of operations, quality of work, or conformance to specification performance requirements, when implemented in the field.

Complete the Blasting Plan using Form TR-40 and include in the submittal of the Blasting Plan along with any necessary documentation. Alternative forms/reports are acceptable for use provided that they contain the information required on Form TR-40. Information and documentation to be submitted with the Blasting Plan must include, but is not limited to, the following:

- A completed Blasting Activity Permit approved by the DEP Bureau of Mining and Reclamation. Include any other necessary permits required to complete blasting activities in accordance with all current applicable federal, state, and local requirements.
- Station limits of the proposed shots, critical distances and directions to structures, buildings, or utilities, and pre-blast survey limits detailed on the plan view sheets. Also, include scaled distance and estimated PPV.
- One plan and section view for each rock cut excavation showing the proposed drill pattern for any blastholes, including blasthole spacing, blasthole diameters, blasthole angles, lift height, drill depth, buffer rows, and burden. Accurately show to scale each cut area to be blasted.
- Loading diagram(s) detailing the type, amount, and specific gravity of explosives, primers, and initiators. Also include the location and depth of stemming.
- Initiation sequence(s) of any blastholes including delay times and delay system(s).
- Schedule and timeframes for notification of the blasting sequence.
- Manufacturer's product data sheets for all explosives, primers, and initiators to be used in the work.
- A Maintenance and Protection of Traffic Plan which details how traffic will be protected and managed during blasting.
- Methods to control site security, vibration, flyrock, and airblast levels.
- Method and quality control of the depth, direction, and alignment of the drilled blastholes for blasting.
- Licensing information, experience, and qualifications of the blaster who will be directly responsible for the loading and firing of each shot.
- The name and qualifications of the licensed blaster in the State of Pennsylvania responsible for designing and directing the blasting operation.

- The qualified independent blasting consultant(s) proposed to conduct and complete the Pre- and Post- blast Surveys, and the Airblast, Vibration, and Water Supply Monitoring Reports.

(d) Blasting Safety Plan. Provide the Department a detailed description of transportation, pick-up and delivery locations, blasting procedures, and the use of explosives at the project work area at least 3 weeks before the start of drilling for blasting. The Blasting Safety Plan must include, but is not limited to, the following:

- Details about hazard communication programs for employees.
- Equipment that will be used to monitor the approach of lightning storms, and evacuation and site security plans in the event of a storm.
- Methods for preventing spills or losses of explosives, drilling fluids, oil, or any other pollutants into the ground during all handling and blasthole loading operations. Include details of all containment and contingency plans for quickly and effectively cleaning up any spilled materials.
- A safe and approved disposal method of all explosive packaging materials.
- Detailed contingency plan(s) for handling misfires of explosives resulting from cutoffs or other causes.
- Fire prevention plan details, including smoking policies, procedures and limitations for work involving any open flames or sparks, and description and location of all firefighting equipment and evacuation plans.
- One hard or electronic copy of the blaster's valid Pennsylvania blasting license and the Contractor's ATF blasting license.
- Other required county or state permits required for explosive use and storage.
- An explanation of how the explosive transport vehicles will meet all applicable ATF, OSHA, federal, state, county, and local regulations.

If applicable and/or when underground mining is identified during design, provide air quality monitoring plans for local buildings.

Post and maintain in a visible area all current licenses required for blasting and explosive handling. A blaster meeting the qualifications specified in Section 207.3(a)1 is required to perform all blasting. Provide a certificate of insurance to the Department showing that the Contractor retain the required insurance to the applicable limits to meet all local, state, and federal regulations. Store explosives on and off the project site according to with OSHA standard, 29 CFR Part 1926.904, Title 27 CFR 181, Part 55, Subpart K, and in compliance with all local requirements. The explosive transporters' valid commercial driver's license(s) with HazMat endorsements must be available and provided upon request. Adequate magazine records must be maintained for stored explosives. On-site storage of bulk blasting agents such as Ammonium Nitrate and Fuel Oil (ANFO) is prohibited. The Contractor is required to remain on site once the blastholes are loaded with explosives until any misfires are resolved or remediated and the blast is completed. In no instance must explosives, blasting agents, detonators, or loaded blastholes be left unguarded or unattended.

(e) Blasting Requirements for all blasting operations:

- Remove all overburden soil and loose rock along the top of the proposed cut and lay back to a stable condition before drilling and blasting.
- The drilling of blastholes must be completed one pattern at a time. When conditions justify simultaneous drilling and loading of blastholes, the two operations shall be separated as widely as practicable and not less than 50 feet apart.
- Check, measure, and record the depth of all blastholes as soon as the drill is retracted from the blasthole. If any blasthole is found not be open to the drilled depth, re-drill the short blastholes to the proper depth at no additional cost to the Department. If any blastholes are too deep, use stemming as specified in Section 207.2(a)1 to fill the blastholes.
- Horizontal blastholes are not allowed.
- Complete and submit with the Blasting Report, the Blasthole Drill Log, using Form TR-39. Alternative forms/reports are acceptable for use provided that they contain the information as required on Form TR-39. Keep accurate drilling logs on each blasthole to show the depth of the geological features such as zones of soft or weathered rock, mud or clay seams, voids, and color of drill cuttings. Also include the drilling rate (drill footage per work shift). Revise the Blasting Plan to address

concerns during drilling. Obtain Department acceptance of the revised Blasting Plan before proceeding.

- Before loading of blastholes, post warning signs at points of access to the blasting site.
- Blastholes must be covered and designed to keep material from falling into the blastholes after drilling. Place reusable plastic hole markers in each blasthole to identify all blasthole locations.
- Measure blastholes before loading any explosives into the blastholes to ensure each blasthole is open to the original drilled depth and free of obstructions before placing a charge. Use precaution to prohibit caving of material from borehole sidewalls during placement of the charges.
- While loading the explosives into the drilled blastholes, only the blaster and those persons necessary for the loading process are allowed within 50 feet of a blast area.
- Stem all unloaded portions of the blastholes between 0.7 and 1.3 times the burden distance. The actual ratio may need to be refined after the initial blast (i.e., test blast section or production blast). Stemming material must be as specified in Section 207.2(a)1.
- Appropriate explosives and accessories must be employed for the various conditions to achieve the specified cut slope design.
- If blasting is permitted on structure foundations, any over break beyond the desired Bottom of Footing Elevation (BOFE) must be repaired by excavating broken materials and leveling off to the BOFE with Class C concrete, or as required.
- Furnish and use sufficient approved blasting mats when necessary to hold and suppress flyrock and prevent subsequent damage to property and roadway.
- Perform all necessary repairs to roadway, structures, utilities, and any property damage as a result of blasting at no additional cost to the Department.
- The Contractor is liable for all injuries or deaths of persons and/or farm/domestic animals, and any damage to property caused by blasting.

(f) Controlled Blasting.

1. Test Section. Conduct test blast sections before the start of full-scale blasting operations as specified in Section 207.3(e), and with the following.

- Conduct initial test blast section as one presplit blast pattern using variable spacing of 18-inches over 18 feet, 24-inches over 24 feet, 30-inches over 30 feet, and 36-inches over 36 feet using a maximum lift of 30 feet.
- Hole to hole spacing requirements for 18-inch and 24-inch presplit patterns must be maintained within 75 to 125 percent of the intended spacing. For 30-inch and 36-inch presplit patterns, hole to hole spacing must be within 6-inches of the intended spacing. Hole to hole spacing must be maintained throughout presplitting. If the deviation of presplit blastholes exceeds the allowable tolerance, provide the Department alternative drilling methods in a revised Blasting Plan to reduce deviation within the above specified tolerances. Alternative drilling methods may include, but are not limited to, revised procedures, drill tooling, cutting bits, or other equipment that provides specified spacing tolerances. Obtain Department acceptance of the revised Blasting Plan before proceeding. Test sections must not exceed 110 feet.
- The test section must demonstrate the suitability of the proposed blast plan relative to fragmentation requirements, over break control, flyrock control, adequacy of stemming, and other appropriate or necessary factors.
- When results of the drill logs are unusual (i.e., encountering zones of soft or weathered rock, mud or clay pockets, voids; rate of penetration; and the color and character of drill cuttings), revise the Blasting Plan as necessary and obtain Department acceptance of the revised Blasting Plan before proceeding.
- When rock of different characteristics is encountered, a blasting test section must be performed.
- Excavate the blasted test section to fully expose the presplit face and provide the means to access the face so that the Department can examine and evaluate the results of the blasted test sections. The Department will examine the completed test section and select the blasthole spacing that demonstrates the best presplit face quality. If no acceptable conditions are found by the Department upon examination of the test section, revise and submit to the Department a new

Blasting Plan for review and acceptance. Drilling and blasting will be suspended until the Blasting Plan is accepted. At no additional cost to the Department, conduct additional test sections at the same blasthole diameter and spacing used for the previous test section and by adjusting the explosive load until desired/acceptable results are obtained without exceeding the established PPV as specified in Section 207.3(j). Unsatisfactory results include, but are not limited to, excessive fragmentation beyond the indicated lines and grade, excessive flyrock, and poor timing delays. Upon completion of test blasting, obtain written approval from the Department to proceed with full scale blasting operations.

- If the Contractor has conducted repeated test blasts using different drilling techniques, reduced the height of the lift in an attempt to meet the borehole deviation limits, provided evidence that the magnitude and direction of deviation between each blasthole has remained constant, and ultimately determined that due to geologic conditions deviation tolerances are not achievable, the Department may review the findings and make an informed decision of any acceptable borehole deviations.
- The Department's approval of the test blasting program and the techniques and procedures associated with test blasting does not relieve the Contractor of any responsibilities to employ appropriate safety measures and exercise proper supervision of blasting operations.

2. Presplit Blasting. Complete all presplitting, including test section blasting, as specified in Section 207.3(e), and as follows:

- Employ a surveyor licensed in the Commonwealth of Pennsylvania to locate and mark each presplit blasthole shown on the Blasting Plan to produce an excavated slope to the lines and grade as indicated. Drill presplit blastholes within 3 inches of the staked location. Blastholes drilled beyond this limit will be rejected.
- Control the angle and bearing at which the drill steel enters the rock with an electro-mechanical or electronic device (smart level meeting accuracy conditions of plus or minus 0.2 degree) by attaching to or resting on the drilling equipment. Blasthole drilling will not be allowed if this device is missing or inoperative.
- Complete a borehole deviation survey of each presplit blasthole before loading the blastholes using an electronic, borehole deviation measuring system with a probe resolution of 0.2-degree accuracy. Provide a report of each blasthole deviation survey to the Representative including blasthole alignment and graphical output data. Also, the report must show that the alignment will produce the excavated face to the line and grade as indicated. Terrestrial Surveying may be employed as necessary to produce this report. The output software must be capable of plotting vertical profiles parallel and perpendicular to the slope. No blasthole must deviate by more than 6 inches parallel and perpendicular from the planned slope. Hole to hole spacing must be maintained throughout presplitting as specified in Section 207.3(f)1.
- Drill a replacement presplit blasthole if the blasthole is 12 or more inches from the intended spacing at no additional cost to the Department. Abandon presplit blastholes not meeting the accuracy requirements using stemming as specified in Section 207.2(a)1at no additional cost to the Department. Drill presplit blastholes between 2.5 inches and 3 inches in diameter. If drilling accuracy requirements cannot be achieved during test blast sections, blastholes with a diameter not exceeding 4 inches may be drilled. Do not exceed a length of 30 feet in blastholes for any lift. The Department maintains the right to decrease the length of the presplit blastholes at any time due to poor performance.
- Drill presplit blastholes a minimum of 30 feet longitudinally beyond the limits of the production blastholes to be detonated or to the end of the cut.
- If the cut height requires more than one lift, a maximum offset of 24-inches between lifts will be permitted for drill equipment clearance. Begin the presplit blasthole drilling at a point that allows for the necessary offsets and adjust to compensate for any drift that may occur in the upper lifts.
- Use only explosives manufactured specifically for presplitting in presplit blastholes. Bulk ANFO is prohibited in presplit blastholes. The maximum diameter of the explosives must not exceed one half the diameter of the presplit blasthole.

- Detonation of explosives in each blasthole in a presplit shot may be simultaneous or delayed due to noise or vibration concerns provided the hole to hole delay doesnot exceed 25 milliseconds.
- Initiate the blasting in the presplit blastholes before initiating the production blasthole explosives by a minimum of 25 milliseconds.

3. Trim Blasting. If the horizontal distance between the existing rock face and the design cut face is less than 15 feet, the Contractor may use trim blasting. Perform trim blasting as specified in Section 207.3(f)1 and 2, except there are no production blastholes.

(g) Production Blasting. Complete all production blasting as specified in Section 207.3(e), and as follows:

- Do not exceed 6.25 inches in diameter for the production blastholes.
- Drill the production blastholes in the patterns and to the depths established in the Blasting Plan. Do not drill blastholes to a depth that exceeds 30 feet.
- Drill the row of production blastholes adjacent to presplit blastholes. Drill the row of production blastholes on a plane parallel to the presplit blastholes. The distance between production blastholes and presplit blastholes will be based on a distance of 1 foot per inch in diameter of production blasthole. Drill the bottom of the production blastholes at an equal depth/elevation to the bottom of the controlled blastholes, except for the bottom lift for sub drilling.
- Do not blast within 5 feet above of an at-grade separation to minimize disturbance. Remove remaining rock above the top of the at grade separation by mechanical methods.
- Drill a line of buffer holes on a parallel plane adjacent to the presplit blastholes. Buffer hole spacing can range from one half the production blasthole spacing to two times the presplit blasthole spacing. Drill buffer holes between 2.5 and 3 inches in diameter, and 3 feet from the presplit line. Do not load the buffer holes with more than 50% of the full explosive load that could be placed in a 3 inch production blasthole.
- Maintain a burden distance which is not more than one half the bench height in order to control blasting effects. Required burden distance must be determined by the Contractor so as not to over or under confine the blast. Burdens must be determined to prevent flyrock and backbreak of the presplit face.
- Drill the production blastholes within two blasthole diameters from the staked drill collar location. Survey the elevation at the collar of each drilled production blasthole to foundation grade and verify the production blastholes are not sub-drilled below final foundation grade. Blastholes drilled outside either tolerance must be backfilled with stemming and re-drilled at the proper location and grade as directed by the Representative and at no additional cost to the Department.
- Detonate production blastholes on a delay sequence toward the free face as specified in the Blasting Plan. Delay the detonation sequence from hole to hole within a row by a minimum of 2 milliseconds per foot of hole spacing. A delay of less than 2 milliseconds is acceptable provided that vibration, pre-spilt performance, and flyrock can be controlled. Delay the detonation sequence from row to row by a minimum of 2.5 times the hole to hole delay.
- Take all necessary precautions to minimize blast damage to the rock backslope during production blasting.
- Remove or stabilize rock along the cut face that is loose, hanging, or creates a potentially dangerous condition during or on completion of the excavation in each lift. Do not drill the next lift until this work is performed.

(h) Blasting Report. Complete and sign the Blasting Report using Form TR-41, submit it within 48 hours after making any blast, and obtain acceptance before drilling of the next blast section is initiated. Alternative forms/reports are acceptable for use provided that they contain the information required on Form TR-41. Only the blaster who was reviewed and approved by the Department may perform blasting operations including drilling of blastholes. At a minimum, the Blasting Report must include the following:

- Drill logs, drilling remarks, and loading and timing delays used in each blasthole of the blast.
- All blast monitoring documentation, which includes vibration and airblast monitoring data.
- Contractor’s evaluation of the blast performance.

- Two High-definition (minimum 1080p resolution and 60p frame rate) digital video recordings submitted in MPEG-4 file format (or acceptable variant as determined by the Representative) on a CD, DVD, or flash drive of any test, controlled, and/or production blasting. The two videos must be recorded at opposite angles of the blast and, if feasible, from an elevated angle and a ground angle.
- All damage incurred and details of complaints or comments.
- Blast area description, weather, Contractor/crew, and layout and timing diagram.

(i) Maintenance and Protection of Traffic (MPT) during Blasting Operations. Coordinate MPT activities with the Department for any portion(s) of roadway that must have temporary closures or lane restrictions during blasts. The MPT Plan for any partial or full roadway closures and detours must be approved by the District Traffic Engineer (DTE). At a minimum, all traffic must be stopped during blasting operations on roadways where the Contractor or the Representative has determined that road users may be impacted by blasting operations. Traffic may be halted for periods not to exceed 15 minutes or unless otherwise approved. Traffic may not resume after a blast until the area is clear of any debris, the excavated slope face is free of any loose material, and the blasted material is stockpiled into a stable mass until it can be removed from the site. An adequate barrier to temporarily separate blasted material must be in place between active roadway lanes and blasted material. Time between traffic stoppages will be determined by the Department. Blasting operations will not be allowed during peak traffic hours as determined by the Department's DTE. Roadway closures are allowed Monday through Friday, 9:00 A.M. to 3:00 P.M. or as determined acceptable by the DTE. No blasting is allowed during holiday periods or local events as determined by the Department's DTE.

Notify the Department RTMC and State/local Police two times before each blasting event. The initial notification must be made 24 hours in advance of the expected blast time. A second notification must be made 15 minutes before stopping traffic for the blast work. Sufficient flaggers must be present to control traffic on all impacted roadways. When traffic is stopped for blasting, monitor the traffic queue. Provide a shadow vehicle on each affected approach, one in each direction, at least 300 feet in advance of the last vehicle in the traffic queue. This vehicle must remain at least 300 feet in advance of the last vehicle as the length of the queue increases. It may be necessary to provide two of these vehicles with drivers working as a team if adequate shoulder or roadside is not available for a single vehicle to safely drive in reverse along the roadway.

Furnish, erect, and maintain on all affected roadways, appropriate standard signing according to the MUTCD, Part 6 Figure 6H-2 Blasting Zone (TA-2). These signs are in addition to any temporary traffic control devices as indicated or according to Publication 213.

Provide patrol vehicles, one in each direction, to drive through the blast area, to determine the site has been completely cleared before the blast is detonated. Employ suitable precautionary measures and devices to prevent roadway damage (including pavement, drainage features, signing, traffic barrier and/or guide rail, lighting, traffic control devices, and any other roadway element). Precautionary measures and devices may include barriers, blasting mats, and other protective and control measures and devices. As soon as the blasting has been completed, inspect the work area for any unsafe conditions. An inspection of the roadway by one patrol vehicle in each direction must be completed before traffic is released. Provide excavation equipment on standby to clear any rock debris from the roadway immediately following inspection.

(j) Vibration Monitoring. Complete vibration monitoring by a qualified independent blasting consultant. Use a minimum of five portable seismographs for each blast according to the International Society of Explosives Engineers Performance Specifications for Blasting Seismographs. Use seismographs capable of measuring particle velocities for three perpendicular components of vibration within a frequency response range from 2 to 250 Hz. Use seismographs that have received a factory calibration within the 12-month period preceding the blast recorded and according to the following:

- Complete the Vibration Monitoring Report using Form TR-44. Alternative forms/reports are acceptable for use provided that they contain the required information required on Form TR-44.
- Place four of the seismographs north, south, east, and west of the blast at the approved locations. Place the remaining seismograph at the nearest critical structure subject to blast induced damage.
- Monitor and record PPV and frequency for each blast.
- Provide the data recorded for each shot to the Department before the next blast.
- Do not blast within 10 feet of the closest structure.
- Do not blast within 250 feet of less than 3-day old concrete.

- Do not blast within 30 feet of newly placed concrete until it has reached 28-day strength unless approved by the Department. For blasting greater than 30 feet away from new concrete, the ground vibration limits apply according to Table A.

Table A

Age of Concrete	Maximum PPV
Less than 3 days	No blasting
After 3 days	1.0 in/sec
After 28 days	2.0 in/sec

- Before test blasting, calculate the value of maximum powder charge per delay permissible using an initial conservative scaled distance of 50 for the distance between the critical structure and shot. The scaled distance is calculated by dividing the true distance (feet) from the blast to a point of concern by the square root of the maximum charge weight in pounds per delay.
- Plot the PPV measured from each seismograph versus the scaled distance between the blast and seismograph location on a logarithmic-logarithmic graph. From this plot determine the site-specific working scaled distance factor for a maximum particle velocity of 1.6 inches per second.
- The Representative and the qualified independent blasting consultant will confirm that the PPV of each component does not exceed the safe limits of the nearest structure subject to vibration damage. The limits for any of the three mutually perpendicular components of PPV must be determined using Figure 1of Title 25 Pa. Code § 211.151.
- For all subsequent blasts, the qualified independent blasting consultant will evaluate the resulting PPV measured by the seismographs by plotting the recorded PPV versus the scaled distance on a logarithmic- logarithmic graph and submit it for approval. If at any time a maximum particle velocity of 2.0 inches per second is exceeded a modification to the initially established working scaled distance is required.
- Stop all blasting operations if the vibration limits are exceeded until the Contractor reports to the Representative that no damage has occurred to structures covered in the Pre-Blast Survey and that corrective measures are in place to lower vibrations to required limits to minimize the potential for any damage from future blasting.

(k) Airblast Monitoring. Monitor airblast between the main blasting area and the nearest structure subject to blast damage or annoyance. Monitor airblast at a second location as determined by the Representative and according to the following requirements:

- Use airblast monitoring equipment of the type specifically manufactured for the purpose of airblast measurements.
- Maintain a peak overpressure below 128 dB (0.007 pounds per square inch) for residential structures. Provide a dated record of the peak overpressure measurements to the Representative immediately after each shot or use the same reporting procedures and time intervals designated for vibration monitoring.
- Stop blasting operations if the established overpressure limits are exceeded until the airblast monitoring specialist reports to the Representative that no damage has occurred or will occur and that corrective action has been taken to lower the peak airblast.

(l) Water Supply Monitoring. Monitor water supply and submit Water Supply Monitoring Reports to the Department before and after blasting operations, and when issues arise during blasting operations. The water supplies must include all wells, springs, or other ground water supplies used for human consumption.

Retain a qualified independent blasting consultant to oversee and complete the water supply monitoring program. Complete the Water Supply Monitoring Report using Form TR-45. Alternative forms/reports are acceptable for use provided that they contain the required information on Form TR-45. The following information is required for the completion of the water supply monitoring program:

- Determine the quantity and quality of water by identifying and monitoring water supplies within 1,000 feet of the blasting location(s). If geologic conditions warrant, water supplies beyond 1,000 feet may be included if there are concerns for potential impact, or if deemed appropriate for risk management.
- Two weeks before the start of blasting operations and between 6 and 8 weeks after blasting operations conclude, where allowed by the owners, for all water supplies identified, measure and record water levels, well depths, existing flow rates, well yield, and any other pertinent information.
- Two weeks before the start of blasting operations and between 6 and 8 weeks after blasting operations conclude, complete field and laboratory analyses for the following field water quality data parameters (and any other requested parameters) from all identified water supplies: pH, Temperature, Specific Conductance, Turbidity, Total Coliforms, Fecal Coliforms/E. Coli, Nitrate, Nitrite, Chloride, Hardness, Iron, and Sulfates.
- Collect water samples using sample collection and preservation techniques specified by the testing laboratory.
- Complete water analyses by a DEP certified laboratory.
- Within 10 weeks after completion of blasting operations provide the Department a final report of the conclusions and results of the water supply monitoring program and, if applicable, indicate any impacts to local water supplies from blasting activities.

The Department will conduct an investigation to determine the cause of a water supply loss. The Contractor is not responsible for damages to the water supplies provided the excavation was done as indicated and the blasting is conducted according to this specification and the Blasting Plan.

(m) Post-Blast Survey. Conduct an Exterior and Interior Post-Blast Survey within 4 weeks after completion of all blasting and rock excavation of all utilities, buildings, or structures for which a Pre-Blast Survey was performed unless a waiver was/is obtained from the property owner. Complete the Exterior and Interior Post-Blast Survey using Form TR-42. Alternative forms/reports are acceptable for use provided that they contain the required information on Form TR-42. Follow the procedures as specified in Section 207.3(b), to obtain arrangements for property access and submittal procedures to the Department. The Post-Blast Survey must be completed by a qualified independent blasting consultant in the presence of the property owner. At the conclusion of the Post-Blast Survey, the property owner must sign both Exterior and Interior Post-Blast Survey Forms and be provided a copy. Submit the duly witnessed and signed Exterior and Interior Post-Blast Survey Forms to the Representative. Include in the report any diagrams and 8-megapixel resolution minimum digital images of structures indicating size and location of cracks, separations or damage in foundations, walls, ceilings, floors, or other structural components. Also, include documentation of any reported damage to water supplies including wells and springs and any differences from the Exterior and Interior Pre-Blast Survey Forms.

The Contractor is responsible for damage resulting from vibration or noise above the established allowable limits, and any other damages, including damages from flyrock, inadequate control or retention of blasted materials, improper or poor blast area security, or other damages resulting from improper or careless blasting practices or construction techniques.

207.4 MEASUREMENT AND PAYMENT— Blasting for Rock Cut Slope Excavation is incidental to excavation or borrow excavation. All material, explosives, labor, tools, and equipment needed for blasting operations including monitoring and survey activities will be considered incidental to the class of excavation specified and will not be paid for separately except as specified in Section 207.4(a).

(a) Controlled Blasting. Linear Foot

Measured on linear foot of acceptable presplit or trim blasthole depth for blastholes drilled within the tolerance as specified in Section 207.3(f).

SECTION 208—SPECIAL ROLLING

208.1 DESCRIPTION—This work is the special rolling of existing embankments; structure foundations on soil; existing subgrades; and the excavation and backfilling of the unstable areas, as indicated or as directed.

208.2 MATERIAL

(a) Selected Borrow Excavation, Section 206.2(a)1.d Rock

(b) Selected Borrow Excavation, Coarse Aggregate, No. 1 (AASHTO No. 1) - Section 703.2(c)

(c) Selected Borrow Excavation, Coarse Aggregate, No. 2A-Section 703.2(c)

(d) Geotextile, Class 4, Type A - Section 735-Table A

(e) Geotextile, Class 4, Type C - Section 735-Table A

208.3 CONSTRUCTION—Perform special rolling in the presence of the Representative who will approve or disapprove the stability of the embankment and recommend corrective measures.

(a) Equipment. Use a roller type meeting one of the following requirements:

1. Pneumatic Tire Roller. Pneumatic-tire roller capable of varying the load from 26 tons to 28 tons.
Use a 2-axle pneumatic roller that will transmit the load through a minimum of four wheels on each axle. The wheels must be equally spaced over the roller width, be equally inflated, and have independent suspension, so that the wheels will carry approximately equal loads when operated over an uneven surface. Use a pneumatic-roller with tires capable of operating at inflation pressures ranging from 100 pounds per square inch to 105 pounds per square inch, the minimum wheel path overlap is 0.5 feet. All tires are to be smooth or have a low void ratio tread. The pneumatic roller should be not more than 10 feet wide overall.

2. Sheepsfoot or Pad Foot Roller. Use a sheepsfoot or pad roller for special rolling of fine grained and cohesive materials. The sheepsfoot or pad roller is to have a minimum foot or pad contact pressure of 160 pounds per square in.

3. Smooth Steel Drum Vibratory Roller. Use smooth steel vibratory drum roller for special rolling with a minimum dynamic force at the drum of 50,000 pounds.

4. Loaded Triaxle Dump Truck. 72,000 pounds Gross Vehicle Weight

(b) Rolling. Perform special rolling on existing subgrades or subgrades in cuts. Do not perform special rolling on newly constructed subgrades. Perform special rolling on embankment foundations, existing embankments where the grade is being raised, and structure foundations with spread footings bearing on soil.

- Before special rolling, compact the area as specified in Section 206.3(b). For areas of subgrade construction, prepare as specified in Section 210.

- For soils as specified in Section 206.2(a).1. a, use either a sheepsfoot, pad foot, or pneumatic tired roller. Do not use vibratory compaction, run all equipment in static mode. Operate roller at a maximum speed of 2 miles per hour. Observe that the sheepsfoot or pad foot roller "walks-out" of the soil. Alternatively, run a pneumatic roller and observe behavior of the roller and material.

- For granular materials as specified in Section 206.2(a)1.b and Section 206.2(a)1.c, compact the area as specified in Section 206.3(b)1.b or Section 206.3(b)1.c. Operate the smooth steel drum vibratory roller at a speed not exceeding 2 miles per hour. Do not use a smooth drum roller with vibratory drum on fine grained soils such as silt and fine sands.

- Compact material to 97% of maximum dry density for embankment foundations or for existing embankments greater than 3 feet below the proposed subgrade elevation. Compact material to 100% of maximum dry density for structure foundations, subgrades, or for material within 3 feet of proposed subgrade elevation. Compact material at a moisture content between minus 3% of optimum moisture content and optimum moisture content. Material that is above the optimum moisture content, shall be dried by disking, scarifying, or other means, until the material meets the moisture content requirements before compaction.

- When moisture-density test data is not available, compact with the proposed equipment using a test strip approach. After each pass of the compaction equipment, check the in-place moisture and density at several pre-determined random locations according to AASHTO T191 or AASHTO 310. When the measured moisture density does not increase by more than 1% over three consecutive passes of the compaction equipment, and the material appears stable, then proceed to special rolling. If the material cannot be compacted to a stable mass, the material is too wet and must be dried and recompacted, as above, to a stable mass before proceeding to special rolling.

- When special rolling using a loaded triaxle dump truck (72,000 pounds, gross vehicle weight), perform special rolling only in the presence of the Representative who will assess, and approve or disapprove the stability of the area being investigated. Run the loaded triaxle dump truck in a systematic manner to investigate the stability of the entire area indicated, or as directed. Additional passes of special rolling equipment may be ordered by the Representative in order to assess the soils. The Representative may waive special rolling requirements in wet or unstable areas if other stabilization or treatment measures are specified or required.

- Do not substitute special rolling for compaction procedures. Protect structures such as bridges, box and pipe culverts, from damage by special rolling equipment. Do not perform special rolling within 10 feet of bridge abutments or approach slabs.

(c) Stability. When the Representative determines the stability of the subgrade is unsatisfactory, stabilize the subgrade by providing compaction or by undercutting/excavating and replacing the unsuitable subgrade material. Unsatisfactory stability due to special rolling is defined as one of the following:

- For existing subgrade, subgrade in cut, spread footing on soil, when the permanent deflection or rutting is greater than 1/2 inch.

- For embankment foundations, including existing embankment when the grade is being raised, if the permanent deflection or rutting is greater than 1 inch of permanent deflection.

(d) Stabilization. When removing and replacing areas of unsatisfactory stability, the length and width of excavation is as directed and as follows:

1. Transition at the beginning and end of undercut shall be constructed with a slope ratio no steeper than 8H:1V. Compact the bottom of the undercut.

1.a. 1 Foot Depth Subgrade Undercut. For subgrade areas with greater than 0.5 inch and less than or equal to 3 inches of permanent deflection when performing Special Rolling, excavate the failed subgrade area to a depth of 1 foot as directed. Place Geotextile Class 4, Type C, as directed at the bottom of the undercut as specified in Section 212.3(e). If directed, drain the undercut by excavating a drainage path and backfilling it with No. 57 aggregate. Place Selected Borrow Excavation or other material as specified in Section 205. Compact aggregate as specified in Section 206.3 and Section 210.3. A minimum of 8 inches of approved material is to be in place on the geotextile before compaction.

2.a. 3 Foot Maximum Depth Subgrade Undercut. For subgrade areas with greater than 3 inches of permanent deflection when performing Special Rolling, excavate the failed subgrade area to a maximum depth of 3 feet as directed. Place Geotextile, Class 4, Type C at the bottom of undercut as specified in Section 212.3(e). If directed, drain the undercut by excavating a drainage path and backfilling it with No. 57 aggregate. Place Selected Borrow Excavation or other material as specified in Section 205. Compact aggregate as specified in Section 206.3 and Section 210.3. A minimum of 8 inches of approved material is to be in place on the geotextile before compaction.

Place a layer of Geotextile, Class 4, Type A as specified in Section 212.3(d) on Selected Borrow Excavation used to backfill the undercut prior to placing subbase on the undercut area. A minimum of 6 inches of subbase is to be placed on the geotextile before compaction.

Protect existing underground utilities during undercut operations.

208.4 MEASUREMENT AND PAYMENT—

(a) Special Rolling. Hour

Special rolling is paid by the hour, measured to the nearest 0.25 hour, in which special rolling is being performed in the presence of the Representative.

Payment will not be made to correct damage caused by the Contractor to the subgrade.

No measurement and payment will be made for idle equipment time for testing of materials, repairs or servicing equipment, loading or unloading ballast, increasing or decreasing tire pressure, inclement weather, or for any other similar reason under the control of the Contractor.

(b) Excavation/Backfill/Compaction. Cubic Yard. Measured in place as compacted material using the average end area method. All labor, materials and equipment required to excavate, drain and backfill areas are included in the cubic yard item.

(c) Geotextiles, Class 4. Square Yard
For the type indicated or specified.

SECTION 210—SUBGRADE

210.1 DESCRIPTION—This work is preparation of the roadbed to establish the top of subgrade elevation for both fills and excavations.

210.3 CONSTRUCTION—

(a) General. Form roadbed to the established top of subgrade elevation and compact as specified in Section 206.3(b).

(b) Preparation and Proof Rolling. Place and compact fill materials to top of subgrade elevation as specified in Section 206.3(b) for the type of material placed. For newly placed fills, maintain materials as specified in Section 206.3(b).

Where undercutting is not directed, compact and proof roll existing subgrades or subgrades in cut areas as specified in Section 206.3(a)1. Seal all subgrade surfaces that have been constructed or disturbed at the end of each workday with a smooth-drum steel wheel roller in the static mode to promote continuous positive drainage and to minimize infiltration of surface water.

Maintain and protect completed subgrade. When the completed subgrade has been in place for more than 60 days or at least one winter season, compact and proof roll the entire subgrade surface as specified in Section 206.3(a)1 before placing the Class 4, Type A geotextile separator and subbase. Promptly reshape and recompact, or remove and replace, damaged or unsatisfactory areas before placement of the geotextile.

After acceptance of the subgrade, place a Class 4, Type A geotextile over the completed subgrade for the entire lane width 8 feet or greater before placing the subbase. Place the geotextile as specified in Section 212.3(d)1. Install the geotextile continuously in a longitudinal direction, with the transverse limits extending to within a minimum of 6 inches and a maximum of 12 inches from the interior edge of the pavement base drain. Do not disturb or damage the geotextile during the installation of the pavement base drain. Repair damaged geotextile at no additional cost to the Department.

(c) Subgrade Requirements. Install reference grade lines with ample supports, or grade stakes, offset along each side of the subgrade, to control the elevation. Maintain reference grade lines until after completing the surface and correcting deficiencies.

Check subgrade for grade and slope. Test the finished surface for irregularities by using a string line stretched tautly, transversely across the subgrade area, between the reference grade lines. Measure the vertical distance from the string line to the finished grade, at various points along the string line, from one side of the surface to the other. Test for surface irregularities at longitudinal intervals of not more than 25 feet.

As an alternative or whenever the Representative suspects an area is deficient or irregular, check the finished surface with a template and 10-foot straightedge. Test the finished surface for irregularities by using a template cut to the required cross-section of the surface. Equip the template with metal or other vertical extensions attached to the top of each end to support a leveling device for checking the cross slope. The bottom of the template is to be at the elevation of the top of the subgrade. Use a 10-foot straightedge to test for longitudinal irregularities in the surface. Hold the straightedge parallel to the road centerline in contact with the surface. Move the straightedge from one side of the surface to the other. Advance along the surface in 5-foot increments.

Where subgrade is constructed using an automatic grading machine that cuts the subgrade and is controlled by a reference line or lines, the longitudinal interval for checking the surface cross-section may be increased to not more than 50 feet.

Where subgrade is constructed using grading equipment controlled by Survey Grade Global Positioning System (GPS), laser technology, and/or combination thereof, the longitudinal interval for checking the surface cross-section may be increased to not more than 500 feet provided the requirements specified in Section 210.3(d) are met.

Correct surface irregularities exceeding 1/2 inch by loosening the surface and removing or adding material as required. Compact the corrected area and surrounding surface by rolling. Recheck the corrected subgrade area for grade and slope.

(d) GPS or Laser-Controlled Equipment. At least 1 week before the preconstruction conference, submit a machine control grading QC Plan to the Department as specified in Section 106.03(b). At a minimum, the QC Plan

must demonstrate that the grading control equipment meets the performance requirements within acceptable tolerances.

At a minimum, set construction stakes at right angles to the centerline on tangents and radial offsets on curves at 500 foot intervals the entire length of mainline. In addition, set a minimum of two constructions stakes on each ramp, on each intersecting roadway, and on projects less than 1000 feet in length. Tabulate offsets and elevations of all stakes using Form D-413 (Grade Sheet) located in Publication 122M, Appendix C, and provide to the Representative. Rough grade and fine grade stakes will be accompanied by a guard stake for easy identification.

Provide control points and conventional grade stakes at critical locations such as, PC's, PT's, superelevation points, and other critical points required for the construction of drainage and roadway structures.

Provide other points of reference necessary to establish quality control or for verification of accuracy by the Department.

Provide the same Survey Grade GPS network to the Department as that used during construction. The Department will review the network and monitor the project.

Check and recalibrate, if necessary, the GPS or laser machine control system at the start of each work day.

Test the finished surface at all hinge points and/or centerline, edge of lane, and edge of shoulders on the cross-section at all critical locations and as established in the QC Plan.

Correct surface irregularities exceeding 1/2 inch by loosening the surface and removing or adding material as required. Compact the corrected area and surrounding surface by rolling. Recheck the corrected subgrade area for grade and shape.

Upon successful quality control testing, notify the Representative the subgrade is ready for acceptance. At a minimum, the Representative will test the finished surface at all hinge points and/or centerline, edge of lane, and edge of shoulders on the cross-section at a random locations every 500 feet for acceptance. Correct all areas exceeding 1/2 inch. If more than 10% of all acceptance tests are determined to exceed 1/2 inch in any phase of the project, the Representative may require stakes and stringline be established as specified in Section 210.3(c).

Provide all electronic data files used for the construction of the fine-grade of the roadway to the Representative.

210.4 MEASUREMENT AND PAYMENT—

(a) Subgrade. Subgrade is incidental to the immediate overlying pavement structure. If required for shaping and finishing unpaved classes of work, subgrade is incidental to those items of work.

(b) Geotextile, Class 4, Type A. Section 212.4(c)

SECTION 212—GEOTEXTILES

212.1 DESCRIPTION—This work is furnishing and installing geotextiles for the class specified.

212.2 MATERIAL—Use geotextiles as specified in Section 735 for the specified class and type.

(a) Bedding. Section 703.2, No. 57 Coarse Aggregate Type C or better.

(b) Securing Pins. Use steel securing pins minimum 8 inches long by minimum 1/4 inch in diameter and with a 1 1/2-inch washer head. If allowed, alternate securing devices that provide equivalent or greater anchorage may be used.

(c) Cover Material. Use cover material as specified or indicated.

212.3 CONSTRUCTION—As shown on the Standard Drawings, and as follows:

(a) General. Remove and replace fabric areas damaged during construction. Lap replaced fabric as specified for the class of fabric used. Do not allow traffic or construction equipment directly on the fabric.

(b) Class 1—Subsurface Drainage. Provide smooth side and bottom trench surfaces so the fabric does not bridge depressions in the soil and is not damaged by rock projections. Lay the fabric flat in the prepared trench without stretching. Lay the top of the fabric back on the sides to allow for the placement of the aggregate backfill and pipe. Place and compact the aggregate backfill up to the pipe invert level and install pipe. Continue filling the remainder of the trench with compacted aggregate backfill, as indicated. Backfill aggregate and install pipe in a manner to prevent damage to the fabric. Lap out or overlap the geotextile as shown on the Standard Drawings for the specific type of subsurface drain being constructed. Use fabric of a width to allow a minimum trench-width overlap across the backfill at the trench top where required. Overlap adjacent ends of rolls an amount equal to the trench width. Do not allow the fabric to be exposed for more than 2 weeks without covering with aggregate.

(c) Class 3—Sedimentation Control. Use Type A or B fabric as indicated or specified. Install as specified in Section 865.3 or Section 866.3.

(d) Class 4—Layer Separation and Erosion Control (Type A).

1. Layer Separation. Prepare the surface and remove any object that may puncture the geotextile. Roll out the geotextile over the prepared surface. Place fabric in a loose and unstretched condition, but without folds or wrinkles. Do not drag the geotextile on the ground during placement and handling. Overlap fabric roll-ends and edges a minimum of 6 inches with adjacent material. Place cover material by back dumping then spread the cover material ahead of all equipment. Do not make abrupt turns with tracked equipment that would result in pulling, folding, or tensioning of the fabric. Steel pins, as specified in Section 212.2, may be used to secure the fabric before placement of the cover material to prevent lifting of the fabric by wind. Do not allow the fabric to be exposed for more than 2 weeks before covering with subbase or other required cover material. Compact the cover material as specified in Section 206.3.

2. Erosion Control. Remove vegetation, large stones, and other debris from the area to be protected and grade the surface to a relatively smooth condition. Undercut areas of soft material and replace with acceptable compacted material, as directed.

Lay the fabric on the prepared area in a loose and unstretched condition. Overlap all adjacent edges a minimum of 1.5 feet. For underwater placement, overlap a minimum of 3 feet. Offset adjacent roll ends a minimum of 10 feet.

Anchor the fabric in place by securing pins or other acceptable methods, along overlaps, at the spacing shown in Table A. Overlap the fabric so the upslope fabric is overtop the downslope fabric and the upstream fabric is overtop the downstream fabric. Place securing pins on a maximum 6 foot spacing on the unlapped portions of the fabric, such as perimeters.

Securing pins may be eliminated for slopes flatter than 6:1, provided that aggregate, rock, or other acceptable

means are used to secure the fabric.

TABLE A
Securing Pin Spacing

Slope	Steeper Than 3:1	3:1 to 4:1	Flatter Than 4:1
Pin Spacing along Overlaps	2 feet	3 feet	5 feet

Cover the fabric with the covering material as soon as possible. Do not expose the fabric for more than 2 weeks. Place cover material in a manner that slippage of the cover material over the fabric does not occur.

Do not drop rocks directly on the fabric from a height greater than 1 foot. Do not allow the rock placement procedure to puncture or damage the fabric. When placing rock greater than 1 foot in size, use a minimum 6-inch layer of bedding on top of the geotextile to prevent damage to the fabric.

(e) Class 4—Stabilization and GRS Abutment Reinforcement (Type C).

1. Stabilization. Fine grade the subgrade as specified in Section 210.3(c), as indicated, and in compliance with the cross sections. Remove any object that may puncture the geotextile. Roll out the geotextile over the prepared subgrade. Place the geotextile free of wrinkles. Do not drag the geotextile on the ground during placement or handling. Overlap adjacent rolls in a minimum of 2 feet. Do not allow any equipment directly on the geotextile until it is covered to full depth of subbase. Place subbase material by back dumping then spread the subbase ahead of all equipment at full plan depth. Place subbase material so that equipment is never in direct contact with the fabric. Do not make abrupt turns with tracked equipment that would result in deformation of the fabric. Maintain positive slope for drainage. Steel pins, as specified in Section 212.2, may be used to secure the fabric before placement of the subbase to prevent lifting of the fabric by wind. Compact the subbase material as specified in Section 350.3. Fill any wheel ruts that form during construction with additional subbase to maintain plan profile. Do not remove the wheel ruts by blading the wheel ruts level.

2. GRS Abutment Reinforcement. Install as shown on the Standard Drawings.

212.4 MEASUREMENT AND PAYMENT—

(a) Geotextiles, Class 1. Linear Foot
Measured by the length of trench.

(b) Geotextiles, Class 3. Square Yard
For the type indicated or specified, except when used as silt barrier fence paid for under Section 865 or Section 866.

(c) Geotextiles, Class 4. Square Yard
For the type indicated or specified.

SECTION 213—TEMPORARY PROJECT AIR POLLUTION CONTROL

213.1 DESCRIPTION—This work is disposal of burnable spoils by the use of an open-pit incinerator, by removal, or by other acceptable disposal methods.

213.3 CONSTRUCTION—Do not perform this work without before obtaining written authorization from the Deputy Secretary for Highway Administration or authorized designee and, if applicable, FHWA.

(a) General. Use temporary air pollution control measures whenever burning is prohibited because it violates the Air Pollution Control Act (Act 245), as approved October 26, 1972, or as amended.

(b) Open Pit Incinerators. For a project where open or free standing burning is not permitted, the DEP will allow the operation of an air curtain destructor (open pit incinerator), as defined in Title 25, Section 129.14, of the Rules and Regulations of the DEP. Use the destructor for destroying wood waste generated by clearing and grubbing operations, provided that the incinerators are properly designed, located, and operated. Permission may be granted for both units within and outside the air basin areas defined in Title 25, Section 121.1 of Chapter 121 of the Rules and Regulations of the DEP, but each proposal is required to be reviewed on an individual basis by the appropriate Regional Air Pollution Control Engineer.

If operating this unit creates an air pollution problem, the DEP will take enforcement action.

213.4 MEASUREMENT AND PAYMENT—Dollar

The proposal will include an item and a predetermined amount of money for Temporary Project Air Pollution Control. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Temporary Project Air Pollution Control item as follows:

(a) Negotiated Price. At a price agreed upon with the Department, before performing the work. If applicable, agreement is also required with FHWA.

(b) Force Account Basis. Section 110.03(d)

SECTION 214—SEALING ABANDONED WATER WELLS AND SPRINGS

214.1 DESCRIPTION—This work is the sealing of water wells or springs.

214.2 MATERIAL—

- Class C Cement Concrete—Section 704, except with a slump of 5 inches to 6 inches
- Spring Box—Section 605
- Spring Box Outlet Pipe—Section 615

214.3 CONSTRUCTION—

(a) Drilled or Driven Wells. Completely seal the well with concrete.

Remove standing water in the well, if possible, before placing the concrete plug.

Do not pull metal casings of wells. If directed, where multiple ground-water aquifers exist, evidenced by a well-casing length longer than normal, pull the casing. To prevent losing the hole when the casing is pulled, proceed as follows:

1. Fill the lower uncased well portion with concrete before pulling casing.

2. As each section is pulled, fill that portion of uncased hole with concrete before removing the next casing section.

3. Continue until all of the casing is removed and the well is completely filled with concrete.

Excavate material around the casing top, at the finished elevation, 1 foot deep and 1 foot in width around the casing. Fill the excavated area with concrete placed monolithically with the top of the well plug.

Seal wells before demolition operations to prevent contamination.

(b) Dug Wells. Completely fill abandoned dug wells with concrete and finish flush with the surface.

(c) Springs. Enclose springs with satisfactory spring boxes and with suitable overflow pipes to collect and direct the flow to inlets or parallel ditches.

214.4 MEASUREMENT AND PAYMENT—

(a) Sealed Drilled or Driven Wells. Each

(b) Sealed Dug Wells. Each

(c) Sealed Springs. Each

SECTION 219—GEOFOAM LIGHTWEIGHT FILL

219.1 DESCRIPTION—This work is furnishing, transporting, and placing geofoam lightweight fill for construction of embankments and for backfilling behind structures.

219.2 MATERIAL—

(a) Expanded Polystyrene (EPS) Geofoam Blocks. Provide blocks from a manufacturer listed in Bulletin 15 and conforming to the following requirements:

TABLE A
EPS Geofoam Block Physical Requirements(1)

Property	Test Method	Type 1	Type 2
Designation	ASTM D 6817	EPS22	EPS39
Density (pcf)	ASTM D 1622	1.35 ±5%	2.40 ±5%
Compressive Strength at 1% Deformation (psi)	ASTM D 1621	7.3	15.0
Compressive Strength at 5% Deformation (psi)	ASTM D 1621	16.7	35.0
Compressive Strength at 10% Deformation (psi)	ASTM D 1621	19.6	40.0
Flexural Strength (psi)	ASTM C 203	35.0	60.0
Oxygen Index (Volume %)	ASTM D 2863	24.0	24.0
Water Absorption (Volume %)	ASTM C 272	3 (max.)	2 (max.)
Dimensions (inch)	-	24 by 48 by 96 (H by W by L)	12 by 48 by 96 (H by W by L)

(1) All values minimum unless indicated otherwise.

- Provide blocks having the same dimensions as all other blocks, except where necessary for project specific fill geometries. Blocks smaller than the dimensions indicated in Table A can be provided where necessary to meet project specific geometries. Provide manufactured blocks that do not deviate from required or specified dimension of the blocks by more than 0.5 percent.

- Provide blocks having perpendicular faces, except as required for project specific geometries. Do not deviate faces from perpendicular planes more than a 1/16 inch over a length of 12 inches.

- Provide blocks with planar faces (i.e., not warped or uneven) that do not deviate from planarity by more than 3/16 inch over a length of 96 inches.

- Provide blocks manufactured using only virgin polystyrene resin. Do not use blocks manufactured with regrind or recycled material.

- Provide blocks manufactured with sufficient flame retardants to meet the minimum Oxygen Index indicated in Table A.

- Unless blocks are fully encapsulated with a geomembrane, provide blocks manufactured with an insecticide to prevent termite and other insect attack.

- Provide blocks that have been seasoned for a minimum of 72 hours after manufacture and prior to shipment. While seasoning, protect blocks from moisture and ultraviolet (UV) radiation, at a temperature of 68F ±2F. Prior to placement store blocks in a well-ventilated facility. Allow the Representative to inspect the storage facility upon request.

- Provide blocks labeled with manufacturer's name, ASTM EPS designation as specified in Table A, the date the block was molded, the weight (in pounds), and density (in pounds per cubic foot) as measured after the required seasoning period.

(b) Hydrocarbon Resistant Geomembrane. Provide a geomembrane from a manufacturer listed in Bulletin 15 and conforming to the following requirements:

- Provide a geomembrane manufactured from a tri-polymer consisting of polyvinyl chloride, ethylene interpolymer alloy, and polyurethane or a comparable polymer combination meeting the physical and chemical requirements specified in Table B.

TABLE B
Hydrocarbon Resistant Geomembrane Physical Requirements(1)

Property	Test Method	Value
Thickness (mils)	ASTM D 751	30
Unleaded Gasoline Vapor Transmission Rate (ounces/ feet^2/day)	ASTM D 814	0.40 (max.)
Grab Tensile Strength(2) (pounds)	ASTM D 751	550
Elongation at Break (percent)	ASTM D 751	20
Toughness(3) (pounds)	-	11,000
Puncture Resistant (ball tip) (pounds)	ASTM D 751	750
Shear(4) (pounds)	ASTM D 751	320
Factory Seams Bonded Width (Each Seam) (inches)	-	2
Pass Cold Crack (1-inch mandrel, 4 hours) (F)	ASTM D 2136	-30 (pass/fail)

(1) All values minimum unless indicated otherwise.
(2) Both machine and cross-machine direction (1-inch grip, 4-inch by 8-inch sample)
(3) A calculated value (grab tensile strength multiplied by percent elongation)
(4) Modified per National Sanitation Foundation. Std. No. 54

- Provide a flexible geomembrane that covers and conforms to 90 degree edges and corners of blocks at ambient temperatures above 45F without additional heating of the geomembrane.

(c) Geotextile, Class 4, Type A. Section 735.

(d) Fine Sand. Section 703.1(c), Type B, No. 1 Asphalt Concrete Sand or sand with 100% passing the No. 16 sieve and a maximum of 10% passing the No. 100 sieve.

(e) Bedding Material. Section 703.2, AASHTO No. 10 Coarse Aggregate, Section 703.1(c), Type A Cement Concrete Sand, or Section 703.1(c), Type C Mortar Sand.

(f) Capping Material. Includes one of the following:

- Material meeting the requirements of Section 206.2(a)1.a, except 100% of the material passing the 3/4 inch sieve.

- Section 219.2(e).

(g) Embankment. Section 206.2(a)1.a.

219.3 CONSTRUCTION

(a) Delivery, Storage, and Handling. Deliver, store, and handle materials in accordance with manufacturer's recommendations.

During all stages of manufacture, shipment, storage, and construction, protect and handle blocks in a manner to prevent physical damage. Do not use any method of lifting or transporting blocks that create dents or holes in block surfaces or that cause losses of portions of block.

If blocks are to be stockpiled at the project site before placement, designate a secure storage area that is located away from any heat source or construction activity that produces heat or flame. Personal tobacco smoking or flames of any kind are not allowed in the storage area. Store blocks off of the ground and out of standing water. Protect blocks from direct sunlight and UV rays. Do not place a cover directly over blocks that might allow the buildup of heat beneath the cover. Do not traverse blocks with vehicles or equipment, and foot traffic by persons must be kept to a minimum. If blocks are exposed to wind, secure with sandbags or other similar "soft" weights that do not dent or otherwise damage blocks.

Protect blocks from contact with and exposure to vapors from organic solvents, including but not limited to acetone, benzene and mineral spirits, and petroleum based solvents, including but not limited to gasoline, kerosene, and diesel fuel.

(b) On-site Scale. Provide a scale on-site that is capable of weighing the blocks to verify block density. Provide a scale with a rated capacity of no more than two and one half times the weight of the heaviest block delivered to the site and accurate to a tenth of a pound. Provide documentation that the scale has been calibrated after being set up at the site. Verify block density by selecting a random block from each truck load of blocks delivered to the project. If the random block is not within density requirements, the entire truck load will be rejected. Individual blocks from a rejected truck load may be accepted if confirmed to be within density requirements. Record the following information: date and time of measurement, ASTM EPS designation as specified in Table A, dimensions and weight of the block, and the calculated density (i.e., block weight divided by block volume). Provide this information to the Representative upon request.

(c) Block Layout Submittal. Before placing blocks submit shop drawings to the Representative for review and acceptance. Indicate on the shop drawings the proposed location and layout of all blocks; location and thickness of bedding material, capping material, embankment material, and pavement section; and the location of the geotextile and geomembrane. The proposed layout must meet the following requirements:

- Place Type 1 blocks for the main body of the fill.
- Cap the top of the Type 1 blocks with a minimum 12 inch thick layer of Type 2 blocks. Type 2 blocks are not required to be used on the side slopes of the block fill.
- Use the maximum amount of full size blocks of minimum dimensions indicated in Table A that the placement geometry allows.
- Place blocks with smallest dimension oriented vertically.
- A minimum of two layers of blocks must be used (i.e., one layer of Type 1 and one layer of Type 2, except on sideslopes).
- The plane on which any given layer of blocks is placed must be parallel to the longitudinal profile of the roadway.
- Within a given layer of blocks, the longitudinal axes of all blocks must be parallel to each other.

- Within a given layer of blocks, vertical joints between adjacent longitudinal rows of blocks must be offset a minimum of 2 feet.

- The longitudinal axes of blocks for layers above and below a given layer must be perpendicular to the longitudinal axes of blocks within that given layer.

- The longitudinal axes of the uppermost layer of blocks must be perpendicular to the longitudinal profile of the roadway.

- Cover blocks with a minimum of 4 feet of material but not to exceed 6 feet. Total cover thickness includes the pavement section, soil embankment and capping material.

- If blocks are placed adjacent to a river, stream, creek, etc., place the bottom layer of blocks a minimum of 3 feet above the 100-year storm elevation, and a minimum of 1 foot above the 500-year storm elevation.

(d) Damage.

1. Blocks. Do not use blocks damaged during manufacturing, shipping, storage, or construction that adversely affects their qualities. Replace damaged blocks at no expense to the Department. Damaged blocks that cannot be used are defined by any of the following:

- Volumetric damage of more than 0.5% of the volume of the single block

- Surface damage of more than 5% of the load bearing area of the single block

- Surface damage of more than 5% of the total block surface area

- Continuous damage of more than 20% of the length of any side of a single block.

Fill acceptable damaged areas on horizontal bearing surfaces with dry, fine sand, meeting the requirements of Section 219.2(d).

2. Geomembrane. Repair any damaged geomembrane by welding patches according to manufacturer's requirements and as approved by the Representative. Extend patches a minimum of 6 inches beyond the limits of the damaged areas in all directions. Protect the blocks from damage during welding.

3. Geotextile. Remove and replace geotextile damaged during construction. Lap fabric over damaged areas and extend a minimum of 12 inches in all directions. Secure fabric lap with a geotextile seaming spray adhesive recommended by the manufacturer. Apply the adhesive to a minimum of 6 inches of the fabric lap. Do not bond the geotextile to the geomembrane during application of the adhesive.

(e) Placement. Place blocks as indicated in the accepted Block Layout Shop Drawing, or as directed by the Representative. Before placement, and for any period deemed necessary by the Representative, a representative from the manufacturer of the blocks must be on site to answer any questions regarding placement of the blocks.

Before placement of blocks at or below original ground, prepare the embankment foundation area in accordance with Section 206.3(a). Before placement of the first layer of blocks, place a leveling course consisting of a 6-inch loose layer of Bedding Material meeting the requirements of Section 219.2(e). Grade the leveling course parallel to the longitudinal profile of the roadway. The leveling course surface must be free of debris and water before placement of blocks.

Place geotextile, geomembrane, and blocks as indicated in the accepted Block Layout Shop Drawing. Where possible, place blocks with the factory skin (i.e., molded, uncut surface) as the outer layer. If blocks are warped/crowned but within the acceptable tolerance, place blocks with crown upward at all times to prevent the ponding of water. Place blocks by hand. Do not use wheeled, tracked, or other equipment on the surface of blocks, geomembrane, or geotextile at any time. Equipment may be used to transport or lift blocks, as long as its use does not damage the blocks.

Where custom shapes and smaller sizes than indicated in Table A are needed and are not provided from the factory, field cut these custom shapes and smaller sizes from full size blocks using a hot wire cutter. Do not use a chain saw, hand saw, or other mechanical shearing or cutting device to cut or shape blocks. Field cut blocks to within 0.5 inch of required or specified dimensions.

During placement of blocks, secure the blocks with sandbags or other similar "soft" weights that do not dent or otherwise damage blocks until the soil cover is placed. Alternatively, mechanical connectors or EPS compatible adhesive approved by the block manufacturer may be used to secure blocks.

Provide full contact between blocks. Do not leave standing water, accumulated snow or ice, or debris of any kind on previously placed blocks prior to placement of subsequent blocks. Do not use de-icing salts, sodium chloride or other products on the blocks that can cause degradation. Place blocks so that all vertical and horizontal joints between blocks are tight. Allow no gaps greater than 0.1 foot on vertical joints. Do not fill vertical joints with sand.

Construct the top finished surface of the blocks to within a tolerance of 1/2 inch over a 10 foot interval of the design longitudinal profile of the blocks and design transverse slope of the blocks. Additionally, construct the finished surface of the blocks beneath pavement sections to within 0.1 foot of the top of block design grade. Construct the finished surface of the blocks on side slopes to within 0.2 foot of the top of block design grade. Any adjustments for grade can be made using either Type 1 or Type 2 block, so long as the Type 2 blocks have a minimum thickness of 12 inches.

(f) Encapsulating Blocks with Geomembrane and Geotextile. After placement of blocks, continue bringing up the hydrocarbon resistant geomembrane to fully encapsulate all blocks in one continuous layer of geomembrane as indicated in the accepted Block Layout Shop Drawing. Field weld all geomembrane seams using a hot wedge welding machine. Do not use hot air or solvents to weld seams. Do not melt or otherwise damage the blocks during welding. Overlap seams according to manufacturer's requirements, but no less than 3 inches. Protect the blocks as needed during field welding of the geomembrane. Replace blocks damaged from welding of the geomembrane, and repair the geomembrane at no expense to the Department.

Immediately after placement of the geomembrane, continue bringing up the Class 4, Type A geotextile to fully cover the geomembrane. Overlap adjacent layers of geotextile a minimum of 12 inches. Secure all overlaps of geotextile with a geotextile seaming spray adhesive recommended by the manufacturer. Apply the adhesive to a minimum of 6 inches of the overlap. Do not bond the geotextile to the geomembrane during application of the adhesive.

Prevent overspray of the adhesive onto the geomembrane. If overspray occurs, insert an additional piece of geomembrane that extends a minimum of 6 inches beyond the limits of the overspray, to act as a bond breaker between the geomembrane and geotextile.

(g) Capping Material Placement. A 6-inch minimum compacted lift of capping material meeting the requirements of 219.2(f) must be placed on top of the geotextile, including on the horizontal surfaces of the side slopes, before placement of embankment material. Place and compact capping material within 2 weeks after placement of the geotextile as specified in Section 206.3 except as follows:

Place the capping material over top of the fully encapsulated blocks by end dumping material just off the blocks, and blading an 8-inch thick loose lift of material across the blocks with pneumatic tire equipment. Do not end dump capping material directly on the blocks. Do not stockpile capping material on previously placed capping material. A single triaxle truck load of capping material may be dumped onto previously placed and compacted capping material. Spread capping material as quickly as practically possible. Do not drive directly on the blocks with any equipment, do not use tracked equipment, and do not make sharp, sudden turns with pneumatic tired equipment that may damage the geotextile and/or geomembrane. Repair any damage to the blocks, geomembrane or geotextile that occurs before or during fill placement.

Compact capping material using a smooth drum roller in static (non-vibratory) mode.

(h) Embankment Placement. Once a 6-inch minimum compacted lift of capping material is in place over top of the geotextile, place and compact soil embankment meeting the requirements of Section 206.2(a)1.a as specified in Section 206.3 and as indicated in the accepted Block Layout Shop Drawing. Place soil embankment to pavement subgrade elevation. Do not stockpile embankment material on previously placed capping or embankment material. A single triaxle truck load of embankment material may be dumped onto previously placed and compacted capping or embankment material. Spread embankment material as quickly as practically possible.

Place embankment over the side slopes of the block fill starting at the bottom of the slope in such a manner as to prevent damage to the blocks, geomembrane, and geotextile. Provide a minimum of 4 feet of embankment material cover vertically and horizontally over the blocks as measured from any exterior face of the block.

219.4 MEASUREMENT AND PAYMENT

(a) Expanded Polystyrene (EPS) Geofoam Blocks. Cubic Yard.

Measure blocks in their final position. Payment will not be made for wasted material. Payment includes furnishing, storing and placing Type 1 and Type 2 geofoam blocks, bedding material, fine sand, capping material, and any incidental materials such as mechanical connectors and adhesives.

(b) Hydrocarbon Resistant Geomembrane. Square Yard.

Payment includes welding seams.

(c) Geotextile, Class 4, Type A. Section 212.4(c).

SECTION 220—FLOWABLE BACKFILL

220.1 DESCRIPTION—This work is furnishing, transporting, and placing flowable backfill. Flowable backfill may be a mixture of coarse aggregate, fine aggregate, water and air entraining agents, either cement or supplementary cementitious material, or a combination of both, and may or may not include bottom ash, or other admixtures. The three types of flowable backfill are as follows:

(a) Flowable Backfill, Type B. Future excavation of the backfill may be necessary such as at utility trenches, pipe trenches, bridge abutments, and around box or arch culverts.

(b) Flowable Backfill, Type C. Excavation of backfills not anticipated, including replacing unsuitable soils below structure foundations, filling abandoned conduits, tunnels and mines, and backfilling around pipe culverts where extra strength is required.

(c) Flowable Backfill, Type D. Construction in areas requiring low-density backfill material as in abutments over highly deformable soils, backfilling retaining walls, filling vaults, and backfilling on top of buried structures.

220.2 MATERIAL—

(a) Cement. Type I, IP, IS, or II, Section 701. If using Type IP cement, adjust the quantity of flyash in the design as necessary. If using Type IS cement, adjust the quantity of slag cement in the design as necessary. From a source listed in Bulletin 15.

(b) Flyash. Type F or C flyash, Section 724 except as follows:

- Flyash—conforming to AASHTO M 295 (or ASTM C 618) Table 1 requirements except maximum loss on ignition is 16%, and excluding the requirements of Table 1A, 2, or 2A.

From a source listed in Bulletin 15 or tested and approved before incorporating into the flowable backfill mix.

(c) Slag Cement. Section 724.3. From a source listed in Bulletin 15.

(d) Fine Aggregate. Type A, B, or C; Section 703.1; except, having a maximum loss of 20% in the Soundness Test, PTM No. 510. The fine aggregate may be natural sand, manufactured sand, or foundry sand meeting Section 703.1. From a source listed in Bulletin 14.

(e) Coarse Aggregate. Type A, B, or C, AASHTO 10, Section 703.2. Except 10% maximum for material finer than the No. 200 sieve. From a source listed in Bulletin 14.

(f) Bottom Ash. From a source listed in Bulletin 14. Coal ash having a maximum loss of 20% in the Soundness Test, PTM No. 510, and conforming to the following dry sieve gradation requirements:

Sieve Size	% Passing
1/2-inch	100
No. 200	0-10

(g) Water. Section 720.1

(h) Admixtures. Section 711.3.

(i) Air Entraining Admixtures. From a manufacturer listed in Bulleting 15, specifically for flowable backfill.

(j) Geotextile, Class 4, Type A. Section 735

(k) Mix Design. Submit a mix design and test results (density, strength, and air content if applicable) to the Representative, at least 3 weeks before construction. Alkali-Silica remediation is not required regardless of the expansion value of the aggregates used in the mix design. Use Table A as a guideline for the mix design or submit an alternate design based on density guidelines and conforming to the strength requirements of Table A. Base the submitted mix design on an absolute volume of 1 cubic yard.

TABLE A
Mix Design

Properties & Criteria	Type B	Type C	Type D
Mix Design (/CY) Cement (lbs)* Supplementary Cementitious Material (lbs)* Bottom ash (lbs)* or Coarse Aggregate or Fine Aggregate Air Generating Admixture*	 50 300 2600	 150-200 300 2600	 300-700 100-400 **
Slump (inches) AASHTO T 119, ASTM C 136	7 min ****	7 min ****	7 min ****
Density (pcf) AASHTO T 121, ASTM C 136	N/A	N/A	30-70 or as specified ***
Water Absorption of Aggregate AASHTO T 85	--	--	20% max
Compressive Strength (psi) PTM No. 604 28 Days	125 max	800 min	90-400

*Quantities may be varied or alternate designs submitted to adapt mix to conform to density and strength requirements or to adapt to specific site conditions.
**Requires using a suitable lightweight aggregate or air entraining admixture. Provide a mix design that achieves the specified strength and density requirements.
***Approximate Value. Use of air entraining agent may reduce these values.
****Some applications may require containing flowable backfill by constructing dikes from the mix by using less water to produce a 3-inch minimum slump, if approved by the Representative. Thickening of the mix in other areas is allowed if approved by the Representative.

Provide mix designs that conform to specific density requirements, if specified. If source of material is changed, submit a revised mix design before using material. Conduct design mix testing at the highest flowability or slump being used for the project.

If applications involve exposed metal or metal coated with a layer of thin concrete (< 1/2 inch), test the design mixes for corrosion resistance as follows:

Resistivity, AASHTO T 288, 60 day cure	> 2000 ohm-centimeters
pH of pulverized flowable backfill	5.0 to 9.5
Chlorides of pulverized backfill after cure	< 200 ppm
Sulfates of pulverized backfill after cure	< 1000 ppm
Sulfides of pulverized backfill after cure	< 200 ppm

(l) Certification. Certify the properties of flowable backfill as specified in Section 106.03(b)3.

(m) Forms. Section 1001.2(h)1

220.3 CONSTRUCTION—

(a) General. Furnish indicated type of flowable backfill conforming to Table A. Do not allow the flowable backfill to contact aluminized materials or compounds.

Produce and transport as specified in Section 704, excluding maximum temperature range of 90F, or by other approved methods from a facility accepted by the Department. The Contractor may adjust the mix in the field provided it achieves the criteria specified in Table A.

(b) Placement. Submit the sequence of operations at least 4 weeks before starting the work. If required, design the forms to sustain lateral fluid pressure equal to total weight of unhardened flowable backfill with a minimum 1.3 factor of safety. Construct formwork as specified in Section 1001.3(a).

Do not place flowable backfill through flowing water. Remove and replace flowable backfill damaged by rain or flowing water. If excavation cannot be dewatered, place flowable backfill by a tremie procedure approved by the Representative.

Break up lumps by remixing or other approved methods.

Ensure that base drain outlets do not intersect areas where placing flowable backfill. Furnish solid base drain outlet pipes in areas intersecting the flowable backfill.

Do not place flowable backfill at a material temperature below 50F or if the temperature of either the air or the surface that the flowable backfill is placed on is 40F or lower. Maintain the temperature of the in-place flowable backfill at no less than 50F for a minimum of 24 hours or until the next lift is placed.

Do not place additional lifts until surface bleed water dissipates or the preceding lift hardens sufficiently to support foot traffic or both.

Protect finished surface from frost, erosion, and damage with suitable covers of soil, aggregate, concrete, pavement, or other material approved by the Representative.

If required, contain flowable backfill by constructing dikes from the mix. For the mix for dikes use less water to produce a 3-inch minimum slump, as directed by the Representative. Dikes will remain an integral part of completed flowable backfill. The Contractor may thicken the mix in other areas if allowed by the Representative.

1. Structure Backfill. When backfilling, place flowable backfill in lifts to prevent lateral pressures from exceeding resisting capacity of structure. Do not place lifts that exceed 4-foot, unless approved by the Representative. Protect structure foundation drains from intrusion and contamination of flowable backfill by using a separation membrane of Class 4, Type A geotextile. During placement of flowable backfill, protect existing structures, drainage facilities, utilities, etc., that are to remain within the fill area from movement or floating, damage, or misalignment. Repair or replace any damaged items, as directed by the Representative, at no additional cost to the Department. Provide preformed drain, no more than 2 inches thick, between the wall and the flowable fill and provide outlets at not more than 15 feet through the wall, or as directed by the Representative.

2. Pipe Bedding and Backfill. Backfill the trench as shown on the Flowable Backfill Detail in the Standard Drawings. Place adequate support to provide the minimum required bedding from trench bottom to bottom of pipe, and protect pipe from damage, movement, floating and improper alignment. Protect pipe from intrusion of flowable backfill. If shown, place Class 4, Type A geotextile membrane around pipe.

Prevent floating of pipe by placing flowable backfill in lifts or use sandbags or other weights to ballast pipe until lift is set. Place the backfill evenly on both sides of the trench to avoid overstressing the pipe. Monitor pipe alignment according to Section 601.3(c).

3. Utility Trench Backfill. Provide adequate tie-downs or weights, if required, for utility conduits to prevent floating. Protect utilities from damage and movement. Maintain proper alignment of conduits during placement of flowable backfill. Perform all utility work according to the permit requirements.

(c) Testing and Acceptance. Section 704.1(d)1, Section 704.1(d)2, Section 704.1(d)4, and as follows:

Test flowable backfill slump, according to AASHTO T 119, test air content according to AASHTO T 152 (do not apply an aggregate correction factor) or T 196, and for yield, according to AASHTO T 121, ASTM C 136, as part of the QC Plan.

Test flowable backfill for proper flowability using the slump cone. Conduct slump tests as often as necessary (at least once daily or every 200 cubic yard) to maintain the correct flowability at placement and if requested by the Representative. The Contractor may add water on-site to maintain flowability as needed. Test flowable backfill for

yield at least once daily, or one test for every 200 cubic yard of material. Record all test results and submit to the Representative.

Mold 4-inch by 8-inch cylinders according to PTM No. 611, except specimens will remain in the mold until just before testing. Mold cylinders from the sample obtained for testing material flowability. Test for compressive strength according to PTM No. 604, except use neoprene caps.

Ensure the Inspector witnesses compressive strength tests. Remove material that does not conform to Table A strength requirements. The Representative may allow the material to remain in place with liquidated damages assessed at $25/cubic yard per lot of deficient flowable fill.

(d) Opening to Traffic. For flowable backfill Type B and Type C material, do not open to traffic until 1 hour after the surface bleed water has dissipated and as allowed by the Representative. Open flowable backfill Type D to traffic when directed by the Representative.

220.4 MEASUREMENT AND PAYMENT—

(a) Flowable Backfill. Cubic Yard. For the type indicated.

(b) Class 4 Geotextile, Type A. Section 212.4(c)

If using flowable backfill in place of a material incidental to another item of work, then the flowable backfill is also incidental.

SECTION 221—EXTENSIBLE REINFORCEMENT FOR MSE WALLS

221.1 DESCRIPTION—This work is furnishing and installing geogrids for the class specified.

221.2 MATERIAL—

(a) Geogrid. Section 738 for the class indicated.

(b) Backfill. Provide backfill consisting of natural materials, free of organic matter and other deleterious substances.

1. Backfill for Class 1 Geogrids.

1.a Mechanically Stabilized Earth (MSE) Walls. Provide backfill for MSE walls consisting of AASHTO No. 8 coarse aggregate, Section 703.2, in areas that require free draining material or in areas that are at or below the 100 year flood elevation. For all other areas of MSE walls provide backfill meeting the following requirements:

Sieve Size	Percent Passing
1/2 inch	100
No. 40	0-60
No. 200	0-10*

*Determination of the fines content (minus No. 200 sieve material) for MSE wall backfill must be determined by wash test according to PTM No. 100. This is in addition to PTM No. 616.

Provide backfill meeting the quality requirements of Type C coarse aggregate or better as specified in Section 703.2(a), Table B, except provide materials free of clay lumps, friable particles, coal and coke. Do not use metallurgical slag or cinders.

Provide backfill with a maximum plasticity index (PI) of 3 as determined according to AASHTO T 89 and T 90. Provide backfill materials with a pH between 5.0 and 9.0, determined according to AASHTO T 289.

Provide backfill with an angle of internal friction of not less than 34 degrees as determined according to AASHTO T 236 on the backfill sample portion that is finer than the No. 8 sieve. Coarse aggregate as specified in Section 703.2 does not require testing for angle of internal friction. Prepare the shear strength test sample by substituting material coarser then the No. 8 sieve with material that passes the No. 8 sieve but is retained on the No. 10 sieve. The percentage of material finer than the No. 10 sieve must remain as proportioned in the original sample before substitution. Shear testing may be performed on samples containing material larger than the No. 8 sieve if the shear device according to AASHTO T 236, Sections 5.4 and 5.5.

2. Backfill for Class 2 and Class 3 Geogrids. AASHTO No. 8 coarse aggregate, AASHTO No. 57 coarse aggregate, or PennDOT No. 2A coarse aggregate, Section 703.2, and as specified or indicated.

(c) Class 4, Type A Geotextile. Section 735.

221.3 CONSTRUCTION—As shown on the Standard Drawings, as indicated or specified, and as follows:

(a) General. Prepare surface as indicated or required. Place geogrid to the vertical spacing, lengths and areas indicated. Provide overlaps as specified. Place geogrids flat and free of wrinkles, stretching and anchoring as necessary. Do not allow traffic or equipment on the geogrid until it has been covered with one lift (8 inch loose layer) of backfill. Dump backfill of the type specified on top of the geogrid and then blade material across the grid to the required lift thickness. Maximum backfill drop height is 3 feet. If using tracked equipment to spread backfill, do not cross track or make sudden turns that result in deforming or damaging the geogrid. Compact backfill as specified in Section 206.3 or as specified. Reject all geogrids with defects, tears, punctures, flaws, deterioration, or damage

incurred during manufacture, transportation, storage, or installation as determined. Replace damaged geogrid at no additional cost to the Department.

(b) Handling and Storage. According to ASTM D 4873 for identification, storage, and handling of geogrid. Provide clear identification to every roll of geogrid that provides identification of product designation, the manufacturer's name, lot number, material quantity, and clearly differentiates between rolls of similar geogrid. Protect all geogrid from direct sunlight, ultra-violet rays, temperatures greater than 140F, mud, dirt, dust, and debris.

(c) Class 1 – Uniaxial Geogrid Reinforcement. Place all uniaxial geogrid in the direction of primary reinforcement (machine or roll direction). The maximum allowable vertical spacing of geogrid is 2 feet for MSE wall applications and any other reinforcement applications. Overlap adjacent layers of geogrid as indicated or required, but in no case less than 3 inches. For concave wall or slope faces maintain the minimum overlap for 75% of the length of the geogrid from the wall or slope face edge of the geogrid. Do not splice or overlap geogrids in the primary reinforcement (machine or roll) direction.

(d) Class 2 and Class 3 – Biaxial Geogrids. Prepare subgrade or foundation surface flat, smooth and level, free of any sharp protrusion or debris. Place a layer of Class 4, Type A geotextile on top of the prepared subgrade before placement of geogrid. Overlap edges of geotextile and geogrid (both machine/roll and cross machine/cross roll directions) a minimum of 1 foot. Maximum vertical spacing of geogrid is 12 inches.

221.4 MEASUREMENT AND PAYMENT—

(a) Geogrid. Square Yard.

For the class indicated or specified. Any required or incidental overlaps of geogrid are not included in measurement and payment. Only the indicated plan view reinforced area per geogrid layer is included in payment.

Backfill used in the installation of geogrid is included in the payment.

(b) Class 4, Type A Geotextile. Section 212.4(c).

SECTION 222—GEOCELL LOAD DISTRIBUTION MAT

222.1 DESCRIPTION—This work is the construction of a geocell load distribution mat over soft or unstable subgrades.

222.2 MATERIAL—

(a) Geocell. Section 737 of the depth and type indicated.

(b) Anchors. Section 709.1(a), Grade 40. Used to hold expanded geocell sections in a fully and uniformly extended position until backfilling of geocell is complete. Provide anchors in accordance with the manufacturer's recommendations and as indicated, except having a minimum bar diameter of 0.375 inches and a minimum length of 12 inches plus the geocell depth.

(c) Mechanical Fasteners. Used to fasten adjacent sections of geocell. Provide mechanical fasterners in accordance with the manufacturer's recommendations and capable of holding adjacent geocell panels in direct contact until pavement or other type of final surface is placed.

(d) Coarse Aggregate. Section 703.2, No. 2A.

(e) Geotextile. Section 735.1, Class 4, Type A.

222.3 CONSTRUCTION—Install the geocell according to manufacturer's instructions and as follows:

(a) Subgrade Preparation. Prepare compacted subgrade to a uniform surface and to the lines and grade indicated.

(b) Geotextile. Install geotextile on prepared subgrade. Provide a minimum 12 inch overlap between adjacent layers and extend a minimum of 6 inches beyond the indicated perimeter of the installed geocell.

(c) Geocell. Store and transport geocell sections in an unexpanded configuration until ready to install.

Position collapsed geocell sections in place and drive in the anchors starting at the outer edge cells. Drive anchors as required by the manufacturer or as required to fully expand a geocell panel to the required cell dimensions and to hold it in place until filling with subbase is complete. Drive anchors so that the anchor extends at least 12 inches below the bottom of the geocell. Allow enough anchor length above the top of the geocell for the anchor to be removed. Remove anchors after filling the cells with subbase and before compaction when used for subgrade support and pavement applications. In situations where it is not practical to use anchors (i.e. over soft soil containing obstructions to driving anchors, existing shallow utilities, etc.) an installation frame may be needed to allow for the expansion of the geocells without anchoring in place. The installation frame must be capable of fully expanding the geocells and holding them in place until the subbase is placed in the cells.

Align adjoining geocell sections and overlap abutting perimeter cell welded ends. Keep top of geocell sections flush before fastening. Connect adjacent geocell sections with mechanical fasteners, in accordance with the manufacturer's recommendations. Mechanical fasteners must be capable of holding adjacent geocell panels in direct contact until pavement is placed. Fasten all adjoining cells of adjacent geocell sections and all overlapped abutting perimeter cell welded ends.

Place subbase in cells of expanded geocell sections. Overfill cells sufficiently to ensure the top of the compacted subbase is at least 1 inch above the top of the geocell to allow fine grading as necessary or required and to protect the geocell from construction traffic and heat during paving operations. Limit the drop height of the subbase to a

maximum of 3 feet to prevent damaging or displacing the cell wall. Do not operate equipment on unfilled geocell sections until cells have been overfilled with loose subbase.

Compact subbase as specified in Section 350, except when cells greater than 6 inches in height are used. When cell height exceeds 6 inches, compact as specified Section 350, except allow compacted lift thickness 1 to 2 inches greater than the cell height.

222.4 MEASUREMENT AND PAYMENT—

(a) Geocell. Square yard.
Includes mechanical fasteners and anchors.

(b) Geotextile. Section 212.4

(c) Subbase. Section 350.4(a)1

SECTION 223-GEOSYNTHETIC REINFORCED SOIL SLOPE(GRS)

223.1 DESCRIPTION—This work is furnishing the required materials and construction of Geosynthetic Reinforced Soil (GRS) slopes, to the lines and grades indicated, and as directed. Any slopes constructed must be designed according to Publication 293-Geotechnical Engineering Manual, Chapter 11 and Chapter 14.

223.2 MATERIAL—

(a) Primary Geosynthetic - Reinforcement. Geogrid, Class 1, Type A or B, as specified in Sections 738.1 and 738.2 and as follows:
Provide primary geosynthetic reinforcement materials of the lengths as indicated and meeting the following minimum tensile strength at 10% elongation (T10), according to the geogrid reinforcement Class and Type used:

The minimum primary geosynthetic tensile strengths at 10% elongation (T10) are:

T10 = __XXX_____ pounds per foot (Class 1, Type A Geogrid, PET polymer)
T10 = __XXX_____ pounds per foot (Class 1, Type B Geogrid, HDPE polymer)
(XXX see Contract Project Specific Details for parameters)

Each roll of geosynthetic must be clearly identified by the manufacturer with the product model designation, manufacturing plant, and lot number. When multiple primary geosynthetic product models are required, provide a visible marking on each entire roll, identifying the product model. This may be accomplished by color coding the roll ends with spray paint, or other means deemed suitable by the Representative.

(b) Secondary Geosynthetic – Compaction Aid and Face Drain. Section 735, Class 4, Type A.

(c) Geosynthetic Face Wrap. Section 735, Class 4, Type A.

(d) Geotextile Backing. Section 735, Class 4, Type A.

(e) Turf Reinforcement Mat (TRM). Section 806.2(b).

(f) Wire Mesh Forms. Consisting of galvanized welded wire mesh and galvanized wire support struts.

1. Wire Mesh Units – galvanized welded wire mesh as specified in Section 709.3, and as follows:

- Formed to a 90-degree “L” shape with equal 18 inch sides
- Minimum length = 10 feet
- Maximum mesh opening = 4 inch by 4 inch
- Minimum wire size number = W4.0
- Minimum coating thickness = Grade 65

2. Support Struts – galvanized wire formed to interlock with mesh longitudinal wires, meeting the same material requirements as the wire mesh units.

(g) Gabions. Corrosion resistant, Type-B (hand-placed rock only) gabion units as specified in Section 626.2, and having the following nominal dimensions:

- Height = 18 inches
- Width = 36 inches
- Length = 6 feet minimum

(h) Reinforced Fill. Provide fill consisting of natural material, having a pH between 5.5 and 9.0 conforming to AASHTO T 289, meeting of one of the following material requirements:

- Section 206.2(a)1. a, Soil, except particles greater than 4 inches must be removed before compaction.
- Section 703.2, AASHTO No. 8 Coarse Aggregate, 2A, 2RC, AASHTO #57s, or AASHTO #67s.
- Well graded granular material meeting the following gradation requirements:

Sieve Size	Percent Passing
50 mm (2 in)	100
4.75 mm (No. 4)	50 - 100
425 µm (No. 40)	15 - 55
75 µm (No. 200)	0 - 35

1. Density: Except for AASHTO No. 8 Coarse Aggregate, provide fill with a compacted unit weight density (γtot) within a range of 110 to 125 pcf, according to PTM No. 106, Method B. For AASHTO No. 8 Coarse Aggregate, provide a minimum compacted unit weight density (γtot) of 90 pcf.

2. Shear Strength: The reinforced fill material once placed and properly compacted to the required density, must meet or exceed the design shear strength requirements. Provide compacted fill that meets or exceeds the minimum shear strength parameters, as follows:

(see Project Specific Details for following parameters)

Minimum internal friction angle (Ø) = _____ degrees

Determine shear strength of reinforced fill according to AASHTO T 236, on the portion finer than the 2.36 mm (No. 8) sieve. Prepare sample substituting material coarser than the 2.36 mm (No. 8) sieve, with material passing the 2.36 mm (No. 8) sieve but retained on the 2.00 mm (No. 10) sieve. The percentage of all fractions smaller than the 2.00 mm (No. 10) sieve shall remain proportioned as the original sample before substitution. Shear strength testing of reinforced fill material consisting of AASHTO No. 8 Coarse Aggregate is not required.

(i) Fertile Soil. Fertile soil as specified in Section 206.2(a)1. a, except that it must have greater than 25% passing the 75 µm (No. 200) sieve. Soil must be capable of supporting and maintaining plant growth. Unless otherwise indicated for special plantings (e.g. wetlands), provide soils within a pH range of a 5.5 to 7.5 determined according to AASHTO T 289.

(j) Seeding and Soil Supplements. Section 804.2(b), Seed Formula C.

(k) Mulching. Section 805.2(a).1.e, Bonded Fiber Matrix (BFM)

(l) Aggregate Lining. Section 703.2, AASHTO No. 1 Coarse Aggregate

(m) Rock Lining. Section 850.2 of the Class Size No. indicated, except minimum size R-4 and the minimum required thickness of rock lining is 2.5 times the top size of the rock lining class indicated.

223.3 CONSTRUCTION—

(a) Material Submittals. Certify as specified in Section 106.03(b)3. Submit electronically the manufacturers' material information that includes identification samples of all primary geosynthetics, and all data necessary to indicate the geosynthetic(s) meet the specified requirements. Submit required information for approval by the Representative as specified in Section 106.02(a)2.c at least 30 days before the beginning of GRS slope construction. For primary geosynthetic reinforcement not listed in Bulletin 15, submit verification samples to the Representative, --a minimum of 6 foot by 6 foot size. Include samples of all primary geosynthetic types to be used in the reinforced slope. Submit verification samples of reinforced fill material to the Representative for testing shear strength parameters, unit weight, gradation and pH. Shear strength testing of reinforced fill material consisting of AASHTO No. 8 Coarse Aggregate is not required.

(b) Foundation Preparation. Prepare foundation horizontal and level to the lines and grade indicated, as specified in Section 206.3, and as follows:

- Excavation for equipment access beyond the line and grade as indicated at no additional cost to the Department.
- Prepare foundation free of deleterious or unsuitable soils.
- Proof roll the foundation to provide a uniform and firm surface as specified in Section 206.3(b).3.
- A foundation will be considered as being unstable if the material exhibits pronounced deformation under the specified proof rolling.
- If the top of rock elevation (bedrock) is encountered during the planned excavation, field adjustments may be made to the foundation elevation as directed, if approved by the District Geotechnical Engineer.
- The foundation will be inspected by the Representative before placing fill or geosynthetics.

(c) Geosynthetics – Delivery Storage and Handling. Protect all geosynthetic materials from temperatures greater than 140F, from direct exposure to sunlight, and from debris that may damage the material. Store geosynthetics elevated from the ground surface. Reject all geosynthetics with defects, tears, punctures, flaws, deterioration, or damage incurred during installation, manufacture, transportation, or storage. Replace any damaged geosynthetic materials at no additional cost to the Department.

(d) Geosynthetic Reinforced Soil (GRS) Slope Construction. Construct the selected GRS slopes as shown on the Standard Drawing, as indicated, and as follows:

- Place primary geosynthetic, of the minimum lengths and strengths indicated, in continuous strips in the primary direction of stabilization, perpendicular to the slope face. Effective length of grid-type geosynthetic is measured beginning and ending at primary transverse ribs. The effective length provided must equal or exceed the minimum length indicated. Maximum allowable vertical spacing of primary geosynthetics is 18 inches. Two layers of secondary reinforcement are placed evenly spaced between layers of primary reinforcement. Vertical spacing between all secondary layers, and between secondary and primary layers above or below, is 6 inches. Splicing of any primary geosynthetic, including seams or connections, is prohibited. Overlap adjacent sections of primary geosynthetic along parallel roll edges a minimum of 2 inches

- For embankments with GRS slopes on both sides, place primary geosynthetics from opposite slope faces, independent of one another. When primary geosynthetic layers from opposite or adjacent (turned corner) slope faces overlap, separate the overlapped portions with a minimum of 3 inches of compacted fill. Do not place secondary geosynthetic at the elevations where a primary geosynthetic is placed.

- All layers of secondary reinforcement must extend from the face of the wire forms for Type A and Type B slopes, from the face of the geosynthetic wraps for Type C slopes, and from the back of the gabions for Type D slopes, to a minimum of the full length of the longer layer of primary geosynthetic reinforcement directly above or below the layer of secondary reinforcement. Place secondary geosynthetic in continuous lengths perpendicular to the slope face whenever possible. Overlap adjacent sections of secondary geosynthetic a minimum of 2 inches along parallel roll edges. If the length of primary reinforcement from

the slope face is less than the roll width of the secondary reinforcement, the secondary reinforcement may be placed in continuous strips parallel to the slope face. Overlap secondary reinforcement in the roll direction (old roll to new roll) a minimum of 1 foot. When placed in lengths perpendicular to the slope face, partial rolls of secondary reinforcement must extend a minimum of 7.5 feet from the slope face before a roll direction (old roll to new roll) overlap is allowed. For Type A and Type B slopes, slit the secondary geosynthetic a length only as necessary to allow installation of the geosynthetic at support struts.

- All geosynthetics, except for face wraps of Type C Slopes, must be backfilled before the end of the workday. Place geosynthetic to lay flat, pulled tight and anchored in place until backfill is placed. Place geosynthetic within ±1/2-inch of the plan elevations and to the minimum length indicated. Do not dump fill directly onto exposed geosynthetics. Place fill on previously spread material and blade out. Place and distribute material without wrinkling the geosynthetic.

- Grade the surface of the fill only as necessary to facilitate surface drainage. Seal surface with a smooth drum roller at the end of each workday. No vehicles are allowed on the geosynthetic until a minimum of 8 inches of loose backfill has been placed. Sudden braking and sharp turning of any vehicle, including tracked equipment, on reinforced fill is prohibited. Correct any disturbance or distortion of geosynthetics due to operation of vehicles or equipment, at no additional cost to the Department.

1. Type A Slope-Vegetated. Construct Type A slopes to the slope ratio(s) indicated, but no steeper than 0.5(H):1(V). Type A Slopes are not allowed within a 500-year floodplain.

1.a Wire Mesh Forms. Use wire mesh forms to establish a stepped face to the slope face ratio and dimensions indicated. Internally brace wire mesh forms to maintain verticality of step faces. Place preformed wire mesh units on the exterior (outside) of all primary and secondary geosynthetics and the TRM. Internally brace wire mesh units with a minimum of seven pre-formed wire struts per each 10 foot length of wire mesh unit, with a maximum strut spacing of 20 inches. Puncture TRM only as necessary to allow fastening of wire strut to wire mesh. Overlap edges of adjacent wire mesh units a minimum of 3 inches to maintain alignment during construction.

1.b Turf Reinforcement Mat (TRM). Place the TRM against the back face of the wire mesh form. Lay the excess material that will cover the top of the step over the front face of the wire mesh form. When fill and geosynthetic layers reach the top of the wire mesh form, wrap the TRM over the top layer of fill. Embed the TRM a minimum of 12 inches horizontally underneath the next wire mesh form. Overlap adjacent strips of TRM a minimum of 3 inches along parallel roll edges.

1.c Geosynthetic Placement. Place geosynthetics as specified in Section 223.3(d).

1.d Reinforced Fill Placement. Section 206.3(b), and Section 206.3(c), and as follows:

- For slopes designed to be vegetated (Type A slopes), it is desirable that the reinforced fill be suitable for establishing and supporting vegetation. If the fill selected consists of crushed gravel, manufactured aggregate or aggregate-like material, or is otherwise unable to support vegetation, then fertile soil capable of supporting vegetation must be placed for the first 12 inches of fill behind the wire mesh form.

- Place and compact fertile soil with adjacent layers of reinforced fill in maximum 8-inch loose lifts. Apply minimal compactive effort on the fertile soil, compacting only sufficient enough to stabilize the material.

1.e Vegetation. Hydraulically apply the seeding, soil supplements, and mulch to the finished slope with two separate applications that yield a total of 125% of the recommended seeding rate of Formula C, as specified in Section 804.3.

2. Type B Slope – Rock Lined with Wire Forms. Construct Type B slopes to the slope ratio(s) indicated, but no steeper than 1(H):1(V).

2.a Wire Mesh Forms. Use wire mesh forms to establish a stepped face to the slope of the slope ratio and dimensions indicated. Internally brace wire mesh forms to maintain verticality of step faces. Place preformed wire mesh units on the exterior (outside) of all primary and secondary geosynthetic lifts and geotextile backing. Internally brace wire mesh units with a minimum of seven pre-formed wire struts per each 10 foot length of wire mesh unit, with a maximum strut spacing of 20 inches. Puncture geotextile backing only as necessary to permit fastening of wire strut to wire mesh. Overlap edges of adjacent wire mesh units a minimum of 3 inches to maintain alignment during construction.

2.b Geotextile Backing, Class 4, Type A. Place the geotextile backing against the back face of the wire mesh form as indicated. Lay the excess material that will cover the top of the step over the front face of the wire mesh form. When fill and geosynthetic layers reach the top of the wire mesh form, wrap the geotextile backing over the top layer of fill as indicated. Embed the geotextile backing a minimum of 18 inches horizontally underneath the next layer of wire mesh form. For portions of GRS slopes within a 500-year floodplain, embed the geotextile backing a minimum of 4 feet horizontally underneath the next layer of wire mesh form. Place geotextile backing as the reinforced slope is constructed. Overlap adjacent strips of geotextile backing a minimum of 6 inches along parallel roll edges.

2.c Geosynthetic Placement. Place geosynthetics as specified in Section 223.3(d).

2.d Reinforced Fill Placement. Section 206.3(b) and Section 206.3(c).

2.e Aggregate Lining and Rock Lining. When in a 500-year floodplain, use the rock lining class specified. When not in a floodplain, the minimum size of rock lining is class R-4. Place the rock lining of the type, size, and thickness indicated on the completed stepped-slope face without damaging the wire mesh forms. Do not end-dump the rock onto the slope. A minimum 12-inch cushion layer of AASHTO No. 1 Coarse Aggregate (aggregate lining) must be placed over the stepped face before placement of the rock lining. Place the aggregate lining and rock lining in lifts not exceeding 4.5 feet, so that no more than three wire mesh forms are exposed. Do not proceed with construction of a fourth sequence of wire mesh forms and primary reinforcement if the aggregate lining and rock lining are not in place for the previous three layers of wire mesh forms and primary reinforcement.

3. Type C Slope – Rock Lined with Wrapped Face. Construct Type C slopes to the slope ratio(s) indicated, but no steeper than 1.25(H):1(V).

3.a Geosynthetic Placement. Place geosynthetics as specified in Section 223.3(d), except as follows:

- Use Class 4, Type A geotextile to wrap layers of the slope face (geosynthetic face wrap) to establish a roughly stepped appearance of the slope ratio and dimensions indicated. Place a layer of primary geosynthetic reinforcement before placement of geosynthetic face wrap layers. The wrap must extend a minimum length of 4 feet from the front edge of the primary geosynthetic. Overlap adjacent strips of geosynthetic face wrap a minimum of 6 inches along parallel roll edges.

- Once the slope has been constructed to the elevation of the next layer of primary geosynthetic, wrap the face of the slope with the geosynthetic face wrap. Extend the face wrap over the top of the fill before placement of the next layer of primary geosynthetic. Embed the geosynthetic wrap a minimum length of 4 feet beneath the next wrapped step of the slope. Place the next layer of primary geosynthetic reinforcement. Place the next geosynthetic face wrap directly on the primary geosynthetic reinforcement.

3.b Reinforced Fill Placement. Section 206.3(b), and Section 206.3(c).

3.c Aggregate Lining and Rock Lining. When in a 500-year floodplain, use the rock lining class specified. When not in a floodplain, the minimum size of rock lining is class R-4. Place rock lining of the type, size and thickness indicated over the geosynthetic face wrap. Place the rock lining so as not to damage the geosynthetic face wrap. Repair any face wrap that is damaged by stitching a patch of the same material over any tears or punctures. Do not end-dump the rock onto the slope. A minimum 12-inch cushion layer of AASHTO No. 1 Coarse Aggregate (aggregate lining) must be placed over the geosynthetic face wrap before placement of the rock lining. Place the

aggregate lining and rock lining in lifts not exceeding 4.5 feet, so that no more than three geosynthetic face wraps are exposed. Do not proceed with construction of a fourth sequence of geosynthetic face wrap and primary geosynthetic if the aggregate lining and rock lining are not in place for the previous three layers of geosynthetic face wraps and primary geosynthetic. If not backfilling immediately, do not leave the geosynthetic face wraps exposed for more than 7 days. If UV exposure exceeds 7 days, place a UV protective cover over geosynthetic until backfill is in place.

4. Type D Slope – Gabion. Construct Type D slopes to the slope ratio(s) indicated, but no flatter than 0.5(H):1.0(V), and no steeper than 0.25(H):1.0(V).

4.a Geotextile Backing, Class 4, Type A. Place the geotextile backing that provides a continuous coverage of the rear face of the gabion baskets as indicated. Lay the excess material that will cover the top of the step over the front face of the gabion basket. When fill and geosynthetic layers reach the top of the gabion basket, wrap the geotextile backing over the top layer of fill as indicated. Extend the geotextile backing a minimum of 18 inches horizontally behind the gabion basket at both the bottom and top of the basket. For portions of GRS slopes within a 500-year floodplain, embed the geotextile backing a minimum of 4 feet horizontally behind the gabion basket at both the bottom and top of the basket. Place geotextile backing as the reinforced slope is constructed. Overlap adjacent strips of geotextile backing a minimum of inches along parallel roll edges.

4.b Geosynthetic Placement. Place geosynthetics as specified in Section 223.3(d).

4.c Reinforced Fill Placement. Section 206.3(b), and Section 206.3(c).

4.d Gabions. Section 626 except as indicated and as follows. Use gabions of the type and size indicated to establish a stepped face of the slope ratio and dimensions indicated. When placing an overlying row of gabions, offset the ends of the individual units by half the width of the gabion, to create an approximate half-bond pattern between successive rows. Place gabions directly on layers of primary geosynthetic. The primary geosynthetic must extend to the face of the gabions that will be placed on top of the primary geosynthetic.

4.e Aggregate Lining and Rock Lining. Where constructed in a 500-year floodplain, place rock lining of the type, size and thickness indicated over the gabions up to the 500-year flood elevation. The minimum size of rock lining is class R-4. Do not place the rock lining at a slope steeper than 1(H):1(V). Provide a horizontal bench at the top of the rock lining of a minimum width equal to the required rock lining placement thickness. Place the rock lining so as not to damage the gabions. Repair any gabion that is damaged by stitching a patch of the same material over any tears or punctures. Do not end-dump the rock onto the slope. A minimum 12 inch cushion layer of AASHTO No. 1 Coarse Aggregate (aggregate lining) must be placed over the gabions before placement of the rock lining. Place the aggregate lining and rock lining in lifts not exceeding 4.5 feet, so that no more than three gabions are exposed. Do not proceed with construction of a fourth sequence of gabions and primary reinforcement if the aggregate lining and rock lining are not in place for the previous three layers of gabions and primary reinforcement.

(e) Construction Tolerances. Construction tolerances are as shown in the Standard Drawings and as follows. All geosynthetic lengths and wrap dimensions are minimums.

1. Elevation Requirements. For all slope types, primary and secondary geosynthetics shall be placed within ±1/2 inch of plan elevation. Top of wire mesh forms must be constructed within ±1/2 inch of plan elevation, and top of gabions within ±1 inch of plan elevation.

2. Horizontal Alignment Requirements. For Type A, B, and D slopes, the horizontal alignment for wire mesh forms and gabion baskets must be within ±1 inch of the plan location anywhere along the face of the wire form and/or gabion for straight and curved alignments. For Type C slopes, the horizontal alignment of the slope face geotextile wrap must be within ±2 inches of the plan location at the base of the wrap.

3. Plumbness Requirements. The face of the wire mesh forms must be constructed within ±1/4 inch of plumb, and the face of the gabions within ±1/2 inch of plumb.

(f) Drainage. Provide surface and subsurface drainage systems as indicated.

(g) Repair of Geosynthetics. For damaged area less than 3 square feet and not on the face of the slope, repair damaged sections by placing a patch over the damaged portion of the geosynthetic, unless otherwise indicated. The patch is to consist of the same geosynthetic material as the damaged material and is to be placed in the same manner and orientation as the undamaged geosynthetic. The patch for the geosynthetic is to extend a minimum of 3 feet beyond the damaged area on all sides. Geosynthetics with damaged areas greater than 3 square feet are required to be completely removed and replaced.

223.4 MEASUREMENT AND PAYMENT—

(a) Geosynthetic Reinforced Soil Slope, Type A. Square Foot

Measured to equal the area of the vertical face of the wire forms, including any vertical face concealed by finished grade. Includes required and discretionary laboratory tests, all excavation except for excavation of unsuitable foundation materials, foundation preparation, all geosynthetics, wire forms, erosion control mulch blanket, all fill materials, all processing of fill materials to obtain specified gradations, topsoil, seeding and soil supplements, mulching, and all drainage components.

(b) Geosynthetic Reinforced Soil Slope, Type B. Square Foot

Measured to equal the area of the vertical face of the wire forms, including any vertical face concealed by finished grade. Includes required and discretionary laboratory tests, all excavation except for excavation of unsuitable foundation materials, foundation preparation, all geosynthetics, wire forms, all fill materials, all processing of fill materials to obtain specified gradations, aggregate lining, rock lining, and all drainage components.

(c) Geosynthetic Reinforced Soil Slope, Type C. Square Foot

Measured to equal the projected vertical area of the geosynthetic reinforced slope face. Includes required and discretionary laboratory tests, all excavation except for excavation of unsuitable foundation materials, foundation preparation, all geosynthetics, all fill materials, all processing of fill materials to obtain specified gradations, aggregate lining, rock lining, and all drainage components.

(d) Geosynthetic Reinforced Soil Slope, Type D. Square Foot

Measured to equal the area of the vertical face of gabions, including any vertical face concealed by finished grade. Includes required and discretionary laboratory tests, all excavation except for excavation of unsuitable foundation materials, foundation preparation, all geosynthetics, all gabions, all fill materials, all processing of fill materials to obtain specified gradations, aggregate lining, rock lining, and all drainage components.

(e) Excavation of Unsuitable Foundation Materials. Cubic Yard

Excavation of unsuitable foundation materials as directed, beyond the limits of excavation indicated, will be paid as specified in Section 110.03.

SECTION 300
BASE COURSES

SECTION 301—PLAIN CEMENT CONCRETE BASE COURSE

301.1 DESCRIPTION—This work is construction of a normal or high early strength plain cement concrete base course. When placed on subgrade, it includes the preparation of subgrade, as specified in Section 210.

301.2 MATERIAL—

- Class A Cement Concrete—Section 704
- High Early Strength Cement Concrete—Section 704
- Supplementary Cementitious Material (SCM)*—Section 724.2
- Expansion Joint Filler—Section 705.1
- Longitudinal Construction Joint Material—Section 705.2
- Concrete Curing Material—Sections 711.1 and 2(b)

* SCM may be substituted for a portion of Portland Cement.

301.3 CONSTRUCTION—As specified in Section 501.3, except interpret references to "pavement" to mean "base course," and for the following sections:

(a) General. Only Section 501.3(a)1 applies.

(d) Forms. Add the following:
Forms are not required for base course widening 6 feet or less in width. However, use acceptable methods to contain the base course.

(g) Slip Form Paving Method. Delete references to reinforcement.

(h) Handling and Placing Reinforcement. Delete this section.

(i) Transverse Joints. Only Section 501.3(i)1 applies.

(j) Longitudinal Joints. Replace with the following:
Where longitudinal joints are indicated or formed for convenience of construction, form a tied joint, as shown on the Standard Drawings for cement concrete pavement joints. In full width construction, sawing is not required.

(k) Final Strike Off, Consolidation, and Finishing. Replace Section 501.3(k)4. with the following:
Rake or broom finish the surface.

(l) Curing Concrete. Modify as follows:
Liquid Membrane Forming Curing Compound, White, will not be allowed.
Liquid Membrane Forming Curing Compound, Black, may be used, provided the cement concrete base course is not accessible to traffic before the surface course is placed. Discontinue use of the compound if it becomes

unsatisfactory as a curing agent; resume curing by other methods, as specified.

(n) Sealing Joints and Cracks. Delete this section.

(o) Surface Tolerance. Replace with the following:
After the concrete has hardened, retest the surface of the base course, using straightedges. Operate the straightedge as specified in Section 501.3(k)3. Remove high points in excess of 1/4 inch by means of grinding or cutting tools, as directed. Remove and replace sections containing depressions of more than 3/8 inch, when directed in writing. Remove the full width of lane in which a depression occurs, for a length of at least 10 feet.

(q) Opening to Traffic. Replace with the following:
The Representative will determine when base course may be opened to traffic. However, do not open to traffic until the base course develops a required minimum compressive strength of 2,750 pounds per square inch as determined by compressive tests made on cylinder specimens in accordance with PTM No. 604 or as determined by maturity method in accordance with PTM No. 640.

(s) Tests for Depth. Revise the traffic lane definition as follows:
A traffic lane will be as indicated or as determined by the Representative.

(t) Defective Work. Replace with the following:
Unless otherwise directed by the Representative in writing, remove and replace pavement defective in surface tolerance, as specified in Section 501.3(o); defective in depth, as specified in Section 501.3(s); defective in air content, as specified in Section 704.1(c)3.; or showing surface defects resulting from the effects of rain, improper final finish, or honeycombing which, in the Representative's opinion, cannot be repaired.
The minimum pavement removal and replacement length is 10 feet, for the full width.
When removing and replacing pavement defective in depth, start at the determined point of deficiency and proceed longitudinally until a section is reached where the deficiency is not more than 1/4 inch, and as specified.
As directed, construct transverse joints needed because of the pavement removal.

301.4 MEASUREMENT AND PAYMENT—Square Yard

(a) Adjustment for Deficient Base Course. Where a deficiency exists, as determined by cores, the Department will pay as follows:

Deficiency in Depth Determined by Cores Inches	Proportional Part of Contract Price Allowed
0.0 to 0.25	100%
0.26 to 0.30	95%
0.31 to 0.35	85%
0.36 to 0.40	75%
0.41 to 0.45	50%
0.46 to 0.50	25%

(b) Defective Base Course Left in Place. The Department will not pay for defective base course left in place, unless otherwise directed in writing by the District Executive. When the District Executive directs that defective base course be left in place, final payment for this base course will be at 5% of the contract price.

(c) Concrete Base Course Cores. Each
The price includes the measuring apparatus, which remains the Contractor's property upon completion of the project. The Department will not pay for additional cores drilled if the depth is deficient by more than 1/4 inch.

SECTION 303—CEMENT TREATED PERMEABLE BASE COURSE

303.1 DESCRIPTION—This work is the construction of a cement treated permeable base course (CTPBC) on a prepared surface. If placed on subgrade, this work includes the preparation of subgrade as specified in Section 210.

303.2 MATERIAL—

(a) Aggregate. Coarse Aggregate, Type A or Type B- Section 703.2 for AASHTO No. 67 or No. 57, except restrict the material passing the No. 200 sieve to a maximum of 2%. Determine the loss by washing according to PTM No. 100. Do not use fine aggregate in the mixture. The use of blast furnace slag or crushed gravel is allowed. When using crushed gravel, provide a minimum of 75% crushed particles with at least two faces resulting from fracture.

(b) Cement. Type I or Type II cement, Section 701.

(c) Water. Section 720.1

(d) Supplementary Cementitious Material. Section 724.2(b)

(e) Mixture Design. Provide a mix design as follows:

- Submit, for review by the Representative, a mix design using 200 pounds of cement per cubic yard based on the saturated surface-dry rodded unit weight of aggregate. Fly ash may be substituted for up to 10% of the required cement, with a substitution ratio of 3.3 pound of fly ash for each 2.2 pound of cement. Design and proportion the cement and water based on the saturated surface-dry weight of the aggregate. Do not exceed a water-cement ratio of 0.40. Provide a mix with 100% coverage of aggregate without runoff. Mix and proportion as specified in Section 704.

- Certify as specified in Section 106.03(b)

(f) Concrete Curing Material. Section 711.1(a), 711.1(e), and 711.2(a) Type 2

(g) Admixtures. Section 711.3

303.3 CONSTRUCTION—

(a) General. The Contractor may perform half-pavement or full-pavement width construction.

(b) Weather Restrictions. Section 501.3(b).1

(c) Concrete Mixtures. Section 501.3(c)

(d) Conditioning of Rubblized Pavement/Subbase. Thoroughly sprinkle water on the rubblized pavement/subbase before placing CTPBC, if necessary to ensure a moist condition. Sprinkle with as much water as it readily absorbs, well in advance of CTPBC placement.

(e) Placement and Compaction. Use an approved asphalt paver or mechanical spreader, equipped with screed, plate vibrator, and fully automated sensors to control profile and transverse grade. Use mechanical equipment for the entire lane width or as much lane width as practical. Adjust screed assemblies to provide the required cross section and depth.

Compact the CTPBC using steel-wheel power rollers having a manufacturer's certified metal weight from 8 tons to 10 tons. Use of vibratory paver screed as sole means of attaining compaction is not allowed. Perform a minimum of one pass with the roller to achieve compaction and do not compact material to the point that the CTPBC is not free draining or the aggregate is crushed. One roller pass is defined as one trip of the roller in one direction over any one spot. Perform handwork as directed. Do not disturb the freshly placed CTPBC. Do not allow more than 1 hour from

the time water is added to the aggregate and cement to the time compaction is complete. The Contractor may use a retarding admixture to increase the time to 1 1/2 hours.

(f) Surface Tolerance. Test the finished surface at locations the Representative suspects are irregular and at transverse joints and paving notches. Test the surface in stages using a 10-foot straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the road centerline and, in successive positions, test the pavement surface from one side to the other. Advance the test location to the next stage by moving the straightedge along the pavement centerline by not more than 5 feet.

Correct irregularities of more than 1/2 inch by loosening surface mixture and removing or adding CTPBC. For irregularities that develop after compaction is completed, correct the irregularity by a method that does not produce contaminating fines or damage the base. Do not grind or mill the CTPBC. The area is defective if irregularities or defects remain after final compaction.

(g) Curing. Begin curing immediately after compaction. Cure with white membrane forming curing compound as specified in Section 501.3(l)1.c. except apply at a rate of 1 gallon per 100 square feet ± 10% of the surface area, or as directed. As an alternative curing method, the Contractor may select to cover the CTPBC with white polyethylene sheeting material as specified in Section 501.3(l)1.a. Maintain curing materials for 24 hours. If the CTPBC temperature falls below 40F during the 24 hour curing period, extend the cure period by an additional 24 hours. At no cost to the Department, remove and replace CTPBC if the CTPBC temperature drops to 32F within 72 hours of the placement.

(h) Protection of Courses. Section 105.13 and as follows: Construction traffic is not allowed on the CTPBC for at least 3 days after the CTPBC has been placed. Do not place overlying pavement on the CTPBC during this time period. After the 3 day period, restrict construction traffic to only allow trucks and equipment required to place the next layer or any adjacent CTPBC lift or pavement course. Remove and replace areas damaged or contaminated at no cost to the Department.

(i) Protection Against Rain. Section 501.3(t)

(j) Tests for Depth. After curing the CTPBC, and at locations determined by the Representative, carefully dig or drill one full-depth, test hole for each 3,000 square yards of completed CTPBC. The Representative will measure the depth of the CTPBC. Where the depth is defective, define the defective limits by digging or drilling additional test holes longitudinally and transversely until the depth meets requirements. Backfill test holes with CTPBC mixture.

(k) Defective Work. CTPBC is defective when the depth is deficient by 1/2 inch or more from the indicated depth, deficient in surface tolerance, or when the surface contains defects caused by rain or improper finish that in the Representative's opinion cannot be repaired. Unless otherwise directed in writing by the District Executive, remove and replace defective CTPBC full depth at no additional cost to the Department. Submit a plan with proposed methods to remove and replace the CTPBC. Remove and replace the CTPBC after the plan is approved.

303.4 MEASUREMENT AND PAYMENT—Square Yard

SECTION 310—CRUSHED AGGREGATE BASE COURSE

310.1 DESCRIPTION—This work is construction of a stone or slag base course. When placed on subgrade, it includes the preparation of subgrade, as specified in Section 210.

310.2 MATERIAL—

(a) Coarse Aggregate (Fine Material). Type A or Type B, No. 10, stone or slag, Section 703.2, except as follows:

Stone having unsatisfactory cementing qualities may be used, provided limestone fines in an amount of 20% are blended with the material.

Acceptable granulated blast furnace slag, meeting the gradation requirements for No. 10 aggregate may be used.

Granulated blast furnace slag, formed when molten iron slag is rapidly quenched in water, is acceptable providing it does not have a density greater than 90 pounds per cubic foot (dry rodded density, AASHTO T 19). Slag material reasonably uniform and free from harmful amounts of clay, silt, vegetation, or other objectionable substances, is acceptable with a maximum size of 2 inches and not more than 20% passing the No.100 sieve.

(b) Coarse Aggregate (Coarse Material). Type A or Type B, No. 1 stone or slag, Section 703.2.

(c) Calcium Chloride. Section 721

(d) Water. Section 720.2

310.3 CONSTRUCTION—

(a) Equipment.

1. Spreaders. Use mechanical spreaders.

2. Compaction Equipment. Use rollers, as specified in Section 108.05(c)3.a. Use vibratory compaction equipment as required for Method 2.

(b) General.

1. Shoulders. Either build up and compact shoulders for full width, to or above the elevation of each layer of base course, before placing base course; or build up and roll shoulders simultaneously with compaction of each layer.

2. Templates, String Lines, and Straightedges or GPS or Laser Controlled Equipment. Use a template cut to the required cross section of the finished base course. Equip the template with metal or other vertical extensions attached to each end, so the bottom of the template will be at the elevation of the top of the base course. Furnish at least three templates. Test the cross section for surface irregularities at intervals of not more than 25 feet.

Use a 12-foot straightedge to test for longitudinal irregularities in the surface of the base course. Hold the straightedge parallel to the road centerline in contact with the surface. Move the straightedge from one side of the base course to the other. Advance along the base course in 5-foot increments.

Refer to Section 210.3(d) for GPS or Laser Controlled Equipment.

3. Replacement Areas. Areas will be marked where base course is required for existing pavement replacement. Remove pavement in these areas to neat lines, as specified in Section 203.

4. Miscellaneous. In areas where spreading and compacting with mechanical equipment is impractical, spread and compact by another acceptable method.

If base course material is placed on existing pavement as an overlay or build-up, construct in compacted layers.

If subgrade or subbase materials become mixed with the base course, remove the mixture; reshape and recompact the subgrade and/or subbase; reconstruct the unsatisfactory base course area.

Use calcium chloride only when and as directed.

5. Initial Layer of Fine Material. Spread an initial layer of fine material uniformly over the subgrade, subbase, or existing pavement as a bed and filler; spread to a depth of 2 inches on subgrade, or 1 inch on subbase or existing pavement.

Do not place this initial layer of fine material on wet, frozen, or unsuitable subgrade or subbase.

(c) Method 1. Use this method when compacting with rollers only.

If the base course is more than 8 inches in compacted depth, construct in two or more layers of approximately equal depth, with no layer less than 4 inches nor more than 8 inches in depth.

1. Spreading Coarse Material. Spread uniformly on the initial layer of fine material to full width, unless otherwise specified. In areas inaccessible to spreading equipment, spread material directly from trucks, if allowed. Remove segregated material and replace with well-graded material. Do not spread the material more than the distance completed in an average day's work ahead of choking and compacting, as specified in Section 310.3(c)3 and (c)4, respectively.

Test each layer of material for surface irregularities, as specified in Section 310.3(b)2, and correct irregularities before rolling.

2. Compacting Coarse Material. On normal crown section, begin rolling at the sides and progress to the center. On superelevated curves, begin on the low side and progress to the high side.

Install string lines with ample supports, offset along each side to control the elevation and depth of the base course. Maintain string lines until the base course is completed and the deficiencies have been corrected.

Roll parallel with the roadway centerline, uniformly lap each preceding track, cover the entire surface with the rear wheels, and continue until the material does not creep or wave ahead of the roller wheels.

Place red flags at the initial limits of compacted coarse material completed. The flags will be moved ahead as additional material is compacted. Do not apply filler to the coarse material outside of the flag-marked sections.

3. Application of Fine Material. After thoroughly compacting coarse material, spread fine material uniformly over the surface with spreading equipment, to assure filling voids. In areas inaccessible to equipment, spreading with a square-edged shovel may be used; spread in a sweeping motion alternately in opposite directions, until the voids are filled. Do not end-dump the material directly on the surface of the coarse material. Immediately following the spreading, sweep and roll the material until remaining voids in the coarse material are filled and the base course is thoroughly compacted and set. Use brooms attached to the roller and hand brooms. Loosen and scatter excess fines formed in piles or cakes upon the surface.

Spread and roll the material in sections of not less than 150 feet nor more than 1,000 feet in length, unless otherwise directed.

Compact and bond each section, as specified in Section 310.3(c)4, before beginning another.

4. Compacting and Bonding. Begin rolling the sides and progress, as specified in Section 310.3(c)2. Cover the entire surface with the rear wheels, applying additional fines where necessary to fill voids, and continue rolling until the base course is thoroughly compacted and set.

After completion of spreading and rolling of fines, sprinkle with water and roll the surface of single-layer construction or roll the surface of each layer of multi-layer construction. Perform diagonal and cross-rolling, as required or directed. Continue the sprinkling and rolling, applying additional fines until voids are filled and a slight wave of grout forms in front of the roller wheels. Use roller-attached brooms and hand brooms to distribute the grout uniformly, filling the voids. Allow the rolled section to dry before proceeding with the surface course. Sprinkle and reroll the surface on succeeding days, as required, to thoroughly bond and to provide a satisfactory base course. The Inspector-in-Charge will determine the quantity of fines and water required to produce a smooth, hard monolithic surface.

Sprinkle water, using acceptable methods.

(d) Method 2. Use this method when compacting with rollers and vibratory equipment.

If the base course is more than 10 inches in compacted depth, construct in two or more layers of approximately equal depth, with no layer less than 5 inches nor more than 10 inches in depth.

1. Spreading Coarse Material. Spread the coarse material, as specified in Section 310.3(c)1.

2. Compacting Coarse Material. Immediately after making surface corrections to the coarse material, compact, using vibratory equipment. Roll the layer, as specified in Section 310.3(c)2.

3. Application of Fine Material. After the coarse material has been set and keyed by vibration and rolling, spread fine material uniformly over the surface in an amount equal to about one-half of that required to fill the voids in the coarse material. Operate the vibrator over the surface so the fines settle into the voids. Spread and vibrate the remaining fines in one or more applications to satisfactorily fill the voids; however, do not cause flotation of the coarse aggregate. Use manual methods to fill areas not completely filled by vibration.

4. Compacting and Bonding. After completing the vibration of the fine material, sprinkle the surface with water and roll. Continue the operation, as specified in Section 310.3(c)4.

(e) Surface Tolerance. Test the finished base course for surface irregularities, as specified in Section 310.3(b)2.

Correct all surface irregularities exceeding 1/2-inch by loosening the surface and removing or adding material as required. Compact the corrected area and surrounding surface by rolling.

(f) Tests for Depth. Cut or dig one test hole to the full depth of the completed base course, where directed, for each 3,000 square yards or less.

The Representative will measure the depth of the base course. The initial bed and filler layer of fine material is considered part of the base course for determining the final compacted depth.

Remove and replace any area in which the depth is deficient by 1/2-inch or more. Additional test holes may be required, if directed, to determine the limits of replacement areas.

After the depth has been measured, backfill test holes with acceptable material and compact.

(g) Maintenance and Traffic. Until placement of the surface course, maintain the completed base course, as specified in Section 901.3(b).

Maintain and protect base course opened to traffic by authority of the Representative, as specified in Section 320.3(j).

Allow only necessary local traffic and essential construction equipment on the base course, unless otherwise directed. Repair or replace marred, distorted, or otherwise damaged pavement.

310.4 MEASUREMENT AND PAYMENT—

(a) Crushed Aggregate Base Course. Square Yard or Ton

(b) Calcium Chloride. Ton

SECTION 312—CRUSHED AGGREGATE BASE COURSE, TYPE DG

312.1 DESCRIPTION—This work is construction of a dense graded stone, gravel, or slag base course, uniformly premixed with a predetermined quantity of water. When placed on subgrade, it includes the preparation of subgrade, as specified in Section 210.

312.2 MATERIAL—

(a) Aggregate. Type A or Type B, Section 703.2. Crush the gravel, if used, as required for asphalt surface courses. Acceptable granulated blast-furnace slag, as specified in Section 350.2, meeting the gradation requirements specified in Table A, may be used.

(b) Calcium Chloride. Section 721

(c) Asphalt Material. Emulsified Asphalt Class E-1, meeting the requirements of Section 702.

(d) Water. Section 720.2

(e) Composition of Mixture. Uniformly combine materials with a predetermined quantity of water, so the final compacted mixture meets the specified gradation within limits of the reviewed job-mix formula.

1. JMF. Establish the JMF within the limits of Table A, when tested in accordance with AASHTO T 27

Add sufficient water to the mixture to provide optimum moisture content at the time of compaction. Do not vary this quantity by more than 2 percentage points from the optimum moisture, as determined in accordance with PTM No. 106, Method B.

2. Uniformity. The composition limits are shown in Table A.

To maintain specified criteria throughout the progress of work, at least twice daily analyze samples of the completed mixture taken at the plant or after spreading. Unsatisfactory results or changes in the supply source may require a change in the JMF. The supply source may be changed, if permitted. Maintain accuracy of control so at least 90% of test samples fall within the tolerance limits of Table A. Remove and replace material failing to meet this requirement.

TABLE A
COMPOSITION OF MIXTURE
(Weight Percent Passing Square Openings Based on Laboratory Sieve Tests)

SIEVE SIZE	PERCENT PASSING	TOLERANCE LIMITS OF THE APPROVED JMF
2 inches	100	
3/4-inch	52-100	± 8%
3/8-inch	36-70	± 8%
No. 4	24-50	± 6%
No. 16	10-30	± 6%
No. 200	0-10	± 3%

3. Testing. Section 313.2

312.3 CONSTRUCTION—

(a) Equipment.

1. Plant. Obtain acceptance of the processing and mixing plant and its operation, before start of work.

Measure the coarse and fine material separately, by either volume or weight, and feed into the mixer in proper proportions and at a rate to insure correct blending. Measure added water by weight, volume, or a metering device, and uniformly distribute in the mix.

Use mixing plants equipped with automatic cutoff devices, which stop the feed to the mixer if delivery of any component of the mix stops.

Provide means to check and verify the accuracy of the proportioning and measuring devices.

Stockpile aggregates for proportioning, by any acceptable method, in a manner that will prevent segregation and degradation of aggregates.

Use mass-proportioning plants, equipped with separate bins for each size aggregate.

2. Spreaders. Section 320.3(a)3

3. Compaction Equipment. Sections 108.05(c)3.a, 3.b, 3.f, and 3.h.

(b) Preparation of Mixture. Before adding water, proportion and uniformly blend required quantities of materials. Distribute measured water uniformly by means of a spray system and continue mixing until materials have been combined into a homogeneous mixture. Do not place materials containing either frost or frozen pieces into the mixture.

When directed, add calcium chloride to the mixture, before adding water, to maintain required moisture. Proportion and uniformly blend calcium chloride, at the rate of 7 pounds per ton of mixture for Type 1 and 5.7 pounds per ton of mixture for Type 2.

(c) Delivery. Handle and transport mixture without segregation or loss of moisture. Use clean hauling vehicles, free of harmful material. To prevent loss of moisture during transportation, cover mixture with suitable covers, if necessary, until deposited in the spreader. Frequent moisture control tests will be made at the point of delivery on the project, as directed.

(d) Replacement Areas. Areas will be marked where base course is required for existing pavement replacement. Remove pavement in these areas to neat lines, as specified in Section 203.

(e) Preparation of Subbase or Subgrade and Shoulders.

1. Subbase or Subgrade. Before placing base course, complete and maintain subbase or subgrade at least 1,500 feet in advance of the leading spreader; keep free of ruts, irregularities, and loose materials.

2. Shoulders. Either build up and compact shoulders for full width, to or above the elevation of each layer of base course, before placing base course or build up and roll shoulders simultaneously with compaction of each layer.

(f) Spreading Mixture. If base course is more than 6 inches in compacted depth, construct in two or more layers of approximately equal depth, with no layer less than 3 inches nor more than 6 inches in depth. Place mixture to provide positive bond and uniform compaction between abutting lanes. Accomplish this by working spreaders in echelon or by alternating spreaders frequently between lanes, to minimize moisture loss.

In locations where machine spreading is impractical, spread manually or by other acceptable methods.

Supply sufficient equipment to spread, shape, and compact mixture at the rate produced by the mixing plant. Complete all operations relating to construction of base course during daylight hours. Do not place mixture on a frozen surface, when air temperature is below 40 F, or when freezing temperatures are forecast to occur within the next 24 hours.

To insure proper bonding between layers of base course, place succeeding layers as soon as practical. Keep base layers moist until covered by the next layer.

Do not cut into an underlying completed layer, except as directed for repairs or corrections. Maintain the proper moisture content in the mixture at all stages of construction, including vertical faces of part-width spread material, to assure positive bonding of abutting lanes.

(g) Overlay and Build Up. Where a base course is placed on existing pavement, construct layers, as specified in Section 312.3(f), unless otherwise directed.

(h) Compaction and Density. Compact each layer of base course to not less than 100% of maximum density, determined in accordance with PTM No. 106, Method B. Determine field density, in accordance with AASHTO T 191. When material is too coarse to use these methods, compaction will be determined, based on nonmovement of material under specified compaction equipment. Where density in any layer fails to meet specified requirements additional compaction will be required. If the density cannot be obtained by additional compaction, thoroughly loosen, remoisten, reshape, and recompact the entire area of the layer with low density. If required density cannot be obtained, remove and replace the affected area with a new mixture that can be compacted as required.

(i) Surface Tolerance. Use a template cut to the required cross section of the finished base course. Equip the template with metal or other vertical extensions attached to each end, so the bottom of the template will be at the elevation of the top of the base course. Furnish at least three templates. Test the cross section for surface irregularities at intervals of not more than 25 feet.

Install string lines with ample supports, offset along each side to control the elevation and depth of the base course. Maintain string lines until the base course is completed and the deficiencies have been corrected.

Use a 10-foot straightedge to test for longitudinal irregularities in the surface of the base course. Hold the straightedge parallel to the road centerline in contact with the surface. Move the straightedge from one side of the base course to the other. Advance along the base course in 5-foot increments.

For surface irregularities exceeding 1/2-inch, immediately correct as follows:

Blade off high spots, as directed, provided the surface is left in a uniformly smooth and dense condition. If high spots cannot be removed by blading, loosen the top layer through its full depth over the affected area, remove excess material, and provide moisture in proper quantity to reshape and recompact to the specified density. If high spots cannot be satisfactorily corrected by either of these methods, remove the top layer over the affected area and reconstruct with a new mixture.

Where it is necessary to add material to low spots, loosen the top layer over the affected area. Incorporate additional material, correctly graded, into the loosened material. Reshape and recompact the entire area at the proper moisture content. If the resulting surface is still unsatisfactory, remove the top layer over the affected area and reconstruct with a new mixture. Do not skin patch or fill low spots with small amounts of material.

Refer to Section 210.3(d) for GPS or Laser Controlled Equipment.

(j) Tests for Depth. Cut or dig one test hole to the full depth of the completed base course, where directed, for each 3,000 square yards or less.

The Representative will measure the depth of the base course. The initial bed and filler layer of fine material is considered part of the base course for determining the final compacted depth.

Remove and replace any area in which the depth is 1/2-inch or more deficient. Additional test holes may be required, if directed, to determine the limits of replacement areas.

After the depth has been measured, backfill test holes with acceptable material and compact.

(k) Construction Joints. Where additional base course is joined by the previous day's work, scarify and moisten the end of existing base course, blend with new mixture, and compact to form a continuous section, without a joint.

(m) Prime Coat. Use a distributor, as specified in Section 460.3(b). Broom the base course to produce a granular texture free of loose material and treat the surface with a single application of asphalt material, at a rate not to exceed 0.15 gallon per square yard of base course.

(n) Maintenance and Traffic. Until placement of the surface course, maintain the completed base course, as specified in Section 901.3(b).

Maintain and protect base course opened to traffic by authority of the Representative, as specified in Section 320.3(j).

Allow only necessary local traffic and essential construction equipment on the base course, unless otherwise directed. Repair or replace marred, distorted, or otherwise damaged pavement.

312.4 MEASUREMENT AND PAYMENT—

(a) Crushed Aggregate Base Course, Type DG. Square Yard or Ton

(b) Calcium Chloride. Ton

SECTION 313—SUPERPAVE ASPHALT MIXTURE DESIGN, STANDARD CONSTRUCTION, BASE COURSE

313.1 DESCRIPTION—This work is the standard construction of a plant-mixed asphalt base course on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor (SGC) using prescribed manufactured additives, or plant process modifications or both.

313.2 MATERIAL—Section 413.2

313.3 CONSTRUCTION—Section 413.3 as specified for standard construction and with additions and modifications as follows:

(b) Weather Limitations. Section 413.3(b). Replace with the following:

Do not place base course on prepared surfaces that are wet or if the temperature of the air or the prepared surface is 35F or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of base course that are en route to the project.

(h) Spreading and Finishing. Revise as follows:

1.b Spreading and Finishing. Add the following:

If the indicated compacted depth of a Superpave 25.0 mm asphalt base course is more than 6 inches, place the asphalt base course in two or more layers of approximately equal compacted depth, with no layer less than 3 inches or more than 6 inches. If the indicated compacted depth of a Superpave 37.5 mm asphalt base course is more than 8 inches, place the asphalt base course in two or more layers of approximately equal compacted depth, with no layer less than 4 inches or more than 8 inches.

(l) Surface Tolerance. Replace the requirement for defective pavement with the following:

The pavement is defective if irregularities are more than 1/4-inch.

(m) Tests for Depth. Replace with the following:

Control the loose depth of each layer to construct the base course to the compacted depth indicated and within the specified tolerance. On the top lift and in the presence of the Inspector, drill full-depth cores at one random location selected by the Inspector according to PTM No. 1 in each 3,000 square yards of completed base course and at other locations the Inspector suspects are deficient.

The Inspector will measure the depth of the full-depth cores according to PTM No. 737. Pavement deficient in depth by 1/2 inch or more and that cannot be satisfactorily corrected is defective. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is less than ½ inch deficient of the design depth.

313.4 MEASUREMENT AND PAYMENT—Section 413.4(a), with modifications as follows:

(a) Asphalt Mixtures (Standard). Revise as follows:

1. Asphalt Courses. Add the following:

1.f Superpave Asphalt Mixture Design, Base Course. Square Yard or Ton

SECTION 316—FLEXIBLE BASE REPLACEMENT

316.1 DESCRIPTION—This work is replacing the existing pavement with Superpave Asphalt Mixture Design, Base Course.

316.2 MATERIAL—

(a) Subbase. Section 350.2

(b) Superpave Asphalt Mixture Design.

- **Base Course, 25.0 mm Mix.** Section 313.2

(c) Asphalt Cement, PG 64S-22. Section 702

316.3 CONSTRUCTION As shown on the Standard Drawings, as specified in Section 313 and as follows:

Mark the perimeter of the area to be replaced. Saw cut or mill the perimeter. Remove all material within the saw cut or milled area to the depth indicated. Compact the existing subgrade or subbase before placing the base course material. Clean all vertical surfaces of the area to be patched and coat the vertical faces with a uniform application of PG 64S-22. Place the asphalt base course in a manner that does not cause segregation and to the lift thickness indicated. Compact to the density specified by use of approved compaction equipment as specified in Section 108.05(c).

316.4 MEASUREMENT AND PAYMENT—Square Yard or Ton

Saw cutting, excavation, hauling and disposal, asphalt tack coat, asphalt material, and sealing of the joints are considered as incidental.

SECTION 323—ROLLER COMPACTED CONCRETE BASE COURSE

323.1 DESCRIPTION—This work is the construction of roller compacted concrete (RCC) base course on a prepared subgrade and subbase for under an asphalt wearing course or a surface treatment, using a stiffer low slump concrete mix, conventional or high-density asphalt paving equipment, and various size rollers to obtain the required thickness and density.

323.2 MATERIAL—Section 502.2, except:

(f) Concrete Curing Material. Section 711.1 and Section 461.2

323.3 CONSTRUCTION—Section 502.3, except:

(i) Joints. Section 502.3(i), except:

3. Control Joints. Section 502.3(i)2 with the following addition:
After saw cutting the RCC control joints and before placing the asphalt wearing course or surface treatment remove loose debris from the saw cutting operation and apply additional emulsified asphalt along the control joints as specified in Section 323.3(j)5.

(j) Curing. Section 502.3(j), except:

3. Curing Compound. Do not use curing compounds.

5. Emulsified Asphalt. Apply emulsified asphalt as specified in Section 460.3(b), over the RCC pavement surface. Provide a uniform void-free application across the RCC pavement surface. Use equipment that does not damage, mar, or alter the surface of the compacted RCC pavement surface when applying the emulsified asphalt. Have the equipment approved by the Representative before placing the emulsified asphalt.

(k) Surface Tolerance. Section 502.3(k), except:

3. Finishing. The RCC pavement surface does not need diamond grinding before placing the asphalt wearing course or surface treatment.

(l) Open to Traffic. Section 502.3(l) except:

When the cure period is complete, the RCC pavement may be open to local traffic before placing the asphalt wearing course or surface treatment.

323.4 MEASUREMENT AND PAYMENT—

(a) Roller Compacted Concrete Base Course. Square Yard

(b) Defective Pavement Left in Place. When the District Executive directs in writing to leave defective pavement in place, the payment will be at 5% of the contract price.

SECTION 341—COLD RECYCLED ASPHALT BASE COURSE, COLD-IN-PLACE

341.1 DESCRIPTION—This work is the on-grade construction and material processing of a cold recycled asphalt base course (base course) that uses emulsified asphalt material combined with RAP, RAM, or virgin aggregates. Construction typically includes milling to an indicated depth, adding and mixing emulsified asphalt, placing, compacting, and testing.

341.2 MATERIAL—

(a) Reclaimed Material. Reduce oversized material until 95% of the material passes the 2-inch sieve. Incorporate all reclaimed material into the recycled asphalt base course.

1. RAM. As specified in Section 703.1, Table A or 703.2, Table B. The Contractor may use RAM from the project or from stockpiles off the project.

2. RAP. Processed paving material containing asphalt and aggregates.

(b) Emulsified Asphalt Material. Add emulsified asphalt material to the reclaimed material according to the approved mix design. Use one of the following emulsified asphalt materials, conforming to the applicable requirements of Bulletin 25:

- Emulsified Asphalt—MS-2, CMS-2, SS-1, CSS-1, SS-1h, CSS-1h, HFMS-2h, HFMS-2, HFMS-2s, CSS-1P, SS-1hP, and CSS-1hP.

(c) Aggregate. Section 703.2 Type A, AASHTO No. 8, No. 57, or No. 67.

(d) Mixture Design. Obtain samples of each reclaimed material and perform testing to establish the mix design. If RAM is included in the depth indicated for removal, take separate samples of RAP and RAM. Establish the mix design according to Bulletin 27 and submit the mix design as specified in Section 108.03.

(e) Mixture. Combine the reclaimed material, aggregates, and emulsified asphalt material according to the mix design and at the mix design recommended optimum moisture and emulsion content. If RAP gradations and composition vary sufficiently, make field adjustments as recommended in the mix design to obtain satisfactory coating and the specified compaction.

1. Review of QC Plan. Prepare a QC Plan, as specified in Section 106, and submit for review at the start of the project. Do not start actual work until the QC Plan has been reviewed.

341.3 CONSTRUCTION—

(a) Equipment. Provide equipment to produce recycled asphalt base course mixture as follows:

1. Provide a self-propelled milling machine having a down cutting drum, screening/crushing plant, and pugmill mixer. Use single-unit or multiple-unit machine with plant and/or mixer as trailer(s). Use pugmill mixer with liquid additive system and spray bar capable of volumetrically controlling liquid additive based on milling depth, milling width, and machine speed.

2. Use equipment capable of automatically metering liquids with a variation of not more than ± 2.0% by weight of liquids.

3. Maintain all equipment as specified in Section 108.05(c).

(b) Mixing. Do not place base course from September 1 to April 30 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, and 10-0; and from October 1 to April 30 in all other districts. With written approval of the Representative, the Contractor may

place base course when no freezing temperatures occur for 24 hours before paving and when the project ambient air temperature is 45F and rising.

Maintain adequate total liquids in the mixture to ensure thorough mixing of the reclaimed material and aggregate with the emulsified asphalt material. If necessary, add water at the mill head using a calibrated meter.

(c) Compaction. After processing, uniformly spread, shape, grade, and compact the base course to the lines, grades, and depth indicated. Before compaction, cure the base course as necessary.

Provide compacted layers between 3 to 5 inches in depth. Use rollers as specified in Section 108.05(c).

Begin rolling at the low side of each layer; except, initially leave 3 to 6 inches from unsupported edges unrolled to prevent distortion.

Determine the maximum density according to PTM No. 402.

Compact the base course to a minimum density of 96% of the average control strip density. Determine the in-place density of each 3,000-square yard area according to AASHTO T 310. If the density of an area is less than the minimum density and if additional compaction does not achieve the minimum density, rescarify, adjust the moisture content, and recompact. If the density is still below the minimum, and the base course is uniform in texture, stable, and determine a new maximum density according to PTM No. 402 and then compact to minimum of 96 % of the new maximum density.

If the Representative determines that the Contractor achieved the minimum density with minimal compaction, the Representative may require the Contractor to determine a new maximum density according to PTM No. 402.

If the completed base course is unacceptable, stop base course construction. Resume construction only after correcting the cause of unacceptable construction.

(d) Finishing. Unless otherwise allowed, complete base course construction during daylight hours.

(e) Protection. Protect completed portions of base course that are opened to construction equipment from marring, distortion, and other damage. Immediately correct damage to the base course caused by construction equipment to the Representative's satisfaction.

(f) Surface Tolerance. If directed, test the completed base course for smoothness and accuracy of grade, both transversely and longitudinally, using a 10-foot straight edge or template. Test a 3,000-square yard area at three locations. At each location determine the maximum space under the straight edge or template. Correct each 3,000-square yard area where the average of the maximum space at the three locations exceeds 1/2 inch.

To control dust or raveling, apply a fog seal as specified in Section 472.3(c) using CSS-1h or SS-1h diluted as specified in Section 472.2, Table A or other approved emulsified asphalt material at no additional cost to the Department.

(g) Maintenance and Traffic. Maintain the completed base course and control traffic as specified in Section 413.3(n). Use a pilot car for speed control if damage, such as raveling, is likely to occur.

(h) Curing. Cure the base course for at least 2 weeks before placing the wearing course or binder course or until the average moisture content is less than 2%. In addition, before placing a wearing or binder course, dry cut or dry extract a minimum of three samples selected at random according to PTM No. 1 from throughout the entire cold-recycled base course project. Ensure each sample size is a minimum of 1,200 g. Determine the moisture content of each sample according to PTM No. 749.

(i) Tests for Depth. Measure milling depth at time of pulverization. Make at least one measurement for each 3,000 square yards or less of work done and record measurements to ensure that specified milling depth is met. Correct or replace any section deficient by 1/2-inch or more from specified depth at no additional cost to the Department.

341.4 MEASUREMENT AND PAYMENT—

(a) Cold In-Place Recycled Asphalt Base Course. Square Yard

(b) Coarse Aggregate for Cold Recycled Asphalt Base Course. Ton

(c) Emulsified Asphalt Material. Gallon

SECTION 342—COLD RECYCLED ASPHALT BASE COURSE, CENTRAL PLANT MIX

342.1 DESCRIPTION—This work is the construction of a cold recycled asphalt base course (base course), central plant mix, using a combination of RAP, RAM, or virgin aggregates, mixed with asphalt material in a continuous or batch type mixer.

342.2 MATERIAL—Section 341.2 and as follows:

(a) Stockpiling. Store reclaimed material in a manner that preserves its quality and suitability. Separate different types of RAP to prevent contamination. Build stockpiles in horizontal layers to minimize segregation. Keep stockpile height to a maximum of 10 ft.

342.3 CONSTRUCTION—

(a) Equipment. Provide equipment to produce recycled asphalt base course mixture as follows:

1. Provide a central plant consisting of a RAP feed hopper, conveyor belts, twin shaft pugmill, metered liquid additive and water systems, pumps and spray bars. Other equipment may include additive storage tanks, beltscales, a stacker belt conveyor, and a storage bin. Provide a screening/crushing unit if the maximum size of RAP cannot be controlled otherwise.

Provide equipment capable of mixing reclaimed material and asphalt material into a homogeneous mixture without stripping the asphalt material. Provide a continuous-flow or batch-type mixer accepted by the Engineer and equipped with batching or metering devices to measure the specified quantities of the materials.

Use a positive displacement pump capable of accurately metering the flow rate of additive into the reclaimed material down to 4 gallons per minute. Provide a positive interlock system that automatically shuts off the pump when material is not in the mixing chamber. Provide a meter capable of registering the flow rate and quantity of additive introduced into the reclaimed material.

2. Use equipment capable of automatically metering liquids with a variation of not more than $\pm$ 2.0% by weight of liquids.

3. Maintain all equipment as specified in Section 108.05(c).

(b) Mixing. Maintain adequate total liquids in the mixture to ensure thorough mixing of the reclaimed material and aggregates with the asphalt material. Add water to the RAP by a calibrated meter, as necessary, to aid in mixing compaction.

(c) Transporting and Placing. Transport the mixture in clean, tightly sealed vehicles. The Representative may require vehicle protective covers. Use mechanical spreaders to place the loose mixture on the prepared surface to a uniform depth. Unless allowed, do not use motor graders.

Do not place base course from September 1 to April 30 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, and 10-0; and from October 1 to April 30 in all other districts. With written approval of the Representative, the Contractor may place base course when no freezing temperatures occur for 24 hours before paving and when the project ambient air temperature is 45F and rising.

(d) Compaction. Section 341.3(c)

(e) Finishing. Section 341.3(d)

(f) Protection. Section 341.3(e)

(g) Surface Tolerance. Section 341.3(f)

(h) Tests for Depth. Control the loose depth of each layer to construct the base course to the compacted depth indicated and within the specified tolerances. The Representative will designate one test location in each 3,000 square yards of completed base course and at locations the Representative suspects the depth is deficient. At each test location, record one depth measurement. If the depth is deficient 1/2 inch or more from the indicated depth, the pavement is defective. Immediately start removal of the defective pavement, beginning at the core location and continuing longitudinally and transversely until the depth is within 1/2 inch of the indicated depth.

(i) Maintenance and Traffic. Section 341.3(g)

(j) Curing. Section 341.3(h)

342.4 MEASUREMENT AND PAYMENT—

(a) Cold Recycled Asphalt Base Course, Central Plant Mix. Square Yard or Ton

(b) Asphalt Material. Section 341.4(c)

(c) Coarse Aggregate for Cold Recycled Asphalt Base Course. Section 341.4(b)

SECTION 344—FULL DEPTH RECLAMATION

344.1 DESCRIPTION—This work consists of in-place pulverizing and mixing a combination of existing roadway material layers, stabilizing additives, and imported aggregate or RAP material, as required, to specified depths and grading, and compacting the mixed materials to form a new pavement base layer upon which an asphalt overlay, or a surface treatment is applied. This work is defined as full-depth reclamation (FDR), and often includes the incorporation of additional materials based on an approved FDR mix design.

344.2 MATERIAL—

(a) Reclaimed Material from Existing Roadway. Pulverize and mix existing roadway material layers, which may include bound pavement layers, aggregate subbase material, and subgrade material, such that 95% of the material passes the 2-inch sieve.

(b) Aggregate.

1. General. Provide fine or coarse aggregate from approved aggregate producers listed in Bulletin 14 or provide reclaimed aggregate material (RAM) meeting the specified size (e.g., AASHTO No. 57) as required by the approved mix design.

2. Fine Aggregate. Section 703.1, Type A or B.

3. Coarse Aggregate. Section 703.2, Type A, B, or C.

(c) Reclaimed Asphalt Pavement (RAP) Material from Other Roadways or Projects. Provide processed RAP material with 95% passing the 2-inch sieve.

(d) Stabilizing Additives. Provide one or more of the stabilizing additive materials listed below as included in the approved mix design. Potential additives are not limited to the materials listed below. Those listed below include references to sections with additional information.

1. Emulsified Asphalt Material.

1.a Emulsified Asphalt Material. Section 702, Class CMS-2, SS-1h, CSS-1h, SS-1hP, HFMS-2 or CSS-1hP.

2. Chemical.

2.a Portland Cement. Section 701

2.a.1 Portland Cement Slurry, Section 701 Portland Cement Slurry must be produced at a concrete plant listed in Bulletin 42 and supplied in Ready Mix Concrete Trucks approved by the DME/DMM. Other slurries must be provided in distributor and tanker trucks equipped with a recirculating pump and/or agitation system to prevent settling of the materials before application.

2.a.1.a Admixtures—Section 711.3

2.b Hydrated Lime. Section 723

2.c Supplementary Cementitious Material. Section 724

2.d. Lime Pozzolan. Section 725

3. Calcium Chloride. Section 721

4. Magnesium Chloride. Use only as permissible on a project approval basis.

(e) Water. Section 720.2

(f) FDR Mix Design. Select one or more stabilizing additives based on the composition of the existing roadway materials according to Publication 242 Pavement Policy Manual. A formal design protocol should be followed to optimize the performance of the pavement section. After selecting the appropriate stabilizing additive(s), develop a mix design following the appropriate mix design procedures for the stabilizing additive(s) as follows:

TABLE A
Mix Design Procedure for Primary Stabilizing Additive Type

Primary Stabilizing Additive	Mix Design Procedure
Asphalt	Pub. 27 (Bulletin 27)
Chemical (Portland Cement, Hydrated Lime, Supplementary Cementitious Material**& Portland Cement Slurry)	Pub. 242 Appendix J.3
Calcium Chloride	PTM No. 106 *, Pub. 242 Appendix J.3

*When used as the primary stabilizing material, calcium chloride should be applied as a minimum 35% solution at a rate between 0.10 to 0.15 gallons per square yard for each inch of depth reclaimed.
**Calcium oxide is used to activate the cementitious performance of Supplementary Cementitious Material.

Submit the mix design for the FDR work as specified in Section 108.03.

(g) Emulsified Asphalt Material. Section 702, Emulsified Asphalt Material, Class AEP, E-1 Prime, or EDP.

(h) Asphalt Tack Coat. Section 460.

(i) Asphalt Fog Seal. CSS-1h or SS-1h diluted as specified in 472.2, Table A.

(j) Calcium Chloride. Section 721.

344.3 CONSTRUCTION—Comply with applicable environmental standards. Appropriate equipment and techniques should be used to protect adjacent properties from fugitive dust or other material components of the FDR process. Dry additive will not be applied when the wind conditions are such that blowing additives become objectionable to traffic or adjacent property owners. Manual and/or gravity (tail gate) spreading of the additives is unacceptable.

Stabilization may be accomplished using asphalt material, Portland cement or other chemical stabilization materials, or calcium chloride according to the recommendations of the FDR Best Practices found in Publication 242 and approved in the project mix design.

(a) Equipment. Provide the necessary equipment to pulverize reclaimed material to a maximum particle size of 2 inches in the greatest dimension, blend, shape, and compact the FDR materials.

1. Reclaimer. Provide a self-propelled, traveling rotary reclaimer or equivalent machine capable of cutting through existing roadway to depths of up to 16 inches, or as required by the design, with one pass. The equipment must also be capable of pulverizing “in-place” the existing pavement, subbase, and subgrade materials, at a minimum width of 8 feet, and mixing any added materials to the specified depth. The cutting drum must have the ability to operate at various speeds (rpm), independent of the machine’s forward speed, to control oversized material and gradation.

Use a machine equipped with a computerized integral liquid proportioning system capable of regulating and monitoring the water application rate relative to depth of cut, width of cut, and speed. Connect the water pump on the machine to the water supply tanker or distributor by a hose, and mechanically or electronically interlock the flow of

water with the forward ground speed of the machine. Mount the spray bar to allow the water to be injected directly into the cutting drum/mixing chamber. Provide equipment capable of mixing water, dry or liquid stabilizing additives, emulsion, and the pulverized pavement into a homogenous mixture. Keep the cutting drum fully maintained and in good condition at all times throughout the project. Equipment such as road planers or cold-milling machines designed to mill or shred the existing roadway rather than crush or fracture them is not allowed.

1.a Use equipment capable of automatically metering liquids in the mixture and ensure thorough mixing of the reclaimed materials. Use equipment that is also able to record the volumes metered.

1.b Maintain equipment as specified in Section 108.05(c).

2. Placement Equipment. Use a motor grader or another method approved by the Representative.

3. Compaction Equipment. Provide suitable compaction equipment as follows. Use a 25-ton (or greater) pneumatic tire roller for breakdown and intermediate rolling if the FDR is emulsion or foamed asphalt based and is less than 8 inches in depth. Use a 25-ton vibratory padfoot roller for initial breakdown if FDR is 8 inches or deeper. Perform finish rolling using a single or tandem steel drum static roller of 12 to 14 tons.

(b) Weather Limitations. Do not place FDR materials when air temperature falls, or is anticipated to fall, below 40F within the subsequent required 7-day cure period. Do not perform reclamation in rain, or if rain is anticipated within 2 hours of completion of the work. Cement slurry with accelerating admixtures may be used in periods of cooler temperatures with the written approval of the DME/DMM. Do not place cement slurry mixtures with accelerating admixtures when the air temperature is anticipated to fall below 35F within the first 24 hours following placement.

(c) Quality Control. Provide a QC Plan for the FDR work a minimum of 2 weeks before the start of work. Identify the equipment, personnel, and processes to be used during the work. Ensure that all equipment is operational and functional before deployment to the job site. All equipment must be properly calibrated before application. This calibration should be verified through the test strip. Operators of water and additive applicators must keep proper records of the amount of material applied and the times of application. Describe means of establishing and controlling centerline, proposed crown and any existing or proposed superelevations.

(d) Test Strip. Before starting full production work, construct a 300-foot test strip demonstrating the FDR process including final compaction and shaping. Verify application rates for materials incorporated into the FDR process including stabilization materials and water. Identify and correct aspects of the work not conforming to the contract requirements before proceeding with full production work. If aspects of the work are not found to be adequately controlled to produce the desired mixed and refinished reclaimed roadway, construct additional test strips until the necessary control is established. After completing the test strip and demonstrating that the minimum density can be achieved as specified in 344.3(e)3.a, determine n=1 density of the FDR according to PTM No. 402 for each 3,000 square yard lot.

(e) Reclamation.

1. Pulverization. Before the application of stabilizing additives, pulverize the roadway to the size and depth specified. Shape the pulverized material to the approximate line and grade. Adding Calcium Chloride during pulverization is acceptable.

2. Mixing. Combine the FDR material, aggregates (if necessary), RAP (if necessary), stabilizing additive(s), and water according to the mix design and at the mix design recommended moisture content. Maintain adequate liquids in the mixture to ensure thorough mixing of the reclaimed material, aggregates, RAP, and stabilizing additives. If conditions change, make field adjustments to obtain a satisfactory FDR material.

If slurries are used, use Ready Mix Concrete Trucks or equip the distributor and tanker trucks with a re-circulating pump and/or agitation system to prevent settling of the materials before application.

If using slurry delivered in Ready Mix Concrete Trucks, verify “cement” application rate by calculating the weight of cement contained in the mixer truck and the area covered by the slurry after discharge by the Ready Mix Concrete Truck. The cement slurry producer shall supply a written record of the amount of cement, water, and

admixture with each load of cement slurry. Evenly and uniformly distribute the cement slurry, over the area of the prepared subgrade, calculated to provide the required application rate. Accelerating or retarding admixtures maybe added to the cement slurry with the written approval of the DME/DMM.

3. Compaction. Compact the FDR material to a minimum density of at least 95% of the laboratory compacted maximum density at optimum moisture content according to PTM No. 106. Demonstrate that the minimum specified density can be achieved during paving of the compaction control strip. After completing the compaction control strip, and establish the roller pattern as specified in Section 344.3(e)3.a , determine n=1 density according to PTM No. 402 for each 3,000-square yard lot.

Commence rolling at the low side of the course. Leave 3 to 6 inches from any unsupported edge(s) unrolled initially to prevent distortion. Compact the entire reclaimed area using the number of uniform passes of compaction equipment determined from the control strip, ensuring that uniform density is achieved throughout.

Complete compaction of chemically stabilized reclaimed material within 4 hours of the water/additive mixing operation.

3.a Compaction Control Strip. Establish a roller pattern that achieves at a minimum the density specified in Section 344.3(e)3 by the construction of at least one 300-foot long control strip during initial reclamation. The compaction control strip may be contained within the project startup test strip. Take nuclear density reading tests according to PTM No. 402 after each pass of the compaction equipment. The properly calibrated nuclear gauge must be operated in direct transmission mode. Continue compaction with each piece of equipment until no appreciable increase in density is obtained by additional passes. Upon completion of compaction, make a minimum of ten tests at random locations according to PTM No. 1 to determine the average in-place density of the compaction control strip. Provide density results to the Representative for verification to the minimum density requirements as specified in Section 344.3(e)3.

If the density of the compaction control strip is less than the minimum density specified in Section 344.3(e)3, but the base course is uniform in texture, stable, and otherwise acceptable, provide additional compaction. If additional compaction does not achieve the minimum density, construct another compaction control strip to verify that the minimum density is achievable with the FDR process and mix design in use. Take a minimum of ten tests at random locations according to PTM No. 1 to determine the average in place density of the new compaction control strip. The minimum density for the new control strip is 98% of the control strip density.

3.b Moisture Content. Verify the original moisture content of the road material to be reclaimed before starting work. The moisture content can be determined according to ASTM D 2216, ASTM D 44643, or AASHTO T 265. Make appropriate adjustment between the moisture content determined at the time of mix design sampling and current moisture content by adjusting the design recommended water application rate.

The moisture content for compaction must achieve the optimum moisture content as determined from the project mix design but cannot exceed optimum by more than 3%.

4. Finishing. Shape the FDR material surface not to exceed 1 1/2-inch irregularity of the existing centerline, grades and/or cross-slope of the proposed roadway. Avoid excessively working the chemically stabilized FDR material, which may detrimentally affect the ultimate strength of the stabilized layer.

5. Cure. Cure the FDR material until the 7-day strength requirement is met. Do not allow heavy traffic on the reclaimed material during the 7-day cure period. Appropriate traffic signs must be posted to prevent heavy traffic on the constructed base until completion of base curing and application of the overlay.

For chemical stabilization, maintain the reclaimed layer in a damp condition by the daily application of water to the surface, or the application of an emulsified asphalt prime material followed by an asphalt fog seal at a residual asphalt rate between 0.02 and 0.10 gallons per square yard, or Tack Coat as specified in Section 460. Apply while FDR material is at optimum moisture content, but not exceeding more than 3%.

The rate of curing depends on many factors. In favorable weather conditions (no rain, sunshine, low humidity, high temperature), curing can take place at a considerably faster rate. Sufficient curing and strength gain could take from 2 or 3 days to at least 2 weeks depending on the type and amount of materials used and the climatic conditions.

FDR should be proof rolled with a vehicle similar to the heaviest vehicle expected in traffic, or base opening on a strength measurement of the FDR, before opening to traffic. Same day return to car traffic at posted safe speeds is possible. In general, the constructed base could be opened to light traffic (vehicles under 5 tons) 2 hours after completion of the base construction, with proof rolling. For emulsified asphalt stabilized roadways, the moisture

content should be at 50% of the design optimum moisture content or 3% total moisture content, whichever is reached first, before overlay. No damage should be apparent at slow speed, less than 10 miles per hour. Immediately correct the damage. Otherwise verify strength by testing as covered under 344.3(g).

6. Surface Tolerance. Test the completed stabilized base for smoothness and accuracy of grade, both transversely and longitudinally. Satisfactorily correct any 3,000-square yard lot where the average surface irregularity exceeds 1/2 inch under a 10-foot template or straightedge, based on a minimum of at least three measurements within the lot.

Provide a minimum final surface cross slope of 1/4-inch per foot, or as otherwise required by the project design.

(f) Maintenance and Protection of Traffic (MPT). Relocate traffic using approved traffic control devices and procedures as specified in Section 901. Provide MPT until the road can be opened to traffic as specified in Section 344.3(h).

(g) Acceptance. Acceptance will be based on each 3,000-square yard lot complying with requirements for surface tolerance as specified in Section 344.3(e)6, for density as specified in Section 344.3(e)3, and strength as follows.

Any lot failing to meet the acceptance criteria will be identified for rework. Cores may be taken to determine the extent of the failing area. Once a failed area has been identified, develop and obtain approval of a new mix design. Failed areas must be reclaimed again with the additional stabilizing material, as necessary, to achieve the required acceptance criteria. Fill core holes remaining outside the reworked area with an approved repair material listed in Bulletin 15.

Make a minimum of three standard Proctor samples according to ASTM D1633 for strength testing for each lot size of 3,000 square yards. Wrap the specimens in plastic wrap, seal in an airtight, moisture proof bag and cure the test specimens for a period of 7 days. Follow PTM No. 1 for selecting sample locations from the reclaimed material after addition of the stabilizing additive. For emulsion based mixes or mixes stabilized with foamed asphalt, an accepted alternative approach will be compaction of specimens with the Superpave Gyratory Compactor (SGC) to a thickness between 2 and 3 inches using 50 gyrations.

1. Asphalt Stabilized FDR. Achieve a minimum indirect tensile strength of 50 pounds per square inch when tested according to Bulletin 27. This requirement is for specimens compacted in the SGC to a thickness between 2 and 3 inches.

2. Chemical Stabilized FDR. Achieve an unconfined compressive strength of 300 to 500 pounds per square inch in 7 days when tested according to ASTM D1633 for the roads to be surfaced with less than a 3-inch overlay or asphalt surface treatment. Achieve an unconfined compressive strength value of 280 to 500 pounds per square inch in 7 days for roads to be surfaced with an asphalt overlay of 3 inches or greater. For emulsion based mixes as well as mixes stabilized with foamed asphalt, the minimum compressive strength requirement will be 280 pounds per square inch. If the average of the specimens does not meet the minimum required strength listed above, rework will be required. Chemically stabilized material tested to strengths greater than 900 pounds per square inch may result in shrinkage cracking, and rework will be required.

(h) Opening to Traffic. Do not open the road to unlimited traffic until the specified 7-day strength has been achieved. Limited local light vehicular traffic may be allowed once the reclaimed material has obtained a stable condition. Repair damage resulting from local traffic. Do not allow trucks to use the road until the above referenced 7-day strength has been achieved.

344.4 MEASUREMENT AND PAYMENT—

(a) Full Depth Reclamation, Excluding Additive. Square Yard.

1. Additional pay items depending on stabilization method.

1.a Chemical Additive. Gallon or Ton.

1.b Emulsified Asphalt Material. Gallon.

1.c Calcium Chloride Additive. Gallon.

1.d Magnesium Chloride Additive. Gallon.

(b) Asphalt Tack Coat. Section 460.4.

(c) Asphalt Fog Seal. Section 472.4.

SECTION 350—SUBBASE

350.1 DESCRIPTION—This work is preparation of subgrade, as specified in Section 210, and construction of a compacted aggregate subbase.

350.2 MATERIAL—

(a) Aggregates. Unless otherwise indicated or directed, Type S or better, No. 2A and/or No. OGS, as specified in Sections 703.2 and 703.5.

350.3 CONSTRUCTION—

(a) Equipment.

1. Compaction Equipment. Sections 108.05(c) 3.i or 4

(b) General. For quantities greater than 1,500 tons, prepare and submit a Subbase Delivery Plan to the Representative, if directed. Indicate the construction equipment and methods necessary to deliver and place the subbase in a manner that is not detrimental to the subgrade. Do not begin subbase operations until the Representative reviews the Subbase Delivery Plan.

Prepare the subgrade as specified in Section 210 before placing subbase. Correct any deficiencies in the subgrade, as specified in Section 210, before placing the subbase. Do not place subbase material on soft, muddy, or frozen areas.

If directed, correct unsatisfactory subbase conditions developing ahead of the base and paving operations by removing the subbase, correcting the subgrade problem, and replacing the subbase.

(c) Mixing. Use acceptable methods to mix materials and water before delivery to the project. Use a blend of materials from different sources only if allowed. Use material containing enough moisture to prevent segregation during stockpiling, hauling, and placing, and to minimize water added during compaction. Maintain subbase in a well-moistened condition from before placement to compaction.

(d) Placement. Before placing subbase, construct berms to confine the material. Verify the Class 4, Type A geotextile has been installed as specified in Section 210.3(b). Place the subbase before paving and as indicated. Control the subbase elevation and depth as specified in Section 210.3(c); except do not use templates if the subbase is trimmed using an automatic grading machine. Place the material on the subgrade and geotextile by back dumping then spreading the subbase ahead of all equipment. Spread, in a manner not causing segregation, to a uniform depth of the layer being placed. Do not make abrupt turns with tracked equipment that would result in pulling, folding, or tensioning of the fabric. Do not disturb or damage the geotextile during the installation of the overlying subbase. Repair any damaged geotextile at no additional cost to the Department. For rigid pavement and shoulders, place a course of No. 2A aggregate to a minimum compacted depth of 3 inches directly on the subgrade and place a course of No. OGS aggregate to a minimum compacted depth of 4 inches on top of the No. 2A aggregate.

For flexible pavement and shoulders, place the indicated type of aggregate courses at the position and depth indicated for the pavement structure. Place each layer of No. 2A aggregate to a minimum compacted depth of 3 inches and place each layer of No. OGS aggregate to a minimum compacted depth of 4 inches. Construct subbase in layers not more than 8 inches in compacted depth; however, when granulated slag is used, limit each layer to not more than 4 inches in compacted depth. If allowed and when using granulated slag, the Contractor may place a maximum compacted layer of 6 inches when the full layer depth is compacted as specified in Section 206.3(b).

If the subbase is constructed in widths less than the full pavement width, neatly trim the edge of completed subbase before placing the abutting subbase.

For simultaneous construction of more than one pavement course, complete and maintain the subbase at least 1,500 linear feet in advance of placing the succeeding pavement course.

(e) Compaction and Density. Compact to a condition of non-movement as specified in Section 206.3(b).

Compact from the sides to the center, with each pass uniformly overlapping the previous pass.

(f) Surface Tolerance. Section 210.3(c)

(g) Test for Depth. At each density test location and after completing the density test, carefully dig one test hole to the full depth of the completed subbase.

The Representative will measure the depth of the finished subbase.

If the subbase depth is deficient by 1/2 inch or more from the depth indicated, the subbase is defective. The Representative may require additional test holes to determine the limits of the defective area. Scarify the subbase to a depth of 3 inches, blend in additional material, and recompact. After recompacting, the Representative may require test holes to verify the subbase depth is within 1/2 inch of the indicated depth.

Backfill the test holes with subbase material and compact.

(h) Maintenance and Traffic. Section 310.3(g) and as follows:

Do not allow traffic, including construction traffic, on a subbase constructed of No. OGS aggregate. If a subbase constructed of No. 2A aggregate is used as a haul road or if a subbase is exposed to weather in excess of 60 calendar days, retest for surface irregularities and depth and correct deficiencies as specified in Section 210.3(c) and 350.3(g). Do not leave subbase or subbase covered with treated permeable base course exposed during winter shutdowns. Place the required asphalt base course over all prepared subbase for flexible pavements and place the required reinforced or plain cement concrete over all prepared subbase (with or without treated permeable base course) for rigid pavements, before the shutdown of paving operations for the construction season.

If subbase is in place over winter without a protective layer (asphalt base course for flexible pavements or cement concrete for rigid pavements), proof roll as specified in Section 206.3(a)1 before placement of flexible or rigid pavement. Remove subbase in any areas indicating instability and remove and replace or repair the subgrade. Replace the subbase after repairs are completed on the subgrade. If the majority of or all subbase exhibits instability during the proof rolling, remove subbase and repair subgrade. Replace subbase in its entirety. Remove subbase, repair subgrade, and replace subbase at no additional cost to the Department.

350.4 MEASUREMENT AND PAYMENT—

(a) Subbase. For the type indicated, and as follows:

1. Area Basis. Square Yard

The Department will not pay the entire quantity of subbase complete in place until the base course or pavement is constructed over the subbase. However, the Department will pay for up to 75% of the estimated quantity of subbase placed in advance of the succeeding operations, if the Contractor satisfactorily completed and is properly maintaining the subbase.

2. Volume Basis. Cubic Yard

3. Mass (Weight) Basis. Ton

SECTION 360—ASPHALT TREATED PERMEABLE BASE COURSE

360.1 DESCRIPTION—This work is the construction of an asphalt treated permeable base course (ATPBC) on a prepared surface. When placed on subgrade, it includes the preparation of subgrade as specified in Section 210.

360.2 MATERIAL—

(a) Asphalt Material. Asphalt Cement, Class PG 64S-22, as specified in Section 702.

(b) Coarse Aggregate. Type A, Section 703.2. When using crushed gravel, provide a minimum of 75% crushed particles with at least three faces resulting from fracture.

(c) Fine Aggregate. Type A or Type B, Section 703.1.

(d) Additives.

1. Hydrated Lime. Before adding the asphalt cement, add hydrated lime to the aggregate to reduce stripping potential.

Furnish hydrated lime conforming to ASTM C 1097 and add the lime as follows:

- Add at least 1% hydrated lime by weight of the total dry aggregate.
- Provide a separate bin or tank and feeder system to store and accurately proportion the lime, in dry form, into the aggregate.
- Provide a convenient and accurate means of calibrating the proportioning device.
- Interlock the proportioning device with the aggregate feed or weight system.
- Mix the lime and aggregate to uniformly coat the aggregate with lime.
- Furnish aggregate containing at least 3% free moisture.
- Do not stockpile lime treated aggregate.
- Control the feeder system by a proportioning device accurate to within 10% of the specified amount.
- Provide a flow indicator or sensor and interlock with the plant controls such that production is interrupted if there is a stoppage of the lime feed.
- Before production, obtain approval of the method to introduce and mix the lime and aggregate.

2. Heat-Stable, Anti-Stripping Additive. The Contractor may use an anti-stripping additive other than hydrated lime. Blend the additive with the asphalt cement before adding the additive and asphalt cement to the mixture. Use the manufacturer's recommended dosage of the additive, but not less than 0.25% by weight of the asphalt. Select an additive that does not harm the completed asphalt concrete mixture and that is compatible with the aggregate and asphalt supplied for the project.

(e) Mixture Design and Production.

1. Design. Size, uniformly grade, and combine aggregate fractions according to Table A below. Marshall test requirements do not apply. Design a JMF with an initial target asphalt content of 2.5% by weight. If necessary, adjust

the asphalt content within the range specified in Table A below to uniformly coat the aggregate and ensure the aggregate has no observable runoff of excess asphalt.

Test materials, proportions, and the mixture at the asphalt concrete plant laboratory. Verify conformance with the uniformity requirements specified in this Section. When required, the Department will perform the tests at the LTS. Provide a JMF that conforms to all Department requirements. Submit a copy of the JMF to the DME/DMM at least 3 weeks before the scheduled start of producing the mixture for the project. If the Department has not used the JMF on previous projects, provide test results from previous mixture production that show the mixture conformed to all JMF production tolerances.

2. QC Plan. Prepare and submit a QC Plan, as specified in Section 106, at the start of the project and at least annually thereafter. Do not start ATPBC production until after the Representative reviews the QC Plan.

3. Production. During the first day of production, take at least three asphalt content and gradation tests to verify the mixture conforms to the JMF. After the first day, perform tests for asphalt content and aggregate gradation according to the QC Plan and PTM No. 1. Produce ATPBC conforming to the gradation requirements in Table A and with a asphalt content within 0.8% of the JMF (n=1). Ensure the aggregate is uniformly coated with asphalt and no runoff of excess asphalt is observed.

4. Acceptance of the Mixture. Obtain material certification from the material producer using the results of QC tests for asphalt content and gradation. Provide the certification to the Inspector-in-Charge within 1 working day after taking QC tests.

TABLE A
Composition of Mixture
(Total Percent by Mass (Weight) Passing Square Openings Based on Laboratory Sieve Tests)

Sieve Size	Percent Passing
37.5 mm (1 1/2-inch)	100
25.0 mm (1-inch)	95 – 100
12.5 mm (1/2-inch)	35 - 65
4.75 mm (No. 4)	12 – 24
1.18 mm (No. 16)	6 - 16
75 µm (No. 200)	0 – 5
Asphalt Content	2.0% - 3.0%*

* For approved gravel and slag mixtures, the Representative may allow the Contractor to exceed the upper limit.

360.3 CONSTRUCTION— Section 413.3, with modifications as follows:

(b) Weather Limitations. Replace with the following:

Do not place ATPBC on surfaces that are unstable, frozen, or below a temperature of 35F. Do not place ATPBC when the air temperature is below 35F or during rain. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of ATPBC that are en-route to the project.

(c) Asphalt Mixing Plant. Add the following:

3. Plant Requirements. The Contractor is not required to provide equipment for developing the design and control test.

4. Preparation of Mixture. Before mixing, dry the aggregate as necessary. Heat the asphalt material so that combining with aggregate produces a completed mixture. Coat the aggregate with the asphalt material to form a film of adequate thickness to provide the required binding properties. Produce ATPBC at a temperature below 320F that

also provides suitable viscosity for adequate coating of aggregate particles, and that does not cause segregation of asphalt and aggregate during transportation.

Do not stockpile ATPBC. The ATPBC must be placed within 8 hours from when it is made.

(f) Rollers. Replace with the following:

Use steel-wheel power rollers with a manufacturer's certified metal weight of 8 tons to 10 tons.

(h) Spreading and Finishing. Replace with the following:

Use a slip form paver, as specified in Section 413.3(e), or a mechanical spreader. Spread and strike off the mixture for the entire lane width or as much lane as practical. Place the mixture in maximum 4-inch compacted lifts. Adjust screed assemblies to provide the cross section and depth indicated. Construct the profile to the design grade line. Use fully automated sensors to control profile and transverse grade. Allow the mixture to cool to 100F before placing subsequent layers or pavement courses. Perform handwork at locations directed by the Representative.

(i) Compaction. Replace with the following:

Perform rolling as soon as the mat has cooled sufficiently to avoid shoving or lateral movement of the ATPBC. Seat ATPBC using an 8 ton to 10 ton, steel-wheeled roller, or vibratory roller operated in the static mode only. Compact ATPBC by applying four roller passes. One roller pass is defined as one trip of the roller in one direction over any one spot. Additional passes are allowed only to eliminate any surface irregularities, or creases. Do not compact the material to the point that it is not free draining or the aggregate is crushed.

(j) Mat Density Acceptance. Delete this section.

(k) Joints. Replace with the following

1. Longitudinal Joints. Spread the ATPBC to overlap the edge of the lane previously placed by 1 inch to 2 inches. Maintain the uniform uncompacted depth adjacent to a compacted lane necessary to provide a smooth joint after compaction.

2. Transverse Joints. At the end of each day's work and when more than a 30 minute interruption occurs in ATPBC paving operations, install a temporary vertical bulkhead to form a straight transverse construction joint. The joint shall be the full depth and width of the ATPBC. Instead of a temporary bulkhead, the Contractor may saw construction joints.

(l) Surface Tolerance. Replace the requirements for correcting irregularities with the following:

Test the finished surface at locations the Representative suspects are irregular and at transverse joints and paving notches. Test the surface in stages using a 10-foot straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the road centerline and, in successive positions, test the pavement surface from one side to the other. Advance the test location to the next stage by moving the straightedge along the pavement centerline by not more than 5 feet.

Correct irregularities of more than 1/2 inch by loosening surface mixture and removing or adding ATPBC. For irregularities that develop after compaction is completed, correct the irregularity by a method that does not produce contaminating fines or damage the base. Do not grind or mill the ATPBC. The area is defective if irregularities or defects remain after final compaction.

(m) Tests for Depth: Binder and Wearing Courses. Replace with the following:

Carefully dig or drill one 6-inch diameter test hole to the full depth of the ATPBC for each 3,000 square yards, or less, of completed base course. The Representative may require additional test holes in areas the Representative suspects are deficient in depth. The Representative will measure the depth of the base course. Using material acceptable to the Representative, backfill the test holes and compact the material to fill the test hole flush with the completed base course.

Remove and replace sections deficient in depth by 1/2 inch or more. Start correction at the point of determined deficiency and continue correction longitudinally and transversely until the depth is within 1/2 inch of the indicated depth.

(n) Protection of Courses. Replace with the following:

Section 105.13 and as follows: Traffic is not permitted on the asphalt treated permeable base material, except for trucks and equipment required to place the next layer. Replace areas damaged or contaminated, as directed and at no cost to the Department. If necessary, re-compact the ATPBC before starting subsequent paving.

Protect the surface from damage before and during the concrete paving process.

(o) Defective Work. Replace with the following:

Unless otherwise directed in writing by the District Executive, remove and replace ATPBC deficient in surface tolerance, deficient in depth, defective in asphalt content, or excessive in percent passing the 75 µm (No. 200 sieve). The ATPBC is defective in asphalt content if production tolerances are exceeded, percent of coated aggregate particles is less than 95%, or the mixture contains observable runoff of excess asphalt.

With written permission from the District Executive, the Contractor may fill low areas during construction of the next pavement course.

Acceptance testing and QA testing does not relieve the Contractor of responsibility for defective material or work.

360.4 MEASUREMENT AND PAYMENT—Square Yard or Ton

SECTION 400
FLEXIBLE PAVEMENTS

SECTION 404—EVALUATION OF ASPHALT PAVEMENT RIDE QUALITY AND PAYMENT OF INCENTIVE

404.1 DESCRIPTION—This work is evaluating an asphalt pavement surface profile and determining the ride-quality incentive associated with the pavement surface profile.

(a) General Requirements. Determine the ride quality of finished pavement surfaces, including overlaid bridge approach slabs and overlaid bridge decks. At least two of the following construction operations must be indicated in areas included in ride-quality lot measurements:

- Profile milling as specified in Section 492.
- Asphalt Base course.
- Asphalt Scratch course.
- Asphalt Leveling course.
- Asphalt Binder course.
- Asphalt Wearing course.

In the presence of the Inspector, measure the pavement surface profile according to PTM No. 428. Provide the resultant International Roughness Index (IRI) data to the Representative. The Representative will determine payment for each ride-quality lot based on the IRI.

Measure the pavement surface of the following excluded areas separate from the pavement surface profile of ride-quality lots. The Representative will not include measurements from excluded areas to determine lot incentive payment;

- Pavement surfaces not constructed as a full-depth overlay, as indicated, such as the vertical transition areas at the limits of paving and at the approaches to bridges.
- Bridge decks unless overlaid.
- Ramps less than 1,500 feet in length.
- Tapered pavements.
- Shoulders, medians, and other pavement surfaces indicated.
- Pavement from 5 feet before and up to 5 feet after any appurtenances such as water boxes, manholes, railroad tracks, and inlets extending out into the pavement.
- Partial lots less than 100 feet
- Roadways with a posted speed limit of 40 miles per hour or lower.

(b) Lot Size. A full lot is 528 feet of a single pavement lane. The Representative will designate lots starting at the beginning limit of paving and continuing to the ending limit of paving for each pavement lane and ramp that is 12 feet or wider. Do not include the length of excluded areas in the 528 feet.

The Representative will designate a partial lot at the ending limit of paving and at an excluded area, when the lot length is less than 528 feet. The Representative will evaluate a partial lot as a percentage of a full lot.

404.3 CONSTRUCTION—

(a) Equipment and Operator. Provide pavement surface profile measuring equipment that has been verified by the Department according to PTM No. 428. In the presence of the Inspector, calibrate the distance sensor and check the profile system calibration before each day's testing.

Provide an operator that is Department certified according to PTM No. 428.

(b) Testing.

1. Lots. Provide the traffic control and station marking necessary to accommodate testing. Remove objects and equipment from the surface and sweep the surface as necessary to remove debris. In the presence of the Inspector, determine the pavement surface profile for each lot according to PTM No. 428. At the completion of testing, immediately submit the lot IRI data, according to PTM No. 428, to the Representative.

2. Excluded Areas. Provide the traffic control necessary to accommodate testing. Test the entire surface of each excluded area in stages using a 12-foot straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the roadway centerline and, in successive positions, test the pavement surface profile from one side of the excluded area to the other. Advance the test location to the next stage by moving the straightedge along the roadway centerline not more than 5 feet.

(c) Acceptance.

1. Lots. The Representative will compare the lot IRI to Table A in Section 404.4 to determine if the lot requires corrective action. Additionally, perform corrective action on any individual bump that requires grinding and where the irregularity is more than 3/16 inch when tested with a 12-foot straightedge.

2. Excluded Areas. Perform corrective action where irregularities are more than 3/16 inch when tested with a 12-foot straightedge. To improve the ride quality and at the Department's expense, the Representative may require grinding of excluded areas that conform to the acceptable straightedge surface tolerances specified in Section 404.3(c).

(d) Corrective Action. Do not produce a deviation, such as a ridge or valley with the adjacent pavement, of more than 3 mm (1/8 inch) when measured on the transverse profile. Correct a sufficient length of pavement to correct the pavement surface profile without producing additional high or low points. Retest the lots and excluded areas after completing corrective action. Perform additional measurements of the pavement surface profile, as necessary, for the Representative to determine which lots do not require additional corrective action. Correct surfaces to a uniform texture and cross section.

Perform all corrective action before testing for pavement depth. Use one or more of the following methods:

1. Carbide Grinding. Use carbide grinding for correcting areas 15 feet in length or less. Use grinders of the walk-behind type that have cutting heads of carbide tipped shackles, stars, or blades and have a locking depth control to produce a uniform pavement surface texture.

Provide a pavement surface texture consisting of parallel grooves between 3/32 inch and 1/4 inch wide with a "land area" between grooves of 1/16 inch and 3/16 inch. Operate the grinder by making multiple passes, if necessary, with a maximum depth of any single pass of 1/8 inch. Grind longitudinally or transversely across the pavement surface.

2. Diamond Grinding. Section 514.3 and modified as follows:

(d) Tolerance. Delete this section.

Unless otherwise approved, grind the entire lane width.

3. Removal and Replacement. Remove the surface course of the entire pavement lane width by milling and replace at least the minimum layer depth of the specified surface course. Place more than the minimum layer depth if necessary to correct the pavement surface profile.

(e) Defective Work. A ride-quality pavement lot is defective if:

- The IRI of the lot exceeds the maximum acceptable IRI according to Table A of Section 404.4.
- Any individual bump (must grind) exists in the lot where the irregularity is more than 3/16 inch when tested with a 12-foot straightedge.
- The surface adjacent to another ride-quality lot contains a ridge or valley of more than 1/8 inch.
- The specifications for pavement construction require removal and replacement of pavement within the ride-quality lot.

Unless the Department and Contractor agree to leave a defective lot in place as specified in Section 404.4, remove and replace defective areas and retest the ride-quality lot.

404.4 MEASUREMENT AND PAYMENT—Dollar

The proposal will include an item and a predetermined amount of money for Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive. The contract item will have a unit of measure of DOLLAR, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the incentive or bonus status of the payment being made, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Evaluation Of Asphalt Pavement Ride Quality And Payment Of Incentive item as follows:

- If the lot is not defective, Table A and the IRI for each lot will be used to determine the incentive payment for ride quality.
- The incentive payment for a lot subjected to corrective action will be determined according to Table A and the IRI for the lot after the Contractor completes corrective action.
- The incentive payment for a partial lot will be determined as a percentage of a full lot.
- After corrective action, the Contractor may leave a defective lot in place if the District Executive provides written approval and the Contractor accepts a $4,000 downward adjustment (rebate) of the amount paid for the lot.
- Costs associated with evaluating pavement ride quality will not be paid for separately.

TABLE A
Payment Schedule for Ride Quality Incentive

SCHEDULE A	
For Expressway Work Using Three Operations	
IRI inches/mile/lot	**Amount**
≤ 35 ≤ 50	$600
≤ 60	$300
≤ 70 *	$150
> 70	$0
	Corrective action required

SCHEDULE B	
For Expressway Work Using Two Operations and Non-Expressway Work Using Two or More Operations	
IRI inches/mile/lot	**Amount**
≤ 45	$600
≤ 55	$300
≤ 70	$150
≤ 90 *	$0
> 90	Corrective action required
* Maximum acceptable IRI	

SECTION 405—EVALUATION OF ASPHALT PAVEMENT LONGITUDINAL JOINT DENSITY AND PAYMENT OF INCENTIVE/DISINCENTIVE

405.1 DESCRIPTION—This work is evaluating asphalt pavement longitudinal joint samples on the surface wearing course for determining densities and the incentive/disincentive. This work also includes any necessary corrective actions required as a result of the evaluation.

405.3 CONSTRUCTION—

(a) General Requirements. Longitudinal joint density lots will be established as specified in Section 405.3(b). These incentive/disincentive lots are completely independent from lots defined in other sections of these Specifications for pavement acceptance. The Representative will determine the payment addition or deduction along with any necessary corrective actions for each longitudinal joint lot based on the test results of the density cores.

(b) Lot Size. A full lot is 12,500 feet of longitudinal joint and will consist of five sublots of 2,500 feet. The Representative will designate lots as the longitudinal joints on the project are constructed, beginning on the first day wearing course paving abuts a previously placed wearing course, forming a longitudinal joint. Joints constructed with tandem pavers will be included, unless otherwise indicated. As paving progresses and longitudinal joints are constructed, drill one core per sublot until a full lot is obtained as specified in Section 405.3(e). Do not include the length of excluded joints in the 12,500 feet lot. A single lot need not be contiguous and may include multiple joints throughout the project limits.

Partial lots with less than three sublots will be combined with the previous lot. Partial lots with three or more sublots will stand as a separate lot.

(c) Quality Control Strip. On the first day paving abuts a previously placed mat, forming a longitudinal joint eligible for evaluation, determine the effectiveness of the material placement and compaction operations as well as the mixture design on longitudinal joint density. In addition to any incentive/disincentive payment sublot cores, obtain five 6-inch diameter core samples located randomly on the longitudinal joint for QC density testing. Test the cores according to PTM No. 715 or PTM No. 716 and provide the results of the tests to the Representative within 24 hours. The Contractor may elect to make adjustments to the mixture design or placement and compaction operations to ensure adequate in place density is being achieved. If proposing changes that impact the field quality control plan or job mix formula, submit any modifications or revisions to the Department for review.

(d) Excluded Areas. The following joint areas are to be excluded from the longitudinal joint lots. The Representative will not obtain samples from excluded areas to determine lot incentive/disincentive payment.

- Joints where one or both sides of the pavements forming the joint were accepted for density by means other than pavement cores
- Joints where one side of the joint is formed by existing pavement not constructed under this contract
- Areas within 1 foot longitudinally of an obstruction during construction of the wearing course (manholes, inlet grates, utilities, bridge structures, pavement notches, etc.)
- Small areas, such as intersections, gore areas or transitions, or anywhere the Representative determines paving and phasing methods do not allow for consistent longitudinal joint construction. Prior to paving, submit requests in writing to the Representative for consideration of any areas to be excluded on this basis. The Representative will make the final determination.

(e) Sampling. The Representative will select one location in each sublot according to PTM No. 1 and PTM No. 729. The Contractor may take one companion core per sublot for quality control purposes. For vertical joints center joint cores on the line where the joint between the two adjacent lifts abut at the surface. For notched wedge joints, center joint cores 6-inches or one half the joint taper width away from the joint line in the direction of the wedge. With the Representative present, drill 6-inch diameter cores as soon as possible, but no later than the day following the construction of the longitudinal joint at each sublot location. Do not compress, bend, or distort samples during cutting, handling, transporting, and storing. If samples are damaged, immediately obtain replacement samples, as directed by

the Representative, from within 12 inches of the original sample location. Within 24 hours after coring, backfill the hole(s) with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

Identify the samples by longitudinal joint lot and sublot number, location, dates of placement, mixture type, and as acceptance samples (Sample Class AS). Provide the daily theoretical maximum specific gravity value as specified in Section 413.2(e)1.d.4 for the mix on each side of the longitudinal joint. The average of the two values will be used for the density calculation of each sublot according to PTM No. 729. Immediately package and deliver the samples to the Representative according to the QC Plan. Use sample containers of sufficient strength to prevent samples from being damaged during transport.

Each joint core will be comprised of portions of two lanes, with the potential for two different JMFs within each core. The Representative will only include samples within a lot having the same JMF combination on one Form TR-447 for testing at the LTS. The Representative will submit separate samples and Forms TR-447 for sublots with different JMF combinations or after work stoppages of more than 5 days.

The LTS will test the density samples according to PTM No. 715, and if necessary PTM No. 716, to determine the percent compaction.

(f) Percent Within Limits (PWL). Once all test results for a lot have been received, the Representative will compute the PWL and average in place density for each lot as specified in Section 106.03(a)3.a and as follows. The lower specification limit (L) will be 91.0 %. No upper specification limit (U) for density will be factored into the PWL determination.

405.4 MEASUREMENT AND PAYMENT—Dollar

The proposal will include an item and a predetermined amount of money for Evaluation of Asphalt Pavement Longitudinal Joint Density and Payment of Incentive/Disincentive. The Contract item will have a unit of measure of DOLLAR, a unit price of $1.00, and a quantity equal to the predetermined amount. When asphalt pavement longitudinal joint density evaluation indicates that a disincentive adjustment is applicable, the appropriate amount will be deducted from money due or to become due to the Contractor through the processing of a contract adjustment.

Due to the incentive or bonus status of the payment being made the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Evaluation of Asphalt Pavement Longitudinal Joints and Payment of Incentive item as follows:

For each lot Table A will be used to determine the incentive/disincentive payment for longitudinal joint density.

The incentive/disincentive payment for a lot containing other than 5 sublots will be determined as a percentage of a full 12,500 feet lot, by the following:

N=3 (60% of the Table A amount)
N=4 (80% of the Table A amount)
N=6 (120% of the Table A amount)
N=7 (140% of the Table A amount)

For a full lot with a PWL ≥ 81, the Contractor will receive a prorated positive incentive payment up to a maximum of $7,500 calculated according to Table A.

For a full lot with a PWL ≤ 49, the Contractor will receive a prorated negative adjustment (disincentive) up to a maximum of $12,500 for the longitudinal joint lot calculated according to Table A. Lots with PWL ≤ 49 and average density ≥ 90.0 % will be assessed a disincentive up to a maximum of $1,000 per sublot regardless of PWL.

Costs associated with providing joint pavement cores will not be paid for separately and will be considered incidental to the construction items for the wearing courses eligible for the longitudinal joint evaluation. Costs associated with corrective action such as traffic control or other costs will not be paid for separately.

TABLE A

Lot by Lot Payment Schedule for Longitudinal Joint Incentive/Disincentive	
Lot PWL	**Amount**
PWL ≥ 81	(PWL -80)/20 x $7,500 (Incentive)
PWL = 50 to 80	$0
PWL ≤ 49	(50-PWL)/50 x -$12,500 (Disincentive)

SECTION 410 – SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED ASPHALT FINE-GRADED COURSES

410.1 DESCRIPTION—This work is the standard and RPS construction of a plant-mixed asphalt wearing course on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor and modified to be a fine-graded (FG) mixture.

410.2 MATERIALS—Section 413.2 using the procedure and volumetric tolerances for the 9.5 mm nominal maximum aggregate size mixture and modified as follows:

(e) Mixture Composition for Standard and RPS Construction.

1. Virgin Material Mixtures. Submit a JMF meeting all of Bulletin 27 requirements for a 9.5 mm nominal maximum aggregate size mixture, except the JMF must have a minimum percent passing the No. 8 sieve of 47% and a maximum percent passing the No. 8 sieve of 67%.

410.3 CONSTRUCTION—Section 413.3 using the test procedures, limits and tolerances for a 9.5 mm nominal maximum aggregate size mixture except where procedures, limits and tolerances are specifically indicated for a 9.5 mm fine-graded nominal maximum aggregate size mixture and as modified as follows:

Revise Table G to include 9.5 mm Fine Grade Wearing Course as follows:

TABLE G
Mixture Minimum Compacted Depths

Mixture	Minimum Depth
9.5 mm Fine Grade Wearing Course	1 in.

410.4 MEASUREMENT AND PAYMENT—Square Yard or Ton

Paid as specified in Section 413.4 for a 9.5 mm Wearing Course.

SECTION 412—SUPERPAVE MIXTURE DESIGN, CONSTRUCTION OF PLANT-MIXED 6.3 MM THIN ASPHALT OVERLAY COURSES

412.1 DESCRIPTION—This work is the construction of a thin lift wearing course of plant-mixed, dense-graded asphalt concrete with 6.3 mm Nominal Maximum Aggregate Size (NMAS), placed on a prepared surface.

412.2 MATERIALS—Section 413.2 with additions and modifications as follows:

(a) Asphalt Material.

1. Virgin Mix. Furnish PG 64E-22, conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified performance grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative a copy of a signed Bill of Lading for asphalt binder material on the first day of paving and when the batch number changes.

1.a. WMA Technology Additives or Modifiers Blended at the Asphalt Material Supplier's Refinery or Terminal. Provide refinery or terminal blended asphalt material blended with an approved WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15. Include in the asphalt material Producer QC Plan, the WMA Technology additive or modifier manufacturer name, WMA Technology name, and source, dosage rates, blending method, QC testing, corrective action points, disposition of failed material, storage, handling shipping, and bill of lading information following the applicable requirements in Section 702. Include the WMA Technology additive or modifier and dosage rate on the bill of lading. Provide certification that the refinery or terminally blended asphalt binder, that when modified with the WMA Technology additive or modifier, meets the requirements for the specified performance grade.

1.b. WMA Technology Additives or Modifiers Blended at the Asphalt Mixture Producer's Plant. Provide a blended asphalt binder consisting of an approved WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15 that is blended with a base asphalt binder of the specified performance grade conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25 and from an approved source listed in Bulletin 15, Section 702. Prepare a Producer QC Plan as specified in Section 106 and conforming to the Producer QC Plan requirements in Section 413.2(e)1.a and the additional Producer QC Plan requirements within this specification.

(b) Aggregate

1. General Requirements. Provide aggregate from approved producers and sources listed in Bulletin 14. Furnish aggregate that conforms to the quality requirements for Superpave Asphalt Mixture Design as specified in Bulletin 27 with modifications as specified in Section 412.2. Provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends for SRL are 50% by mass (weight) of each aggregate. Blend the aggregates using an approved method.

2. Fine Aggregate. Section 703.1, except Table A gradation does not apply and as follows:

- Determine the uncompacted void content according to AASHTO T 304, Method A, or use the value listed in Bulletin 14, and ensure the uncompacted void content conforms to AASHTO M 323, Table 6.
- Determine the sand equivalent value according to AASHTO T 176 and ensure the sand equivalent value conforms to AASHTO M 323, Table 6.

All manufactured sand fine aggregates used in NMAS 6.3 mm mixtures must be from a source that has a coarse aggregate SRL rating listed in Bulletin 14 as specified. Manufactured sand fine aggregate must be manufactured from

the same parent material(s) as the Bulletin 14 listed coarse aggregate, and will have the same SRL rating as the listed coarse aggregate.

All natural sand fine aggregates, and manufactured sand fine aggregates without a coarse aggregate from the same source with an SRL rating listed in the Bulletin 14 used in NMAS 6.3 mm mixture must be submitted to the LTS for SRL determination.

3. Coarse Aggregate. Type A, Section 703.2, except Table C gradation does not apply and revise the following requirements of Table B:

- Abrasion, Maximum Percent Loss as specified in Bulletin 27, Chapter 2A, Table 5A
- Flat and Elongated Particles in Coarse Aggregate maximum percent as specified in ASTM D4791using material retained on the No. 4 sieve, Maximum 10 percent for 1:5 ratio, and Maximum 20 percent for 1:3 ratio.
- Crushed Fragments, Minimum Percent, as specified in AASHTO M 323, Table 6, for Fractured Faces, Course Aggregate using the material retained on the No. 4 sieve.

The coarse aggregate must satisfy specified SRL requirements. Do not use coarse aggregate or anti-skid aggregate in the mixture until the quality, type, and SRL, are determined.

(c) Recycled Asphalt Material. Do not use Reclaimed Asphalt Pavement (RAP) or Recycled Asphalt Shingles (RAS) in the 6.3 mm Wearing Course.

(d) Filler. Follow Section 703.1(c)1. Do not use fly ash if the design traffic is greater than or equal to 3 million Equivalent Single Axle Loads (ESALs). Hydrated lime is allowed as a filler and may constitute up to 2 % of the weight of total dry aggregate unless otherwise shown on the plans. Provide hydrated lime that conforms to the requirements of ASTM C977.

(e) Mixture Composition.

1. Virgin Material Mixtures. Design 6.3 mm NMAS mix that meets all Department requirements. Size, uniformly grade, and combine aggregate fractions, asphalt binder, and an approved WMA Technology in proportions to develop a JMF that conforms to the material, gradation, and volumetric Superpave Asphalt Mixture Design requirements as specified in Bulletin 27, Chapter 2A, except as modified in Table A.

The WMA Technology Manufacturer Technical Representative (Technical Representative) will address laboratory procedure modifications necessary to prepare, compact, and test WMA mixtures and to achieve a uniform blend. Develop a JMF and incorporate the WMA Technology additive, modifier, or process into that JMF during production. Do not develop a volumetric JMF based on incorporating the WMA Technology additive, modifier or process during the volumetric asphalt mixture design process. For all JMFs, perform moisture susceptibility analysis according to Bulletin 27 and ensure the asphalt mixture used for the analysis includes the WMA Technology. Ensure the WMA Technology additive, modifier, or process is not detrimental to the moisture resistance of the mixture.

Submit a complete copy of the JMF, including a Form TR-448A signed by a certified Asphalt Level 2 Plant Technician, to the DME/DMM at least 3 weeks before the planned start of mixture production. Include a list of all material sources and the asphalt mixture producer on the TR-448A. Provide the calibration factors (C_f for both asphalt content and 75 µm (No. 200) sieve) required by PTM No. 757 with the JMF on the TR-448A. Do not start mixture production until after the DME/DMM reviews the JMF.

Submit a completely new JMF, including a new Form TR-448A, with a change in material sources or if a new JMF is necessary to produce a mixture conforming to this specification.

TABLE A
Mix Design Requirements for Thin Lift 6.3 mm Asphalt Wearing Course

AGGREGATE GRADATION REQUIREMENTS, PERCENT PASSING	
Sieve Size	**Min. – Max.**
9.5 mm (3/8 inch)	100 Min.
6.3 mm (1/4 inch)	90-100
4.75 mm (No. 4)	0-85
2.36 mm (No. 8)	37-55
300 µm (No. 50)	8-25
75 µm (No. 200)	3-10
VOLUMETRIC DESIGN REQUIREMENTS	
Design Gyrations (N_{design}) for All Specified Ranges of Design ESALs	75
Voids in Mineral Aggregate (VMA), Min. %, for All Specified Ranges of Design ESALs	16.5
Design Air Voids (V_a), %, for All Specified Ranges of Design ESALs	3.5-4.0
Binder Draindown (AASHTO T 305), % Maximum, for mixture with greater than 7.0% Asphalt Content	0.3%
Binder Grade for All Specified Ranges of Design AASHTO M 332	PG 64E-22

1.a Producer QC Plan. Section 413.2(e)1.a

1.b Plant Technicians. Section 413.2(e)1.b

1.c Annual JMF Verification. Section 413.2(e)1.c except conform to the single and multiple sample tolerances in Section 412.2(e)1.d Tables B and C.

1.d Production. Section 413.2(e)1.d except as follows:

1.d.1 Apparent Moisture Content. Section 413.2(e)1.d.1

1.d.2 Asphalt Content. Include in the producer QC Plan a frequency of obtaining mixture samples according to PTM No. 1 and performing asphalt content tests to verify that the mixture conforms to the tolerances of Table B. Test the samples according to either PTM No. 757, PTM No. 702, or PTM No. 742. After obtaining a minimum of three test results, determine compliance with the multiple sample tolerances in Table B. After obtaining five or more test results, determine compliance with the multiple sample tolerances in Table B using the running average of the last five consecutive test results.

Printed ticket results may be used in place of laboratory test results for QC of asphalt content of the mixture if the producer is currently approved to use printed tickets according to Bulletin 27. During mixture production, maintain 90% of printed ticket results for each day of production within 0.2 percentage points of the JMF.

1.d.3 Gradation. Sample the completed mixture, the combined aggregate from the hot bins of a batch plant, or the combined aggregate belt of a drum plant, according to PTM No. 1 and at the frequency in the producer QC Plan. If mineral filler is used in the mixture, determine gradation by testing samples of the completed mixture.

- Test the completed mixture according to PTM No. 757 or according to PTM No. 702 and PTM No. 739.
- Test combined aggregate samples according to PTM No. 743.

Produce a mixture within the tolerances of Table B. Determine compliance with the multiple-sample tolerance after obtaining a minimum of three test results for the mixture. After obtaining five or more test results for the mixture, determine compliance with the multiple-sample tolerances using the running average of the last five consecutive test results.

1.d.4 Theoretical Maximum Specific Gravity. Section 413.2(e)1.d.4

1.d.5 Volumetric Analysis of Compacted Specimens. Sample the completed mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Prepare a minimum of two specimens from each sample according to AASHTO T 312.

Produce a mixture with volumetric properties conforming to the tolerances of Table C. Determine the bulk specific gravity of the specimens as specified in AASHTO T 312 and calculate air voids (V_a) and Voids in Mineral Aggregate (VMA) at N_{design} according to AASHTO R 35 and as specified in Bulletin 27.

TABLE B
Composition Tolerance Requirements of the Completed Plant Mix

		Single Sample (n = 1)	**Multiple Samples (n ≥ 3)**
Gradation			
Passing 6.3 mm (1/4 inch) to 300 µm (No. 50) Sieves (Inclusive)		±6%	±4%
Passing 75 µm (No. 200) Sieve		±3.0%	±2.0%
Asphalt Content			
6.3 mm		±0.6%	±0.4%
Temperature of Mixture (F)			
Class of Material	**Type of Material**	**Minimum**	**Maximum**
PG 64E-22	Asphalt Cement	285	330
Job-Mix Tolerance Requirements for Combined Hot Bin Gradations			
Gradation		**Single Sample (n = 1)**	
Passing 6.3 mm (1/4 inch) to 300 µm (No. 50) Sieves (Inclusive)		±4%	
Passing 75 µm (No. 200) Sieve		±3.0%	

TABLE C
Volumetric Tolerance Requirements of the Plant Mixed, Laboratory Compacted Mixture

	Single Specimen (n = 1)	**Multiple Specimens (n ≥ 2)**
Air Voids at N_{design} (V_a) from Target	±2.0%	±1.5%
Minimum VMA %	16.0	-

1.e Corrective Actions. Immediately take corrective actions if one or more of the following occurs:

- QC test results on a single sample (n=1) for percent passing the 6.3 mm (1/4 inch) sieve, 2.36 mm (No. 8) sieve, 300 µm (No. 50) sieve, 75 µm (No. 200) sieve, or asphalt content are not within the tolerances in Table B.
- The average of multiple samples (n≥3) for percent passing any sieve or asphalt content, as determined according to Section 412.2(e)1.d, are not within the tolerances in Table B.
- QC test results on a single specimen (n=1) or on multiple specimens (n≥2) are not within the tolerances in Table C.
- Independent assurance (IA) or QA sample results tested at the producer's plant are not within the tolerances of Tables B or C.

After taking corrective actions, sample the completed mixture within 150 tons of production. After sampling, test the mixture and provide test results to the Representative. If less than three samples are tested for mixture composition, determine conformance with Table B by comparing each result to the multiple sample tolerances. If the mixture does not conform to the single and multiple sample tolerances in Table B and the single and multiple specimen tolerances in Table B, suspend production and shipping to the project and determine the cause of the problem. Provide a written explanation of the problem and a proposed solution to the Department. After the Representative reviews the proposed solution and authorizes production to continue, resume production and perform JMF verification according to the QC Plan. During corrective actions and JMF verification, mixture acceptance is according to the approved acceptance level of Section 413.2(f) Table C.

2. Draindown Sensitivity. For mixtures with greater than 7 percent total asphalt content determine the driandown sensitivity of the mixture using AASHTO T 305 at the maximum mixture temperature listed in Table B

minus 5F. Use Fibers to reduce binder draindown if draindown exceeds the requirements of Table A. Use stabilizer types specified in Section 419.2(d) as needed to address draindown.

(f) Mixture Acceptance. Section 413.2(f) except as follows:

1. General. The Department will accept the mixture according to the certification acceptance in Section 412.2(f)2 or lot acceptance in Section 412.3(h)2.

2. Certification Acceptance. Acceptance by certification is appropriate for the following applications:

- Scratch Courses, Leveling courses and driveway adjustments.
- Mixtures used by Department maintenance forces.
- Mixtures purchased by local municipal governments.
- Mixture placed in quantities less than 350 tons in a continuous placement operation unless otherwise directed by the Representative.
- Other conditions, or applications as approved by the Representative.

2.b Certification of Mixture. Certify each mixture daily if QC test results conform to the single sample and multiple sample JMF production tolerances of Table B. The acceptance values will be:

- Asphalt Content
- Percent Passing the 75 µm (No. 200) sieve

If using printed ticket results in place of laboratory test results for asphalt content, certify that at least 90% of each day's printed ticket results for asphalt content are within 0.2 percentage points of the JMF.

If the mixture does not conform to the above requirements, do not certify the mixture. Instead, provide all QC test results to the Inspector-in-Charge. If using printed ticket results for asphalt content, provide the percentage of daily printed ticket results within 0.2 percentage points of the JMF to the Inspector-in-Charge. Payment will be determined according to Table D based on the QC test results.

If a day's production is interrupted by corrective action, material produced after the corrective action may be certified if QC test results conform to production tolerances.

(g) WMA Technologies (Additive(s), Modifier(s), or Processes) and WMA Manufacturers. Section 413.2(f)

(h) Anti-Strip Additives. Section 413.2(g)

(i) WMA Technology Manufacturer Technical Representative (Technical Representative). Section 413.2(h)

(j) 6.3 mm Mixture use with Membrane Systems Specified in Section 467 or Section 680. Do not use 6.3 mm wearing course paving mixture for material placed directly on top of membrane systems.

412.3 CONSTRUCTION—Section 413.3 with additions and modifications as follows:

(a) Preplacement Requirements. Provide asphalt courses as indicated for the entire project.

1. Paving Operation QC Plan. Prepare a paving operation QC Plan, as outlined on Form CS-409, for field control and evaluation of asphalt concrete paving operations. Submit the QC Plan to the Representative before or at the pre-construction conference. The QC Plan shall describe the construction equipment and methods necessary to construct and test the asphalt concrete courses as specified in Section 412.3. The WMA Technical Representative will provide all recommendations and direction specific to the WMA technology in the paving operation QC Plan. Do not start paving until after the Representative reviews the QC Plan.

2. Preplacement Meeting. At least 2 weeks before placing asphalt paving mixtures, schedule an asphalt preplacement meeting with the Representative to review at a minimum the specification, paving operation QC Plan, sequence of paving operations, mixture acceptance, density acceptance and the care and custody of asphalt acceptance samples.

(b) Weather Limitations. Do not place 6.3 mm wearing course paving mixtures from October 1 to March 31 in Districts 1-0, 2-0 (except Juniata and Mifflin Counties), 3-0, 4-0, 5-0 (Monroe and Carbon Counties only), 9-0 (Cambria and Somerset Counties only), and 10-0; and from October 16 to March 31 in Districts 2-0 (Juniata and Mifflin Counties only), 5-0 (except Monroe and Carbon Counties), 6-0, 8-0, 9-0 (except Cambria and Somerset Counties), 11-0 and 12-0. No exceptions to paving weather limitations will be allowed unless approved in writing by the District Executive. Do not place asphalt paving mixtures when surfaces are wet, when the air or surface temperature is 50F or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are en route to the project.

1. Paving Season Extensions. Section 413.3(b)1. With the following addition:

If an exception to the Weather Limitation dates is approved by the District Executive for 6.3 mm wearing course, the minimum surface temperature of 50F, and an air temperature of 40F will be strictly enforced and compaction of the asphalt mixture completed as quickly as possible.

(c) Asphalt Mixing Plant. Section 413.3(c).

1. Batch Plant. Section 413.3(c)1.

2. Drum Mixer Plant. Section 413.3(c)2.

(d) Hauling Equipment. Section 413.3(d)

(e) Paving Equipment. Section 413.3(e)

(f) Rollers. Use an adequate number steel-wheeled rollers, each weighing a minimum of 10 tons and as specified in Section 108.05(c)3 to keep up with the paving operation. Operate rollers according to manufacturer's recommendations. Use rollers equipped with a watering or soapy watering system that prevents material from sticking to the rollers. Do not use pneumatic wheeled rollers.

Do not use rollers in vibratory mode unless it can be demonstrated to the satisfaction of the Representative that no breaking of aggregate or flushing of asphalt binder results from the vibration. Monitor pavement cores for aggregate breakage on every lot. Discontinue vibration if aggregate breakage or flushing of asphalt binder occurs.

(g) Preparation of Existing Surface. Section 413.3(g) with the following modification:

1. Conditioning of Existing Surface. Before delivering asphalt mixtures, remove and dispose of loose and foreign material and excess joint sealer and crack filler from the surface of existing pavement or previously placed pavement courses. If necessary, use a power broom. Remove all thermoplastic pavement markings. If practical, do not allow traffic on the existing surface after cleaning, to prevent contamination.

Before placing a wearing course, correct irregularities in the binder course. Repair potholes and gouges greater than 1 inch in depth. Fill and seal all pavement cracks or joints that exceed 1/8 inches in width. Use fillers and sealants conforming to PennDOT specifications.

Paint all existing vertical surfaces of curbs, structures, gutters, and pavements that will be in contact with asphalt mixtures with a uniform coating of either emulsified asphalt, consisting of PennDOT Material Class TACK, or NTT/CNTT, applied in two or more applicationsor hot asphalt binder of the class and type designated for the asphalt course.

Before overlaying existing surfaces, apply a tack coat to the clean surface according to Section 460. Allow adequate time for tack to break completely prior to placing any material.

(h) Spreading and Finishing. Section 413.3(h) with the following modification:

1. General Requirements.

1.a Placing. Unless otherwise allowed, deliver, place, and compact 6.3 mm paving mixtures during daylight hours. Ensure the mixture does not contain lumps of cold material. Deliver and place 6.3 mm paving mixtures at the laying temperatures specified in Table B.

Utilize a Material Transfer Vehicle (MTV) as specified in Section 108.05(c)5 for 6.3mm paving mixtures unless otherwise approved by the Representative.

1.b Spreading and Finishing. Section 413.3(h)1.b with the following addition:

Plan and schedule operations to minimize hand work of 6.3 mm paving mixtures.

1.c Field Technician. Section 413.3(h)1.c

2. Mixture Lot Acceptance. Section 413.3(h)2 with the following modification:

2.a Lots and Sublots. 413.3(h)2.a.

2.a.1 Partially Completed Lots (n=2 or less). When process conditions change to an extent that a partially completed lot cannot be combined with the most recently completed lot, samples will be independently evaluated on the partially completed lot. For asphalt content and percent passing the 75 µm (No. 200) sieve, mixture acceptance samples will be evaluated individually as specified in Table B (n=1) criteria. For density, mat density acceptance samples will be evaluated individually using the criteria in Table E.

If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve meet the n=1 criteria of Table B, and samples tested for density meet the criteria in Section 413.3(h), Table E, payment will be 100% of the contract unit price. If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve do not meet the n=1 criteria of Table B, the material will be considered defective work.

Unless otherwise directed in writing by the District Executive, remove and replace defective work.

2.b Mixture Acceptance Samples. Section 413.3(h)2.b and add the following to the end of the first paragraph:

If a representative mixture acceptance sample cannot be obtained directly behind the paver, the loose mixture acceptance sample for each sublot may be taken from the paver hopper or from the paver screed representing the sample sublot location. Determine the approved mixture acceptance sample collection method for loose mixture acceptance samples at the preconstruction or prepaving meeting.

2.c Mixture Acceptance Sample Testing. LTS Testing will be utilized unless otherwise indicated in the proposal.

2.c.1 LTS Testing. The LTS will test the mixture acceptance samples according to PTM No. 757 or PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, to determine asphalt content and the percent passing the 75 µm (No. 200) sieve. The LTS will use the calibration factors (C_f and 200 C_f) provided with the JMF for PTM No. 757. The minimum sample size for PTM No. 757 is 1000 grams when 6.3 mm mix is used. For individual increment test results outside of the single sample (n=1) tolerances in Table B, the LTS will analyze the test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 412.3(h)2.a.1. The Department will accept lots with three or more test results as specified in Section 412.4(a)2.

If the asphalt content or the percent passing the 75 µm (No. 200) sieve is not within the single sample (n=1) or multiple sample (n≥3) tolerances in Table B for two consecutive lots or a total of three lots, stop all production of the JMF. Determine the cause of the problem and provide a proposed solution to the Department.

Do not resume production of the JMF until the Representative reviews the proposed solution and authorizes production to continue.

3. Pattern Segregation. Section 413.3(h)3.

4. Flushing. Section 413.3(h)4.

(i) Compaction. Begin rolling immediately after placement of mixture. Compact the 6.33 mm paving mixture to achieve the optimum rolling pattern requirements and to eliminate all roller marks. Compact the mixture while it is in proper condition and adjust roller speed, pattern, and roller size (and/or amplitude and frequency if vibratory rolling

is approved by the Representative) to eliminate displacement, shoving, cracking, and aggregate breakage as specified in Section 412.3(f). Satisfactorily correct displacement resulting from reversing roller directions and other causes. Do not use pneumatic-tire rollers.

Without using excess water, maintain wheels of steel wheel rollers moist and clean to prevent the mixture from adhering to the wheels.

For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

Remove areas that are loose, broken, mixed with dirt, or show an excess or deficiency of asphalt material. Replace removed mixture with fresh, hot 6.3 mm paving mixture and compact the mixture even with the surrounding pavement surface.

(j) Mat Density Acceptance. The Department will accept the mat density based on non-movement and optimum rolling pattern.

1. Non-Movement. The Department will accept the density when the mixture does not move under the compaction equipment.

2. Optimum-Rolling Pattern. With the Representative and the Contractor's certified asphalt field technician present, determine density with an approved nuclear gauge according to PTM 402, or determine density with an approved electrical impedance gauge according to PTM No. 403. Nuclear gauges must be operated by a licensed nuclear gauge operator. In the presence of the Representative, follow the control strip technique specified in PTM No. 402 to construct at least one control strip to establish the optimum rolling pattern for each course. Document readings using the forms provided in PTM No. 402 and provide the completed forms to the Representative. Compact the course according to the optimum rolling pattern. During paving, the Representative may require the Contractor to construct a new control strip to verify the optimum rolling pattern.

Use one of the following gauges or approved equal:

- Troxler Electronics, Model 3411B or Model 4640B
- Campbell Pacific Nuclear, Model MC-2
- Seaman Nuclear, Model MC-2
- TransTech Systems, Inc., PQI™, Model 300 or Model 301
- Troxler Electronic Laboratories, PaveTracker™

Submit a copy of the certificate of nuclear gauge annual calibration according to ASTM D2950 and documentation of training of the nuclear gauge operator. Recalibrate any nuclear gauge that is damaged or repaired.

(k) Joints. Section 413.3(k)

(l) Surface Tolerance. Section 413.3(l)

(m) Tests for Depth: Wearing Courses. Section 413.3(m)

(n) Protection of Courses. Section 413.3(n)

(o) Defective Work. Section 413.3(o)

412.4 MEASUREMENT AND PAYMENT -

(a) Standard 6.3mm Asphalt Construction.

1. Asphalt Courses.

1.a Thin Lift 6.3 mm Asphalt Wearing Course. Square Yard or Ton

1.b Thin Lift 6.3 mm Asphalt Wearing Course (Scratch). Ton

2. Asphalt Tack Coat. Section 460.4

3. Mixture Acceptance by Certification and Density Acceptance by Non-Movement, Optimum-Rolling Pattern. The Representative will pay at the contract unit price, adjusted according to Table D. The total payment factor percentage is the sum of adjustments for each test criterion subtracted from 100%. The adjustment for an individual test criterion is the payment factor percentage subtracted from 100%. The pavement will be considered defective if the payment factor for asphalt content and percent passing the 75 µm (No. 200) sieve are both 85%.

TABLE D
Contract Unit Price Adjustments - Mixture Acceptance by Certification

Mixture NMAS	Test Criteria	Test Value		Payment Factor Percentage
Asphalt Content				
6.3 mm	Printed Tickets	At least 90% of Daily Printed Tickets Within 0.2% of JMF		100
		Less than 90% of Daily Printed Tickets Within 0.2% of JMF		85
6.3 mm	QC Sample Testing**	Single Sample (n=1)	Multiple Samples (n≥2)	
		±0.7%	±0.5%	100
		±0.8% to 1.0%	±0.6%	85
		> ±1.0%	≥ ±0.7%	*
Gradation				
		Single Sample (n=1)	Multiple Samples (n≥2)	
6.3 mm	QC Sample Testing for % Passing 75 µm (No. 200) Sieve**	±3.0%	±2.1%	100
		±3.1% to ±4.0%	±2.2% to ±2.7%	85
		> ±4.0%	≥ ±2.8%	*
Mat Density				
6.3 mm	Non-Movement	Section 412.3(j)1.		100
	Optimum-Rolling Pattern	Section 412.3(j)2.		100

* Defective pavement. Remove and replace or, when permitted by the District Executive in writing, leave in place and the Department will pay 70% of the contract unit price.

** For these test criteria, the daily Payment Factor Percentage will be determined by the single sample test result from the daily QC sample. If more than one QC sample test result is available for a day, the Payment Factor Percentage will be determined based on the average of the results using multiple sample tolerances. If corrective action is taken, Payment Factor Percentages will be separately determined for material placed before and after the corrective action.

4. Mixture Acceptance by Lot and Density Acceptance by Optimum Rolling Pattern. The Department will pay on a lot-by-lot basis at the contract price, adjusted for Payment Factor Percentages as specified in Table E. For the payment factor percentages based on percent within tolerance, the Department will determine the percent within tolerance according to Section 106.03(a)3, using the upper and lower specification limits in Table F.

TABLE E
Contract Unit Price Adjustments - Mixture Acceptance by Lots

Mixture NMAS	Test Criteria	Test Value	Payment Factor Percentage
Asphalt Content			
6.3 mm	Acceptance Sample Testing	All individual sublot acceptance sample test results for the lot (n=1) are within ± 0.6% and the lot average (n≥3) is within ± 0.4%*	100
		Percent Within Tolerance if any individual sublot acceptance sample test result for the lot is not within the n=1 tolerances or the lot average is not within the n≥3 tolerances listed above.	Table G
Gradation			
6.3 mm	Acceptance Sample Testing for % Passing 75µm (No. 200) Sieve	All individual sublot acceptance sample test results for the lot (n=1) are within ± 3.0% and the lot average (n≥3) is within ± 2.0%*	100
		Percent Within Tolerance if any individual sublot acceptance sample test result for the lot is not within the n=1 tolerances or the lot average is not within the n≥3 tolerances listed above.	, Table G
Mat Density			
6.3 mm	Optimum-Rolling Pattern	Section 412.3(j)2	100

* The Department may elect to randomly select and test only one sublot acceptance sample from each lot to determine conformance to the specifications. If only one sublot acceptance sample is tested, tighter tolerances will be used to determine conformance to the specifications for the entire lot. If the one sublot is within ±0.2% of the JMF for asphalt content and within ±1.0% of the JMF for percent passing the 75 µm (No. 200) sieve, the lot will be considered to conform with the specifications and the lot's payment factor percentage will be determined according to this table. If the one sublot fails to meet the tighter tolerances, all acceptance samples from the lot will be tested to determine the payment factor percentage according to this table.

TABLE F
Upper and Lower Specification Limits for Calculating Percent Within Tolerance

	Testing Criteria	
Mixture NMAS	**Lower Specification Limit (L)**	**Upper Specification Limit (U)**
	Asphalt Content from JMF Value, %	
6.3 mm	-0.4	+0.4
	Percent Passing the 75 µm (No. 200) sieve from JMF Value, %	
6.3 mm	-2.0	+2.0

TABLE G
Payment Factor Based on Percent Within Tolerance

Percent Within Tolerance	Payment Factor Percentage
99	97
98	97
97	97
96	96
95	96
94	96
93	95
92	95
91	95
90	95
89	93
88	91
87	90
86	88
85	86
84	84
83	83
82	81
81	79
80	78
79	76
78	74
77	72
76	71
75	69
74	67
73	66
72	64
71	62
70	60
69	59
68	57
67	55
66	54
65	52
64	50
Less than 64	Defective Lot**

**Remove and replace the lot. If only one lot characteristic has a percent within tolerance less than 64, the District Executive may allow the Contractor to leave the defective lot in place. The Department will pay for the defective lot at 70% of the contract unit price.

4.a Payment. The Representative will compute the percent of the contract unit price paid as follows:

$$\text{Lot Payment} = C_P(2P_D + P_B + P_A)/400$$

C_P = Contract unit price per lot (unit price times lot quantity)

P_D = Payment Factor Percentage for density

P_B = Payment Factor Percentage for asphalt content.

P_A = Payment Factor Percentage for percent passing the 75 µm (No. 200) sieve

4.b Dispute Resolution. For mixture acceptance testing performed by the LTS, the Contractor may request in writing that the Department retest a lot if the initial test results indicated a defective lot (remove and replace). Provide written retest requests to the District Executive within 3 weeks of the date the LTS test results are released. Retests will not be allowed if a written retest request is not received within 3 weeks of the date the LTS test results are released. Provide quality control test results and control charts, companion sample test results (if available), test data trend evaluation, and any other pertinent information to justify the retest request. The Department will evaluate the information and may allow retesting if the information submitted provides a reasonable basis to conclude that the failing test results may not represent the in-place material. The LTS will perform the retest with the Contractor present, unless otherwise agreed to in writing with the Contractor.

For retesting of materials failing for asphalt content or percent passing the 75 µm (No. 200) sieve, the Inspector will identify the locations where the original box samples were collected. The Inspector will select retest sample locations 24 inches from the original sample locations longitudinally in the direction of traffic. If the 24 inch offset causes the retest sample location to fall outside of the sublot, the Inspector will select the retest sample location 24 inches from the original sample locations longitudinally in the opposite direction from traffic.

With the Inspector present, provide appropriate traffic control and drill two 6-inch diameter cores at each retest sample location for retesting purposes. Rinse all retest cores thoroughly with water immediately after drilling to remove all loose material on the core from the drilling operation. Within 24 hours after coring, backfill the holes with asphalt mixture of the same JMF or with asphalt mixture used for subsequent courses and compact and seal the asphalt mixture. Provide traffic control, core, and backfill the core holes at no cost to the Department. The test method used for asphalt determination during the original acceptance testing (PTM No. 757 or PTM No. 702) will be used for the retest, unless the (DME/DMM) grants written approval for a change in test method. The results of the retest cores will be used to calculate payment for both asphalt content and percent passing the 75 µm (No. 200) sieve for the lot.

The Department will deduct from the payment the cost per lot associated with conducting a retest as follows in Table H:

TABLE H
Dispute Resolution Retest Cost Table

Test Method	Mixture Acceptance Retest Cost if Retest Results Indicate 100% Pay Factor(s)*	Mixture Acceptance Retest Cost if Retest Results Indicate <100% Pay Factor(s)
PTM No. 702/739	$900	$3,500
PTM No. 757	$500	$2,000

SECTION 413—SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED ASPHALT COURSES WITH PERCENT WITHIN LIMITS AND LTS TESTING (PWL-LTS)

413.1 DESCRIPTION—This work is the Standard and RPS construction of a plant-mixed, dense-graded, asphalt pavement course on a prepared surface using a volumetric asphalt mixture design developed with the Superpave Gyratory Compactor (SGC), using prescribed manufactured additives or modifiers, or plant process modifications or both. Acceptance of the work is based on testing of field samples by the LTS and statistical evaluation of sample test results by Percent Within Limits (PWL) procedures.

413.2 MATERIALS—Do not incorporate any materials into the asphalt mixture that are not specified including additives, rejuvenators, or other materials.

(a) Asphalt Material

1. Virgin Mix, Mix Containing 5% to 15% RAP, or Mix Containing 5% Recycled Asphalt Shingles (RAS). Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative a copy of a signed Bill of Lading for asphalt binder on the first day of paving and when the batch number changes.

2. Mix Containing More than 15% RAP or Mix Containing Both 5% RAS and 5% or More RAP. The LTS will evaluate the asphalt binder in the RAP and, if applicable, the RAS source material. The LTS will determine the class (grade) of asphalt binder that the Contractor is required to use in the mixture.

Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative a copy of a signed Bill of Lading for asphalt binder on the first day of paving and when the batch number changes.

3. WMA Technology Additives or Modifiers Blended at the Asphalt Binder Supplier's Refinery or Terminal. Provide refinery or terminal blended asphalt binder blended with a WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15. Include in the asphalt binder Producer QC Plan, the WMA Technology additive or modifier manufacturer name, WMA Technology name, and source, dosage rates, blending method, QC testing, corrective action points, disposition of failed material, storage, handling shipping, and bill of lading information as specified in Section 702. Include the WMA Technology additive or modifier and dosage rate on the bill of lading. Provide refinery or terminally blended asphalt binder modified with the WMA Technology additive or modifier as specified in Section 413.2(a)1 or Section 413.2(a)2 for the specified grade.

4. WMA Technology Additives or Modifiers Blended at the Asphalt Mixture Producer's Plant. Provide a blended asphalt binder consisting of an approved WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15 that is blended with a base asphalt binder of the specified grade conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25 and from an approved source listed in Bulletin 15, Section 702. Prepare a Producer QC Plan as specified in Section 106 and conforming to the Producer QC Plan requirements as specified in Section 413.2(e)1.a . Provide asphalt binder blended with the WMA Technology additive or modifier at the asphalt mixture production plant as specified Section 413.2(a)1 or Section 413.2(a)2 for the specified grade.

(b) Aggregate and RAM.

1. General Requirements. Provide aggregate from sources listed in Bulletin 14. Aggregate and RAM shall conform to the quality requirements for Superpave Asphalt Mixture Design according to Bulletin 27. For wearing courses, provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor

may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends are 50% by mass (weight) of each aggregate. Blend the aggregates using an approved method. Do not use 4.75 mm asphalt mixtures in applications that require an SRL designation higher than L.

2. Fine Aggregate. Section 703.1, except Table A gradation does not apply and as follows:

Determine the uncompacted void content according to AASHTO T 304, Method A, or use the value listed in Bulletin 14, and ensure the uncompacted void content conforms to AASHTO M 323, Table 6. Determine the sand equivalent value according to AASHTO T 176 and ensure the sand equivalent value conforms to AASHTO M 323, Table 6.

3. Coarse Aggregate. Section 703.2, Type A, except Table C gradation does not apply and revise the following quality requirements of Table B:

- Abrasion, Maximum Percent according to Bulletin 27, Chapter 2A, Table 5A
- Thin and Elongated Pieces, Maximum Percent according to AASHTO M 323, Table 6, for Flat and Elongated
- Crushed Fragments, Minimum Percent, according to AASHTO M 323, Table 6, for Fractured Faces, Coarse Aggregate

(c) Recycled Asphalt Material

1. RAP. If RAP material is proposed for use in the mixture, use at least 5% RAP consisting of cold milled or crushed asphalt mixture. Include a plan to control RAP and the procedures to handle RAP of significantly different composition in the producer QC Plan. Maintain all processed material free of foreign materials and minimize segregation. Process the RAP so that the final mixture meets requirements as specified in Section 413.2(e).

2. Manufacturer Waste Recycled Asphalt Shingles (RAS). If RAS material is proposed for use in the mixture, use 5% RAS by mass (weight) of the total mixture consisting of manufacturer waste shingles that are rejected asphalt shingles or shingle tabs that are discarded in the manufacturing process of new asphalt roofing shingles. Do not use post-consumer asphalt roofing shingles that are removed from the roofs of existing structures. Due to significant composition differences, keep rejected asphalt shingles manufactured with fiberglass felt or paper or organic felt separate. Do not use both fiberglass felt, and paper or organic felt asphalt roofing shingles in the same mixture. Obtain certification, as specified in Section 106.03(b)3, from the manufacturer of the waste shingles certifying that the waste shingles were discarded during the manufacturing process of new asphalt roofing shingles and certifying the type of felt used during manufacturing of the waste shingles. Maintain and provide the Representative access to all certification records for manufacturer waste shingles.

Process RAS material by shredding, screening or other methods so that 100 percent passes the 9.5 mm (3/8 inch) sieve. RAS may be uniformly blended with fine aggregate as a method of preventing the agglomeration of RAS material. If RAS and fine aggregate are blended, blend at 50% by mass (weight) of each material.

Include a plan to stockpile and control RAS and the procedures to handle RAS of significantly different composition in the producer QC Plan. Maintain all processed material free of foreign materials and minimize segregation. Process the RAS so that the final mixture conforms to Section 413.2(e).

(d) Filler. Section 703.1(c)1. Do not use fly ash if the design traffic is greater than or equal to 3 million Equivalent Single Axle Loads (ESALs).

(e) Mixture Composition for Standard and RPS Construction.

1. Virgin Material Mixtures. Size, uniformly grade, and combine aggregate fractions, asphalt binder, and either WMA Technology additive(s) or modifier(s) in proportions to produce a JMF that conforms to the material, gradation, and volumetric Superpave Asphalt Mixture Design requirements according to Bulletin 27, Chapter 2A. Produce an asphalt mixture for the specified nominal maximum aggregate size and design ESALs except as procedurally modified by the WMA Technology Manufacturer Technical Representative (Technical Representative) to address laboratory procedures when preparing, compacting and testing asphalt mixtures to achieve a uniform blend.

Special additive(s) or modifier(s) need not be used if mixture temperature, workability, and compaction can be achieved solely through plant mechanical modification to produce foamed asphalt. Do not incorporate the WMA Technology additive, modifier or process during the volumetric asphalt mixture design process, so that the JMF volumetrics and material percentages are based on a mixture with no WMA Technology. Only use the WMA Technology additive, modifier or process to evaluate results from moisture susceptibility testing during the mix design process. Develop an asphalt mixture JMF, then incorporate the WMA Technology additive, modifier, or process into that JMF during production. Create an asphalt JMF cover sheet (Form TR-448A) for approval containing the WMA Technology used, additive dosage rate or percent water added for foaming, material code, and the TSR data from the moisture susceptibility testing.

Submit a copy of each completed JMF, signed by a certified Asphalt Level 2 plant technician, to the DME/DMM at least 3 weeks before the planned start of mixture production. Include a list of all material sources and the asphalt mixture producer in the JMF. Provide the calibration factors (C_f and 200 C_f) according to PTM No. 757 with the JMF. Do not start mixture production until after the DME/DMM reviews the JMF.

Submit a new JMF with a change in material sources or if a new JMF is necessary to produce a mixture conforming to this specification.

1.a Producer QC Plan. Each producer must prepare a QC Plan as specified in Section 106 and conforming to the additional QC requirements of this specification. Submit the QC Plan to the DME/DMM annually at least 3 weeks before the planned start of mixture production and do not start production until the DME/DMM reviews the QC Plan.

1.a.1 QC Organization Chart.

- Names of personnel responsible for QC.
- Area of responsibility of each individual.
- List outside agencies, (e.g., testing laboratories) and a description of services provided.

1.a.2 Testing Plan with Action Points.

- List of all tests to be performed.
- Frequency of testing.
- List action points to initiate corrective procedures.
- Recording method to document corrective procedures.
- Procedures for conducting JMF verification testing.

1.a.3 Materials Storage and Handling.

- Aggregate/RAP/RAM/RAS stockpiles.
- Cold-feed systems for aggregates/RAP/RAM/RAS.
- Additives or modifiers for mixture
- Modified asphalt/liquid additive storage tanks.
- Surge/storage silos for mixture. Do not store more than one JMF in a surge/storage silo at any given time.
- All measuring and conveying devices, including calibration procedures.

- Haul vehicle loading procedures.
- WMA Technology additive or modifier manufacturer name, WMA Technology name, and source as listed in Bulletin 15.
- WMA Technology additive or modifier storage and handling before blending.
- All measuring, conveying and blending devices for the WMA Technology and anti-strip additive (if required), including calibration procedures.
- WMA Technology additive or modifier and anti-strip additive (if required) method of introduction, dosage rates, blending with the asphalt binder and method of automation, recordation and print outs.
- Storage and handling of the blended asphalt binder with the WMA Technology additive or modifier.
- Asphalt production temperature range for normal paving and any specific temperature ranges for special conditions or situations.
- Asphalt laboratory compaction temperature for QC volumetric analysis. Determine the SGC compaction temperature for the production QC which yields the same target air voids as the designed JMF.

1.b Plant Technicians. During mixture production, provide a certified Asphalt Level 1 plant technician at the plant and an on-call certified Asphalt Level 2 plant technician, both meeting the requirements according to Publication 351. Instruct and train the certified technicians to perform all tests and to control plant operation. The Department may use its own certified Asphalt plant technicians to verify tests and to work in coordination with the producer's technicians. All technicians must carry a valid certification card during mixture production.

1.c Annual JMF Verification. During initial production of each JMF, verify, according to the QC Plan, that the mixture conforms to this specification. If the mixture does not conform to the single and multiple sample tolerances in Tables A and B within 2 days of production, suspend shipping the mixture to the project. Do not ship the mixture to the project until after the Representative reviews and verifies that results conform to the single and multiple sample tolerances in Tables A and B. During JMF verification, mixture acceptance is according to the approved acceptance level of Table C.

1.d Production. After JMF verification, sample and test the mixture according to the QC Plan. For daily production of each JMF greater than 50 tons, determine asphalt content, gradation, and theoretical maximum specific gravity from the same sample at least once each day. For daily production of each JMF greater than 150 tons, determine asphalt content, gradation, theoretical maximum specific gravity and perform volumetric analysis of compacted specimens from the same sample at least once each day. Perform additional sampling and testing as directed. Produce a mixture within the following production limits:

1.d.1 Apparent Moisture Content. If the water absorption of a coarse aggregate, determined according to AASHTO T 85, exceeds 2.0%, sample the mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Determine the apparent moisture content in the mixture according to PTM No. 749. Produce a mixture with the apparent moisture content not to exceed 0.5%.

1.d.2 Asphalt Content. Include in the producer QC Plan a frequency of obtaining mixture samples according to PTM No. 1 and performing asphalt content tests to verify that the mixture conforms to the tolerances of Table A. Test the samples according to either PTM No. 757, PTM No. 702, or PTM No. 742. After obtaining a minimum of three test results, determine compliance with the multiple sample tolerances in Table A. After obtaining five or more test results, determine compliance with the multiple sample tolerances in Table A using the running average of the last five consecutive test results.

Printed ticket results may be used in place of laboratory test results for QC of asphalt content of the mixture

if the producer is currently approved to use printed tickets according to Bulletin 27. During mixture production, maintain 90% of printed ticket results for each day of production within 0.2 percentage points of the JMF. If RAP or RAS is used in the mixture, determine asphalt content by testing samples of the completed mixture.

1.d.3 Gradation. Sample the completed mixture, or sample the combined aggregate from the hot bins of a batch plant or the combined aggregate belt of a drum plant, according to PTM No. 1 and at the frequency in the producer QC Plan. If mineral filler, RAP, or RAS are used in the mixture, determine gradation by testing samples of the completed mixture.

- Test the completed mixture according to PTM No. 757 or according to PTM No. 702 and PTM No. 739.
- Test combined aggregate samples according to PTM No. 743.

Produce a mixture within the tolerances of Table A. Determine compliance with the multiple-sample tolerance after obtaining a minimum of three test results for the mixture. After obtaining five or more test results for the mixture, determine compliance with the multiple-sample tolerances using the running average of the last five consecutive test results.

1.d.4 Theoretical Maximum Specific Gravity. Sample the mixture according to PTM No. 1 at the frequency required in Bulletin 27. Condition and test the samples according to Bulletin 27.

Calculate the percentage of unfilled voids and the theoretical maximum density of the mixture using the most recently determined theoretical maximum specific gravity value or average value according to Bulletin 27. Certify the theoretical maximum specific gravity value to the Inspector daily using Form CS-4171B. If the theoretical maximum specific gravity value varies 0.030 or more from the previous test or from the JMF value, immediately notify the DME/DMM.

1.d.5 Volumetric Analysis of Compacted Specimens. Sample the completed mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Prepare a minimum of two specimens from each sample according to AASHTO T 312.

Produce a mixture with volumetric properties conforming to the tolerances of Table B. Determine the bulk specific gravity of the specimens according to AASHTO T 312 and calculate air voids (V_a) and Voids in Mineral Aggregate (VMA) at N_{design} according to AASHTO R 35 and according to Bulletin 27. Determine compliance with the multiple specimen tolerances using the average of the results for all specimens prepared from the sample.

TABLE A
Job-Mix Formula
Composition Tolerance Requirements of the Completed Mix

	Single Sample (n = 1)	**Multiple Samples (n ≥ 3)**
Gradation		
Passing 12.5 mm (1/2 inch) and Larger Sieves	±8%	±6%
Passing 9.5 mm (3/8 inch) to 150 µm (No. 100) Sieves (Inclusive)	±6%	±4%
Passing 75 µm (No. 200) Sieve	±3.0%	±2.0%
Asphalt Content		
19.0 mm Asphalt mixtures and smaller	±0.7%	±0.4%
25.0 mm Asphalt mixtures and larger	±0.8%	±0.5%

Temperature of Mixture (F)				
Class of Material	**Type of Material**	**Chemical, Organic, Foaming Additives Minimum***	**Mechanical Foaming Equipment/Process Minimum***	**Maximum***
PG 58S-28	Asphalt Binder	215	230	310
PG 64S-22	Asphalt Binder	220	240	320
PG 64E-22	Asphalt Binder	240	260	330
All other Binders	Asphalt Binder	The higher of 215 or the minimum temp. specified in Bulletin 25 minus 45F	The higher of 230 or the minimum temp. specified in Bulletin 25 minus 30F	As specified in Bulletin 25
* Outline in the Producer QC Plan and follow more restrictive temperature requirements provided by the WMA technology manufacturer or Technical Representative(s) for production and placement of the mixture. Determine the SGC compaction temperature for the production QC which yields the same target air voids as the designed JMF . Include the SGC compaction temperature in the Producer QC Plan. Compact the completed mixture in the SGC for QC volumetric analysis at the SGC compaction temperature according to the guidelines provided by the Technical Representative.				

TABLE B
Job-Mix Formula
Volumetric Tolerance Requirements of the Laboratory Compacted Mix

Property	**Each Specimen**	**Multiple Specimens**
Air Voids at N_{design} (V_a)	(±2%)	(±1.5%)
Minimum VMA % for 4.75 mm	16.0	-
Minimum VMA % for 9.5 mm	15.0	-
Minimum VMA % for 12.5 mm	14.0	-
Minimum VMA % for 19.0 mm	13.0	-
Minimum VMA % for 25.0 mm	12.0	-
Minimum VMA % for 37.5 mm	11.0	-

1.e Corrective Actions. Immediately take corrective actions if one or more of the following occurs:

- QC test results on a single sample (n=1) for percent passing the 2.36 mm (No. 8) sieve, the 75 µm (No. 200) sieve, or asphalt content are not within the tolerances in Table A.
- The average of multiple samples (n≥3) for percent passing any sieve or asphalt content, as determined as specified in Section 413.2(e)1.d, are not within the tolerances in Table A.
- QC test results on each specimen or on multiple specimens are not within the tolerances in Table B.
- Independent assurance (IA) or QA sample results tested at the producer's plant are not within the tolerances of Tables A or B.

After taking corrective actions, sample the completed mixture within 150 tons of production. After sampling, test the mixture and provide test results to the Representative within 500 tons of production. If less than three samples are tested for mixture composition, determine conformance with Table A by comparing each result to the multiple sample tolerances. If the mixture does not conform to the single and multiple sample tolerances in Table A and the single and multiple specimen tolerances in Table B, suspend production and shipping to the project and determine the cause of the problem. Provide a written explanation of the problem and a proposed solution to the Department. After the Representative reviews the proposed solution and authorizes production to continue, resume production and

perform JMF verification according to the QC Plan. During corrective actions and JMF verification, mixture acceptance is according to the approved acceptance level of Table C.

2. Mixtures with RAM, 5% or More RAP, and/or 5% RAS. Section 413.2(e)1 and as follows:

2.a RAM and RAP SRL. For asphalt wearing courses, limit the total combination of RAM and RAP to a maximum of 15% of the mixture by mass (weight) unless documentation of the SRL designation of the coarse aggregate in the RAM and RAP materials is provided to the DME/DMM and the RAM and RAP meet the specified SRL or can be blended for SRL as specified in Section 413.2(b)1.

2.b RAP and/or RAS Asphalt Content and Gradation. Determine the average asphalt content and gradation of the RAP and/or RAS stockpile(s) according to Bulletin 27. Determine the proportions of RAP, RAM, RAS, and virgin materials necessary to conform to the JMF requirements. Maintain and provide the Representative access to records of all sampling, testing, and calculations.

(f) WMA Technologies (Additive(s), Modifier(s), or Processes) Produce the asphalt mixture using approved or provisionally approved WMA Technologies, including additives, modifiers or processes from manufacturers listed in Bulletin 15. If blending WMA additives or modifiers with asphalt material, provide asphalt material blended with the WMA additive or modifier as specified in Section 413.2(a)3 or Section 413.2(a)4. For WMA Technology additives or modifiers blended with the asphalt mixture at the asphalt mixture production plant, prepare a QC Plan as specified in Section 106 and also conforming to the additional Producer QC Plan requirements within this specification. Submit the QC Plan to the DME/DMM annually and at least 3 weeks before the planned start of the blending of WMA Technologies with asphalt material. Do not start blending until the DME/DMM reviews the QC Plan.

(g) Anti-Strip Additives. Use either a compatible, heat stable, amine-based liquid anti-strip or a compatible alternate anti-strip additive. If the WMA Technology includes an anti-strip additive as part of its WMA Technology, perform moisture susceptibility analysis as specified in Section 413.2(e)1 and add additional anti-strip additive or make other adjustments to the JMF if needed to meet the specified moisture susceptibility requirements.

(h) WMA Technology Manufacturer Technical Representative (Technical Representative). If the Asphalt Producer is using a provisionally or conditionally approved WMA Technology listed in Bulletin 15 or is using a fully approved WMA Technology for the very first time, identify one or more Technical Representative(s) that are knowledgeable in how the WMA Technology will affect the storage, handling, blending, mixture production, mixture QC testing, placement and compaction requirements of the mix. Have one or more Technical Representative(s) on-call and capable of being in direct, verbal contact with the Producer, Contractor, and/or Department within 2 hours after initial contact. Have one or more Technical Representative(s) review the Producer's QC Plan to ensure that all of the data as specified in Sections 413.2(e) 1.a.2 and 413.2(e) 1.a.3 are supported according to current manufacturer's recommendations. Include the Technical Representative's office and mobile telephone numbers in the Producer's QC Plan.

(i) Mixture Acceptance.

1. General. For standard construction, the Department will accept the mixture according to the appropriate level in Table C. For RPS construction, the Department will accept the mixtures by lot acceptance as specified in Section 413.3(h)2.

TABLE C
Mixture Acceptance

Acceptance Level	Acceptance Method
Certification Acceptance	Producer Certification of Mixture (Section 413.2(i)2)
Lot Acceptance	Mixture Acceptance Sample Testing (Section 413.3(h)2)

2. Certification Acceptance. Acceptance by certification is appropriate for the following mixtures, conditions, or applications:

- Scratch courses, leveling courses less than 2 inch depth and driveway adjustments.
- Mixtures used by Department maintenance forces.
- Mixtures purchased by local or municipal governments.
- Mixtures placed in quantities not exceeding 500 tons in a continuous placement operation unless otherwise directed by the Representative (See Section 101.01).
- Mixtures used for parking lots.
- All 4.75 mm NMAS asphalt mixtures.
- Other mixtures, conditions, or applications as approved by the Representative (See Section 101.01).

2.a General. Obtain certification from the mixture producer. Use all QC tests during mixture production as acceptance tests. Certify mixtures using Form CS-4171B. Include, or attach, the QC test results on the form. Provide the form to the Inspector-in-Charge within 1 working day after completing the QC tests. Certify mixtures as specified in Section 106.03(b)3 and the requirements below.

2.b Certification of Mixture. Certify each mixture daily if QC test results conform to the single sample and multiple sample JMF production tolerances of Table A. The acceptance values will be:

- Asphalt Content
- Percent Passing the 2.36 mm (No. 8) sieve (not applicable for 4.75 mm NMAS asphalt mixtures)
- Percent Passing the 75 μm (No. 200) sieve

If using printed ticket results in place of laboratory test results for asphalt content, certify that at least 90% of each day's printed ticket results for asphalt content are within 0.2 percentage points of the JMF.

If the mixture does not conform to the above requirements, do not certify the mixture. Instead, provide all QC test results to the Inspector-in-Charge. If using printed ticket results for asphalt content, provide the percentage of daily printed ticket results within 0.2 percentage points of the JMF to the Inspector-in-Charge. Payment will be determined according to Table H based on the QC test results.

If a day's production is interrupted by corrective action, material produced after the corrective action may be certified if QC test results conform to production tolerances.

2.c Maintaining Approval to Certify Mixtures. The Department may suspend a plant's approval to certify mixtures if QC is not performed according to the producer QC Plan, mixtures are not produced according to Bulletin 27, a mixture cannot be certified on 2 consecutive production days, or as described below.

The Department may take IA samples of the completed mixture at the plant. In the presence of the Department, test the IA samples for asphalt content and gradation according to the test methods indicated in the producer QC Plan. Take immediate corrective actions if the mixture does not conform to Table A.

The Department may take QA samples of the completed mixture at the plant or on the roadway directly from the uncompacted mixture placed by the paving equipment specified in Section 413.3(e). The Department will test QA samples according to PTM No. 757 or PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, for conformance to Table A. If the results of the QA samples do not comply with Table A, review the producer QC Plan and the QC test results that followed the QA samples for conformance to Table A. If QC results do not conform to Table A, perform the corrective actions necessary to provide a mixture conforming to Table A.

After completing corrective actions or the sample review, the Department will perform an on-site evaluation of the producer's plant operation and QC and then take a sample of the completed mixture at the plant. In the presence of the Representative, test the sample. If the sample does not comply with Table A, the Department will suspend certification. Immediately suspend shipping mixtures accepted by certification to the project.

After testing verifies that the produced mixture conforms to Tables A and B and with the Representative present, conduct JMF verification according to the producer QC Plan. After successfully completing JMF verification, resume both certification and shipping mixtures accepted by certification to the project.

413.3 CONSTRUCTION—

(a) Preplacement Requirements.

1. Paving Operation QC Plan. Prepare a paving operation QC Plan, as outlined on Form CS-409, for field control and evaluation of asphalt concrete paving operations that addresses all recommendations and direction from the Technical Representative(s) associated with any WMA Technology being used. Submit the QC Plan to the Representative before or at the pre-construction conference. The QC Plan shall describe the construction equipment and methods necessary to construct and test the asphalt concrete courses as specified in Section 413.3. Do not start paving until after the Representative reviews the QC Plan.

2. Preplacement Meeting. At least 2 weeks before placing asphalt paving mixtures, schedule an asphalt preplacement meeting with the Representative to review at a minimum the specification, paving operation QC Plan, sequence of paving operations, mixture acceptance, density acceptance and the care and custody of asphalt acceptance samples.

(b) Weather and Seasonal Limitations. Do not place any asphalt paving mixtures outside of the following dates, unless an extension of the paving season, as specified in Section 413.3(b)1, is granted in writing by the District Executive.

- For all PG 64E-22 wearing courses, >10 million ESALs wearing courses, 4.75 mm wearing courses, or other wearing courses placed at compacted depths less than 1.5 inches, paving may occur April 1 to October 15.
- For all other courses, paving may occur April 1 to October 31.

Do not place asphalt paving mixtures when surfaces are wet or when the air or surface temperature is 40F or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are en route to the project.

1. Paving Season Extensions. Submit requests in writing for paving outside of the dates listed in Section 413.3(b) at least 14 calendar days before performing any extended-season paving operations. With the written request, submit an Extended-Season Paving Plan on Form CS-409ES that addresses quality control operations in detail. The plan must address steps at the plant and in the field to ensure that a quality product will be delivered and constructed. Do not commence paving during the extended-season until the Representative reviews the Extended-Season Paving Plan.

An extension of the paving season will be granted in writing by the District Executive with the following additional requirements:

- For all PG 64E-22 wearing and binder courses, >10 million ESALs wearing courses, 4.75 mm wearing courses, or other wearing courses placed at compacted depths less than 1.5 inches, paving may occur April 1 to November 15.
- For all other courses, paving may occur March 1 to December 15.
- Density acceptance will be by pavement cores, regardless of quantity, for mixtures placed at the minimum compacted depths in Table G. For pavements not meeting the requirements for pavement cores, density acceptance will be by optimum-rolling pattern. For non-RPS pavements, the Representative may waive the pavement core requirement at their sole discretion provided the contractor's quality control efforts give confidence that optimum density has been achieved throughout the course.
- Utilize a Material Transfer Vehicle (MTV) as specified in Section 108.05(c)5 on any day when the paving length will exceed 1,500 linear feet, unless the Representative determines the MTV to be infeasible for the location.
- Use an approved asphalt JMF, according to the temperature restrictions specified in Section 413, Table A
- Do not ship material to the project until the Representative on the project releases the shipment.
- At least five days before extended-season paving, schedule an extended-season preplacement meeting with the Representative to review, at a minimum, the details of the Extended-Season Paving Plan.
- If the Representative determines that the Extended-Season Paving Plan is not being followed, stop paving operations, modify processes to comply with the Extended-Season Paving Plan, and communicate process

modifications to the Representative. Do not resume paving operations until the Representative authorizes paving operations to continue.

- Within 24 hours of paving completion, provide Form CS-409EQC to the Representative with all documentation and measurements associated with the extended-season paving operations outlined in the Extended-Season Paving Plan. Payment will not be made until the documentation is received.
- Paving work completed during the fall portion of the Extended-Season will be subject to a spring evaluation and manual survey by the Department to be conducted by May 1. Manual surveys will be conducted according to Publication 336. The Department will evaluate the material and workmanship looking at characteristics of fatigue cracking, transverse and miscellaneous cracking, raveling/weathering, rutting, flushing, potholing, joint and edge deterioration, and loss of bond/delamination to determine acceptance or remedial action as outlined below:

Extended Season Paving Performance Requirements and Remedial Actions

Performance Criterion	Threshold Level	Remedial Action
Fatigue Cracking**	All low, medium or high severity*	Remove and replace as specified in Section 496, Table A
Transverse and Miscellaneous Cracking	All low to medium severity*	Crack seal as specified in Section 469
	All high severity*	Remove and replace as specified in Section 496, Table A
Raveling/Weathering	All medium or greater severity*	Remove and replace as specified in Section 496, Table A
Rutting	> ¼ inch	Remove and replace as specified in Section 496, Table A
Flushing	All	Remove and replace as specified in Section 496, Table A
Potholes, Loss of Bond, Delamination	All	Remove and replace as specified in Section 496, Table A for Potholes
Longitudinal Joint or Edge Joint Deterioration	All low severity*	Crack seal as specified in Section 469
	All medium or greater severity*	Remove and replace distressed layer full lane width on both sides transversely of the distressed area and a minimum of 24 inches beyond the distressed area in all longitudinal directions.

* The Threshold Level according to Publication 336.
** Fatigue cracking will only be considered in those portions of the pavement under which the contractor has performed base course placement operations

The Department will solely make the determination and notify the Contractor whether the work is accepted or remedial action is required. The contractor may witness the manual performance survey. As specified in 413.3(o), the BOPD, CMD will review representative determinations of defective material or workmanship. Remove and replace or repair defective work as directed at no additional cost to the Department. Should the distance between repair areas be less than 100 feet, make one continuous repair. All repairs must meet the surface tolerance requirements as specified in Section 413.3(l).

- A Final Acceptance Certificate will not be issued for paving completed during the extended season until the spring evaluation and any repair work is completed.
- Any necessary changes to means, methods, or materials are at no additional cost to the Department. Complete all work by the Required Completion Date or Construction Engineering Liquidated Damages, as specified in Section 108.07(a), will apply. If repairs are required following the spring evaluation, liquidated damages will not be applied during the winter shutdown period on the project and will be applied during the repair and associated work period.

(c) Asphalt Mixing Plant. Obtain asphalt mixtures from a plant fully automated and recordated and currently listed in Bulletin 41. Make any plant modifications, if needed, to introduce the WMA Technology additives, modifiers, or processes according to specific recommendations and direction from the WMA Technology Technical Representative(s) or process manufacturer to achieve a uniform blend of the WMA Technology additive, modifier or foaming process. The necessary facilities for inspection include a plant office as specified in Section 714.5(a), except the minimum floor space is 120 square feet. For recycled mixtures, add the following requirements:

1. Batch Plant. Modify the batch plant to measure the mass (weight) of the RAP and/or RAS before adding it into the pug mill. Design the cold-feed bin(s), conveyor system(s), charging chute(s), and all special bins to prevent RAP and/or RAS from segregating and sticking. Dry the virgin aggregate and RAM and then heat the virgin aggregate and RAM to a temperature that, after adding RAP and/or RAS, produces a completed mixture within the temperatures specified in Table A for the class and type of material used. Dry the aggregate according to the specific recommendations and direction from the WMA Technology Technical Representative(s) and heat to a temperature so the resulting completed mixture temperature is within the mixture temperature recommended by the WMA Technology Technical Representative(s) or manufacturer and Table A. Ensure that the aggregate is free of unburned fuel oil and excess moisture as specified in Section 413.2(e) 1.d.1 when delivered to the pug mill.

2. Drum Mixer Plant. Modify the drum mixer plant to prevent RAP and/or RAS from directly contacting the burner flame and prevent RAP and/or RAS from overheating. Design the cold-feed bin(s), conveyor system(s), charging chute(s), and all special bins to prevent RAP and/or RAS from segregating and sticking. Produce a completed mixture that is within the mixture temperature range recommended by the WMA Technology Technical Representative(s) or manufacturer and Table A. Ensure that the aggregate and completed mixture is free of unburned fuel oil and excess moisture as specified in Section 413.2(e) 1.d.1.

(d) Hauling Equipment. Haul the mixtures in tightly sealed vehicles that do not contain petroleum oils, solvents, or other materials that adversely affect asphalt mixture. Provide covers of sufficient size and quality to protect the entire load under all conditions. Maintain the proper and uniform placement temperature as specified in Section 413.3(h)1. Provide insulation on all sides of the truck body, a double-walled truck body, or a heated truck body when the air temperature is below 50F from October 1 to April 30. Provide a 3/8 inch diameter hole near the center and approximately two-thirds the distance down from the top of the vehicular box, on both sides, to allow for asphalt mixture temperature checks.

(e) Paving Equipment

1. Asphalt Pavers. Provide self-contained, power-propelled units with activated screeds or activated strike-off assemblies and with automatic screed controls, capable of producing a finished surface of specified evenness and texture. Provide heated units capable of spreading and finishing the mixture to the widths and depths indicated. Provide units capable of being operated at forward speeds consistent with satisfactory placement of the mixture, equipped with receiving hoppers having sufficient capacity for uniform spreading, and equipped with distribution systems that place the mixture uniformly in front of the screeds.

Use hydraulic or other extension types against abutting lanes or longitudinal joints only if the unit feeds and activates the extension by the same method as the main screed. For fixed width paving operations on pavers where the screed is fed by augers, provide auger extensions to within 18 inches or less of the end gate. At the outside edge of pavement widths that cannot be uniformly placed, the Contractor may use a non-activated extension when approved by the Inspector-in-Charge.

Do not use equipment that tears, shoves, or gouges the mixture, or that causes tracks, indented areas, flushing, segregation, or other permanent blemishes. Do not use blade graders or drags.

2. Asphalt Wideners. Provide self-contained, power-propelled units with strike-off assemblies capable of producing a finished surface of specified evenness and texture. Provide units capable of spreading and finishing the mixture to the widths and depths indicated. Provide units capable of being operated at forward speeds consistent with satisfactory placement of the mixture, equipped with receiving hoppers having sufficient capacity for uniform spreading, and equipped with distribution systems that place the mixture uniformly in front of the strike-off assemblies.

Do not use equipment that tears, shoves, or gouges the mixture, or that causes tracks, indented areas, flushing, segregation, or other permanent blemishes.

(f) Rollers. Use steel-wheel, pneumatic-tire, vibratory, or oscillating rollers as specified in Section 108.05(c)3a, 3b, 3c, 3e, 3f, 3h, or 4. Operate rollers according to manufacturer's recommendations. Use vibratory and oscillating rollers with separate controls for frequency and amplitude.

(g) Preparation of Existing Surface.

1. Conditioning of Existing Surface. Before delivering asphalt mixtures, remove and dispose of loose and foreign material and excess joint sealer and crack filler from the surface of existing pavement or previously placed pavement courses. If necessary, use a broom.

Before placing a wearing course, correct irregularities in the binder course. If practical, do not allow traffic on the binder course to prevent contamination. Remove and replace binder course that cannot be cleaned to the Representative's satisfaction.

Paint existing vertical surfaces of curbs, structures, gutters, and pavements that will be in contact with asphalt mixtures with a uniform coating of either emulsified asphalt, consisting of PennDOT Material Class TACK or NTT/CNTT and applied in two or more applications, or hot asphalt binder of the class and type designated for the asphalt course.

Before overlaying existing surfaces and previously placed courses, apply a tack coat as specified in Section 460 unless otherwise indicated.

2. Scratch and Leveling Courses. Where indicated, place a separate scratch or leveling course ahead of resurfacing operations. Use a scratch course to fill wheel ruts and other local small depressions even with the surrounding pavement. Use a leveling course to provide a relatively uniform working platform for placing binder or wearing courses.

3. Paving Notches. Mill the existing pavement surface at tie-in locations of the wearing course as shown on the Standard Drawings, or as otherwise indicated. Perform milling as specified in Section 491.

(h) Spreading and Finishing.

1. General Requirements.

1.a Placing. Unless otherwise allowed or indicated, deliver, place, and compact asphalt paving mixtures during daylight hours. Ensure the mixture does not contain lumps of cold material. Deliver and place mixtures at the laying temperatures specified in Table A for the type and class of material used. Do not incorporate any material delivered outside the temperature limits as specified in Table A

Utilize a Material Transfer Vehicle (MTV) as specified in Section 108.05(c)5 for RPS pavements unless otherwise approved by the Representative (See Section 101.01).

1.b Spreading and Finishing. Spread and strike off the mixture for the entire lane width or as much lane width as practical. Adjust screed assemblies to provide the required cross section and depth. After spreading, do not add mixture to the pavement mat that is segregated, below the minimum temperature, contains either a deficiency or an excess of asphalt content, or is otherwise unsuitable to add to the pavement mat.

If the course is more than 6 inches in compacted depth, construct it in two or more layers of approximately equal depth, with no layer less than 3 inches or more than 6 inches in compacted depth. For binder or leveling courses that have isolated areas exceeding 6-inch compacted depth, use a scratch or leveling course to eliminate the isolated areas before full-depth paving.

Immediately after placing the asphalt mixture, work the exposed outer edges to eliminate sharp, ragged, and open edges, to eliminate an unfinished appearance, and to reduce edge breakdown. Immediately repair edge breakdowns.

In areas where mechanical spreaders cannot be used, place and screed the mixture with suitable hand tools. Do not use rakes.

Adjacent to flush curbs, gutters, and other abutting structures, place the wearing course mixture uniformly higher so that after compaction the finished surface is slightly above the edge of the abutting structure. Remove harmful material, clean, and seal the surface of wearing courses adjacent to curbs to form an asphalt gutter. Seal the mixture surface with a hot asphalt material of the class and type listed in Table A. Evenly apply the asphalt material a minimum width of 12 inches from the curb. The Contractor may use emulsified asphalt, consisting of PennDOT Material Class TACK or NTT/CNTT, instead of hot asphalt binder material if allowed by the Inspector-in-Charge.

Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint along the curb. If necessary, apply emulsified asphalt in two or more applications. After sealing, remove excess sealant material.

1.c Mixture Production, Delivery and Placing Temperatures When Placing Over Membrane Systems as Specified in Section 467 or Section 680. If a project includes an item or items of work for membrane systems, as specified in Section 467 or Section 680, produce and place asphalt mixture on top of the membrane at elevated mixture temperatures as per the membrane manufacturer's recommendation and within the Table A temperature requirements. Ensure proper adhesion between the asphalt pavement overlay and the underlying membrane.

1.d Field Technician. Provide a certified asphalt field technician, with the qualifications according to Publication 351, to control the placement of asphalt mixtures. Instruct and train the certified asphalt field technician to control the paving operation so that the completed paving work complies with the specified requirements. A certified asphalt field technician must be onsite and carry a valid certification card during placement of all asphalt mixtures.

1e. Safety Edge. Construct the Safety Edge as the standard edge treatment on the outside edge of asphalt pavements and shoulders. Use the Safety Edge for both wearing and binder courses with a depth of 1.5 inches or greater. Do not place the Safety Edge at total depths greater than 5 inches. The Safety Edge is not required where curb or sidewalk are encountered or where the face of guiderail is directly over the edge of pavements. Do not place the Safety Edge for base, leveling, or scratch courses.

Construct the Safety Edge with the same material used to construct the roadway course being placed or, if specified, the paved shoulders. Attach a device to the paver to confine material at the end gate and extrude the asphalt material in a wedge shape. Use an adjustable device that allows the operator to vary the slope extruded at the paver to account for the angle becoming steeper during compaction (roll up). Before construction, the Safety Edge device must be approved by the Representative(s) (See Section 101.01).

Compact the roadway or paved shoulder as required by the specifications. Do not delay rolling of the mat adjacent to the Safety Edge. After compaction of the mat is complete, provide a Safety Edge meeting the final shape requirements as shown on the Standard Drawings. The completed angle of the Safety Edge must be 26 to 40 degrees measured from the pavement cross slope extended. At the beginning of each days paving, measure the angle of the Safety Edge from the pavement cross slope extended. Perform measurements after final compaction is complete. If the angle of the Safety Edge does not meet the slope requirements, stop paving and provide corrective action. Do not resume production paving until final shape requirements of Safety Edge are achieved.

Allow automatic transition to intersections, driveways, guiderail sections, and obstructions.

Use the device to constrain the asphalt head, reducing the area and increasing the density of the extruded profile. A single plate strike-off method is not allowed. Do not place the Safety Edge on organic material.

2. Mixture Lot Acceptance (Standard and RPS Construction). Lot acceptance is appropriate for standard construction placed in quantities that allow consistent operation of the plant and is appropriate for RPS construction.

2.a Lots and Sublots. Material will be accepted in the field on a lot by lot basis. Lots will be established cumulatively and will be specific for each JMF. Each lot consists of five equal sublots (n=5). A completed sublot has a mixture acceptance box sample as specified in Section 413.3(h)2.b and either a core collected according to PTM No. 1 and PTM No. 729, or other density acceptance as specified in Section 413.3(j).

A normal lot size is 2,500 tons with five, 500 ton sublots (n=5), unless operational conditions or project size dictate otherwise. If operational conditions or project size dictate, readjustment of the lot will be made as specified in Table D. Breakdowns or stoppages of short periods due to such causes as weather or equipment failure will not be considered as reasons to adjust the lot size. The original lot will be continued when work resumes after short stoppages of less than 5 calendar days. If a lot is ended due to a stoppage of 5 calendar days or more, adjust the lot size and number of sublots as specified in Table D. If the work stoppage is 5 calendar days or more, a new lot will be established.

To terminate a lot without a work stoppage of 5 calendar days or more, stop paving operations and notify the Inspector-in-Charge in writing of the lot termination and include the reason for termination. Do not begin paving again until the Inspector-in-Charge authorizes paving activities to resume. If a lot is terminated when quantities exceed a normal size lot of 2,500 tons, the work will be considered two separate lots, a normal size lot and a terminated lot. The terminated lot will be only that portion of the work which exceeds the 2,500 ton normal sized lot up to the point the paving operations were stopped.

A terminated lot will be evaluated based on the samples obtained before the lot was terminated. For terminated lots with three or more sublots, acceptance will be determined using PWL pay factor adjustments. Terminated lots with two or fewer sublots will be evaluated as specified in Section 413.3(h) 2.a.1. For terminated lots where density acceptance is by pavement cores, if the first randomly selected coring location was not yet reached at the time the lot was terminated, the Inspector will recalculate one new sample location according to PTM No. 1, PTM No. 729, and PTM No. 746 from the pavement placed.

The payment for any terminated lot the Contractor elects to terminate will be 95% of the contract unit price or the payment value determined by evaluating the samples tested, whichever is less. Remove and replace terminated lot pavements when test results indicate defective work. The District Executive will not consider requests for reduced payment on terminated lots when test results indicate defective work.

TABLE D
Re-adjustment of Lot Size and Associated Number of Sublots

Remaining Quantity* Following Last Full Lot	**Action**
Less than 500 tons without a combination of one mixture acceptance sample and one core**	Quantity combined with the previous lot, (n=5)
Less than 500 tons with a combination of one mixture acceptance sample and one core**	One new sublot defined and quantity combined with the previous lot, (n=6)
500 tons to less than 1,000 tons without a combination of two mixture acceptance samples and two cores**	One new sublot defined and quantity combined with the previous lot, (n=6)
500 tons to less than 1,000 tons with a combination of two mixture acceptance samples and two cores**	Two new sublots defined and quantity combined with the previous lot, (n=7)
1,000 tons to less than 1,500 tons without a combination of three mixture acceptance samples and three cores**	Two new sublots defined and quantity combined with the previous lot, (n=7)
1,000 tons to less than 1,500 tons with a combination of three mixture acceptance samples and three cores**	New lot defined, (n=3)
1,500 tons to less than 2,000 tons without a combination of four mixture acceptance samples and four cores**	New lot defined, (n=3)
1,500 tons to less than 2,000 tons with a combination of four mixture acceptance samples and four cores**	New lot defined, (n=4)
2,000 tons to less than 2,500 tons without a combination of five mixture acceptance samples and five cores**	New lot defined, (n=4)
2,000 tons to less than 2,500 tons with a combination of five mixture acceptance samples and five cores**	New lot defined, (n=5)
*For contract items bid on an area basis, compute equivalent tons based on design depth of paving course and design density as specified in Section 110.04(b)4.b. ** If mat density is accepted using pavement cores and mixture acceptance is by lots.	

2.a.1 Partially Completed Lots (n=2 or less). When process conditions change to an extent that a partially completed lot cannot be combined with the most recently completed lot, samples will be independently evaluated on the partially completed lot. For asphalt content and percent passing the 75 μm (No. 200) sieve, mixture acceptance samples will be evaluated individually as specified in Section 413.2(e), Table A (n=1) criteria. For density, mat density acceptance samples will be evaluated individually using the criteria in Table E.

If samples tested for asphalt content and percent passing the 75 μm (No. 200) sieve meet the n=1 criteria of Table A, and samples tested for density meet the criteria in Table E, payment will be 100% of the contract unit price. If samples tested for asphalt content and percent passing the 75 μm (No. 200) sieve do not meet the n=1 criteria of Table A, the material will be considered defective work. If samples tested for density are no more than 2.0% below the minimum or no more than 2.0% above the maximum limits of Table E, payment will be 90% of the contract unit price. If samples for density are more than 2.0% below the minimum or more than 2.0% above the maximum limits of Table E, the pavement will be considered defective work.

Unless otherwise directed in writing by the District Executive, remove and replace defective work.

TABLE E

Density Limits for Partially Completed Lots

MIXTURE NMAS	DENSITY LIMITS
All RPS 9.5 mm, 12.5 mm, 19 mm, and 25 mm Wearing or Binder Courses	≥ 92.0% and ≤ 98.0%
All Standard 9.5 mm, 12.5 mm, 19 mm, and 25 mm Wearing or Binder Courses	≥ 91.0% and ≤ 98.0%
All 25 mm and 37.5 mm Base Courses	≥ 90.0% and < 100.0%

2.a.2 For JMF's placed in quantities less than 2,500 tons. For JMF's placed in quantities of greater than 500 tons and less than 2,500 tons, the tonnage will be considered a lot. The lot will be divided into five equal sublots.

For JMF's placed in quantities of 500 tons or less, mixture acceptance will not be applicable for PWL pay factor adjustments and will be accepted by certification. If density acceptance is by pavement cores, the tonnage will be considered a lot and the lot will be divided into three equal sublots. Density acceptance will be determined using PWL pay factor adjustments.

2.b Mixture Acceptance Samples. The Representative will select different sample locations in each sublot according to PTM No. 1 and PTM No. 746. In the presence of the Inspector, obtain one loose mixture sample for each sublot directly from the uncompacted mixture placed by the paving equipment specified in Section 413.3(e) and immediately package. For 19 mm and smaller NMAS mixtures, package individual samples in cardboard boxes dimensioned approximately 3 3/4 inches x 4 3/4 inches x 9 1/2 inches. For 25 mm and larger NMAS mixtures, package individual samples in cardboard boxes dimensioned approximately 5 inches x 5 1/2 inches x 9 inches. Do not package samples in cardboard boxes with any one dimension greater than 10 1/4 inches or any one dimension smaller than 3 1/2 inches.

Immediately after packaging and in the presence of the Representative, identify the samples by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as acceptance samples (Sample Class AS). Leave at least one side of the cardboard sample box free of any writing or marking for LTS use in testing the samples.

Immediately after identifying, submit the samples to the Representative.

For quality control purposes, a maximum of one loose sample per sublot may be obtained. No loose mixture or core samples may be taken by the Contractor for mixture composition testing after the mixture acceptance samples are obtained. Do not obtain any other pavement samples, except those which are directed by and surrendered to the Department, unless allowed in writing from the District Executive.

The Contractor may elect to expedite delivery of the acceptance samples to the LTS at no additional cost to the Department. If the delivery is expedited, the Inspector will secure all containers with Department issued, uniquely numbered security tape. The Inspector will record the information from the security tape onto Form TR-447 which will be packaged inside the secured container and return the secured containers to the Contractor for transport to the LTS.

The Contractor may transport the secured samples to the LTS or utilize a third-party shipping service. If the Contractor elects to utilize a third-party shipping service, the service must provide the ability to track package delivery.

Provide all expedited delivery details in the QC Plan and discuss expedited delivery details at the preconstruction and pre-paving meetings. For expedited delivery, provide all containers, cushioning material, and packaging supplies to the Inspector. The Inspector will package all samples in the provided containers and secure the samples prior to surrendering the secured containers to the Contractor.

Upon arrival at the LTS, the secured containers will be visually examined for evidence that the tape has not been compromised and the unique numbers will be compared between the security tape and the value recorded on Form TR-447 inside the container. If sample security has not been compromised, samples received under expedited delivery will be tested on a priority basis. If the containers show any signs of compromised security, the following conditions apply:

- Obtain replacement samples as directed within 12 inches longitudinally of the original samples.
- Immediately stop expedited delivery and all samples will be delivered to the Inspector for transport.
- Conduct an investigation to determine the cause of the compromised security and provide a written explanation to the Representative.
- Do not resume expedited delivery until the Representative has reviewed the written explanation and is satisfied that proper steps have been taken to address the issue. The Department reserves the right to terminate expedited delivery after the first occurrence of compromised sample security.

2.b.1 Theoretical Maximum Specific Gravity (Gmm) Verification Samples. For federally funded projects or projects on the National Highway System, when density acceptance is by pavement cores, obtain a second loose mixture sample as specified in Section 413.3(h)2.b in each sublot at the same location as the mixture acceptance sample and immediately package in cardboard boxes sized as specified in Section 413.3(h)2.b. The second loose mixture sample at each location will be used to determine the theoretical maximum specific gravity (Gmm) and corresponding theoretical maximum density (lbs/ft^3) values for each sublot.

Immediately after packaging and in the presence of the Inspector, identify the sample by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as Gmm verification samples (Sample Class FV). Leave at least one side of the cardboard sample box free of any writing or marking for LTS use in testing the samples.

2.c Mixture Acceptance and Gmm Verification Sample Testing. Utilize LTS Testing unless otherwise indicated in the proposal. These procedures apply to standard and RPS construction.

2.c.1 LTS Testing. The LTS will test the mixture acceptance samples according to PTM No. 757 or PTM No. 702, Modified Method D and PTM No. 739, if previously identified problematic aggregates are used in the mixture, to determine asphalt content and the percent passing the 75 μm (No. 200) sieve. The LTS will use the calibration factors (C_f and 200 C_f) provided with the JMF for PTM No. 757. For individual increment test results outside of the single sample (n=1) tolerances in Table A, the LTS will analyze the test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 413.3(h)2.a.1. The Department will accept lots with three or more test results as specified in Section 413.4(a)4 or Section 413.4(b).

If the asphalt content or the percent passing the 75 μm (No. 200) sieve is not within the single sample (n=1) or multiple sample (n≥3) tolerances in Table A for two consecutive lots or a total of three lots, stop all production of the JMF. Determine the cause of the problem and provide a proposed solution to the Department.

Do not resume production of the JMF until the Representative reviews the proposed solution and authorizes production to continue.

The LTS will test Gmm verification samples as specified in Section 413.3(j)4.d

3. Pattern Segregation. Pattern segregation is continuous or repeated areas of non-uniform distribution of coarse and fine aggregate particles in the finished mat. The Department will address pattern segregation as follows:

3.a Evaluating Pattern Segregation. If the Representative observes pattern segregation that may result in defective pavement, then:

- The Inspector will notify the Contractor of the observed pattern segregation.
- The Contractor may continue to work at their own risk while immediately and continually adjusting the operation to eliminate the pattern segregation from future work.
- As a minimum and in the presence of the Representative, determine the average depth of pavement surface macrotexture according to PTM No. 751 in areas with the pattern segregation and in areas with non-segregated pavement. The pattern segregation is unacceptable if the difference in average pavement texture depth between the non-segregated and segregated areas exceeds 0.024 inch. The Representative will determine if the pavement is defective as specified in Section 413.3(h)3.c.

3.b Test Section. If the macrotexture tests identify unacceptable pattern segregation, then:

- Immediately suspend placing the asphalt course. Evaluate the cause of pattern segregation according to the Paving Operation QC Plan and as directed. Provide proposed corrective actions to the Representative and do not resume placing the asphalt course until after the Representative reviews the proposed corrective actions and authorizes paving to continue.
- Determine if the pattern segregation resulted in defective pavement as specified in Section 413.3(h)3.c.

- After the Representative allows paving to resume, place a test section not to exceed 200 tons. If the corrective actions do not eliminate observed pattern segregation, the Department will suspend paving, even if it is before the Contractor places the entire test section. Propose additional corrective actions, and construct another test section. Resume normal paving operations after constructing an entire test section without pattern segregation as determined by the Representative.

3.c Defective Pavement. At locations selected by the Inspector and with the Inspector present, drill a minimum of three 6-inch diameter cores from the area of pattern segregation and a minimum of three cores from the pavement representing a non-segregated area. Do not compress, bend, or distort samples during cutting and handling and immediately provide the cores to the Inspector. The Inspector will transport cores to the producer's laboratory. With the Inspector present, test the cores at the plant for density, asphalt content, and gradation. The Department may request additional tests as part of its evaluation of pattern segregation. Determine the maximum theoretical density according to Bulletin 27, the core density according to PTM No. 715, and asphalt content according to PTM No. 757 if previously identified problematic aggregates are used in the mixture, PTM No. 702 modified Method D, and PTM No. 739 or other test method identified in the producer QC Plan.

An area of pattern segregation contains defective pavement if the summation of absolute deviations from any two sieves is 20% or more from the JMF, the core density is defective, the mixture is defective in asphalt content, or the mixture is defective for percent passing the 75 µm (No. 200) sieve. Remove and replace the full width of the affected lane and a minimum of 5 feet beyond each end of the area with unacceptable pattern segregation. Construct replacement pavement conforming to the appropriate surface tolerances as specified in Section 313.3(l) or Section 413.3(l).

4. Flushing. Provide a mix that will not flush. Flushing is continuous or repeated areas of excessive asphalt on the pavement surface. The Department may recognize flushing until the Department approves the project through final inspection. The Department will address flushing as follows:

4.a Evaluating Flushing. When the Representative observes flushing, then:

- The Representative will immediately notify the Contractor of the observed flushing.

- The Contractor may continue work at their own risk while immediately and continually adjusting the operation to eliminate flushing from future work.

- In the presence of the Representative, determine the average depth of pavement surface macrotexture according to PTM No. 751 in areas of suspected flushing. If the average texture depth is less than or equal to 0.006 inches, then the pavement will be considered to be flushed and is defective.

4.b Test Section. If the macrotexture tests identify flushing, then:

- Immediately suspend placing the paving course. Evaluate the cause of flushing according to the Paving Operation QC Plan and as directed. Provide proposed corrective actions to the Representative and do not resume placing the paving course until after the Representative reviews the proposed corrective actions and authorizes paving to continue.

- Remove and replace the defective wearing course at no additional cost to the Department for the full width of the affected lane and a minimum of 5 feet beyond each end of the area of defective wearing course. Construct replacement wearing course conforming to the appropriate surface tolerances as specified in Section 413.3(l).

- After the Representative allows paving to resume, place a test section not to exceed 200 tons. If the corrective actions do not eliminate observed flushing, the Department will suspend paving even if it is before the Contractor places the entire test section. Propose additional corrective actions and construct another test section. Resume normal paving operations after constructing an entire test section without flushing as determined by the Representative.

(i) Compaction. Compact the mixture to achieve the density acceptance requirements and to eliminate all roller marks. Compact the mixture while it is in proper condition and adjust roller speed, amplitude, frequency, pattern, and

roller size to eliminate displacement, shoving, cracking, and aggregate breakage. Satisfactorily correct displacement resulting from reversing roller directions and other causes.

Without using excess water, maintain wheels of steel-wheel rollers moist and clean to prevent the mixture from adhering to the wheels. Use suitable methods to clean wheels of pneumatic-tire rollers.

Use pneumatic-tire rollers for compacting scratch courses.

For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

Remove areas that are loose, broken, mixed with dirt, or show an excess or deficiency of asphalt material. Replace removed mixture with fresh hot mixture and compact the mixture even with the surrounding pavement surface.

(j) Mat Density Acceptance.

1. General. The Department will accept the mat density of standard construction according to one of the levels in Table F. Areas may be accepted by non-movement or optimum-rolling pattern based on the criteria in Sections 413.3(j)2 and 413.3(j)3. Do not place mixtures for non-movement or optimum-rolling pattern acceptance until the Department has approved the density-acceptance level.

The Department will accept the mat density of RPS construction by lots and pavement cores as specified in Section 413.3(j)4. The Department will accept mat density of all 4.75 mm NMAS asphalt mixtures by non-movement or optimum-rolling pattern.

TABLE F
Density Acceptance

Density Acceptance Level	Acceptance Criteria
Non-Movement	Table H
Optimum-Rolling Pattern	Table H
Pavement Cores	Table I

2. Non-Movement. The Inspector-in-Charge will approve density acceptance by non-movement for the following materials, conditions, or applications:

- Scratch courses or leveling courses less than 1-inch in depth or equal to or less than 110 pounds per square yard.
- Areas of paving or patching less than 4 feet in width or narrow enough to cause bridging of the area by approved compaction equipment.

The Inspector-in-Charge will accept density by non-movement for the following materials, conditions, or applications if they are determined by the Representative to be non-critical for density:

- Materials placed in small quantities not exceeding 500 tons in a continuous placement.
- Mixtures placed on unstable or non-uniform bases.
- Mixtures used for patching, road widening, shoulders, driveway adjustments, parking lots, and other miscellaneous applications determined by the Representative. Shoulders where density is critical will be accepted by pavement cores as specified in Section 413.3(j)4.a.

The Department will accept the density when the mixture does not move under the compaction equipment.

3. Optimum-Rolling Pattern. The Inspector-in-Charge may accept density using an optimum-rolling pattern for the following materials, conditions, or applications:

- Materials placed in small quantities not exceeding 500 tons in a continuous placement.
- Mixtures placed on unstable or non-uniform bases.

- Leveling courses or other courses that are greater than or equal to 1-inch in depth or greater than or equal to 110 pounds per square yard.

- Mixtures used for patching, road widening, driveway adjustments, parking lots, shoulders where density is not critical, and other miscellaneous applications determined by the Representative. Shoulders where density is critical will be accepted by pavement cores as specified in Section 413.3(j)4.a.

- Mixtures placed at less than the minimum compacted depths in Table G.

With the Representative and the Contractor's certified asphalt field technician present, determine density with an approved nuclear gauge according to PTM No. 402, or determine density with an approved electrical impedance gauge according to PTM No. 403. Nuclear gauges must be operated by a licensed nuclear gauge operator. In the presence of the Representative, establish the optimum-rolling pattern for each course according to PTM No. 402 or PTM No. 403. Document optimum-rolling patterns using the appropriate Form TR-4276B or Form TR-4276C and provide the completed forms to the Representative. Compact the course according to the optimum-rolling pattern. During paving, the Representative may require the Contractor to verify the target density established by the optimum-rolling pattern. If the target density is not achieved, establish a new optimum-rolling pattern as directed. The Representative will suspend paving when the optimum-rolling pattern is not being followed.

Use one of the following gauges or approved equal:

- Troxler Electronics, Model 3411B or Model 4640B
- Campbell Pacific Nuclear, Model MC-2
- Seaman Nuclear, Model MC-2
- TransTech Systems, Inc., PQI™, Model 300 or Model 301
- Troxler Electronic Laboratories, PaveTracker™

Submit a copy of the certificate of nuclear gauge annual calibration according to ASTM D2950 and documentation of training of the nuclear gauge operator. Recalibrate any nuclear gauge that is damaged or repaired.

4. Pavement Cores (Standard and RPS Construction).

4.a General. Pavement cores are required for accepting the density of RPS construction. Pavement cores are required for standard construction of extended-season paving, unless waived by the Representative as specified in Section 413.3(b)1. Pavement cores are appropriate for accepting the density of standard construction if all of the following materials, conditions, or applications exist:

- Materials placed at compacted depths greater than or equal to the minimum depths specified in Table G.

- Materials placed on stable and uniform bases.

TABLE G
Mixture Minimum Compacted Depths

Mixture	Minimum Depth
9.5 mm Wearing Course	1 1/2 in.
12.5 mm Wearing Course	2 in.
19 mm Binder Course	2 1/2 in.
25 mm Binder Course	3 in.

4.b Lots and Sublots. Section 413.3(h)2.a.

4.c Density Acceptance Samples. The Inspector will select different sample locations in each sublot according to PTM No. 1, PTM No. 729, and PTM No. 746. With the Inspector present, drill 6-inch diameter cores as soon as possible but no later than the day following placement. The core at each location will be used to determine the bulk specific gravity (Gmb) and density (lbs/ft^3) of the compacted mix. Do not compress, bend, or distort samples during cutting, handling, transporting, and storing. If samples are damaged, immediately obtain replacement samples, as directed by the Inspector, from within 12 inches of the original sample location. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

In the presence of the Inspector, identify the samples by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as acceptance samples (Sample Class AS). Provide the daily theoretical maximum specific gravity value as specified in Section 413.2(e) 1.d.4 for the density calculation of each sublot in the lot. If density samples from the lot are taken from more than 1 day's placement, the daily theoretical maximum specific gravity values from each production day will be used to calculate the percent of theoretical density for each individual density acceptance core placed on that production day upon Gmm verification as specified in Section 413.3(j)4.d.1. Immediately deliver the samples to the Inspector and provide sample containers of sufficient strength to prevent samples from being damaged during transport. The Representative will submit samples for one lot in one container.

For quality control purposes, a maximum of one pavement core per sublot may be obtained unless the Representative allows additional cores. No cores may be taken by the Contractor after the acceptance cores are obtained. Do not obtain any other pavement cores, except those which are directed by and surrendered to the Department, unless allowed in writing by the District Executive.

The Contractor may expedite delivery of the acceptance samples to the LTS at no additional cost to the Department. If the delivery is expedited, the Inspector will secure all containers with Department issued, uniquely numbered security tape. The Inspector will record the information from the security tape onto Form TR-447 which will be packaged inside the secured container and return the secured containers to the Contractor for transport to the LTS.

The Contactor may transport the secured samples to the LTS or utilize a third-party shipping service. If the Contractor elects to utilize a third-party shipping service, the service must provide the ability to track package delivery.

Provide all expedited delivery details in the Paving Operation QC Plan and discuss expedited delivery details at the preconstruction and pre-paving meetings. For expedited delivery, provide all containers, cushioning material, and packaging supplies to the Inspector. The Inspector will package all samples in the provided containers and secure the samples prior to surrendering the secured containers to the Contractor.

Upon arrival at the LTS, the secured containers will be visually examined for evidence that the security tape has not been compromised and the unique numbers will be compared between the security tape and the value recorded on Form TR-447 inside the container. If sample security has not been compromised, samples received under expedited delivery will be tested on a priority basis. If the containers show any signs of compromised security, the following conditions apply:

- Obtain replacement samples as directed within 12 inches longitudinally of the original samples.
- Immediately stop expedited delivery and all samples will be delivered to the Inspector for transport.
- Conduct an investigation to determine the cause of the compromised security and provide a written explanation to the Representative.
- Do not resume expedited delivery until the Representative has reviewed the written explanation and is satisfied that proper steps have been taken to address the issue. The Department reserves the right to terminate expedited delivery after the first occurrence of compromised sample security.

4.d Acceptance and Gmm Verification Sample Testing. These procedures apply to standard and RPS construction.

4.d.1 LTS Acceptance and Gmm Verification Testing. The LTS will test each density acceptance sample according to PTM No. 715, and if necessary PTM No. 716, to determine the bulk specific gravity (Gmb) and bulk density (lbs/ft^3) of the compacted mixture. For individual increment test results outside of the lower and upper specification limits in Table I, the LTS will analyze the bulk density test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 413.3(h)2.a.1. The Department will accept lots with three or more test results as specified in Section 413.4(a)4 or Section 413.4(b)

For lots with no required Gmm verification loose mixture samples, the Contractor's daily theoretical maximum specific gravity values from each production day will be used for acceptance.

For lots with required Gmm verification loose mixture samples, the LTS will randomly select one of the Gmm verification loose mixture samples obtained as specified in Section 413.3(h)2.b.1 from the lot according to PTM No. 1. The LTS will test the randomly selected Gmm verification loose mixture sample to determine the theoretical maximum specific gravity (Gmm) of the compacted mixture according to AASHTO T 209 as modified in Bulletin 27, with the following exception:

- The samples will be obtained as specified in Section 413.3(h) 2.b.1.

The LTS will compare the randomly selected Gmm verification sample test result with the Contractor's daily Gmm value for that same production or placement date. If the LTS and Contractor Gmm values do not differ by more than ± 0.030, the Contractor's daily Gmm values in the whole lot will be considered verified and the Contractor's daily Gmm values will be used to determine the percent of theoretical maximum density for each density acceptance sample placed on that date. If the initial randomly selected LTS Gmm verification sample test result differs from the Contractor's daily Gmm value for that same production or placement date by more than ± 0.030, the LTS Gmm test result value will be used as the acceptance Gmm value to determine the percent of theoretical maximum density for the individual density acceptance cores produced or placed on that same date. The Department reserves the right to select more than one Gmm verification sample from the lot representing the same production or placement date and to select other Gmm verification samples from the lot representing different production or placement dates to verify the Contractor's daily Gmm values. When more than one Gmm verification sample is selected from the lot representing the same production or placement date, the LTS Gmm test results will be averaged and the average will be used to verify the Contractor's daily Gmm value for that same production or placement date.

Individual sublot density values will be calculated and then rounded to the nearest tenth of a percent of theoretical maximum density according to ASTM E 29. Lot average density will subsequently be calculated from the individual sublot values and then rounded to the nearest tenth of a percent theoretical maximum density according to ASTM E 29. The Department will determine acceptance, with respect to density, as specified in Section 413.4(a)4 or Section 413.4(b).

If cores are not taken within 1 day after placing the mixture, or if the density for two consecutive lots or for a total of three lots does not meet the density payment factor percentage of ≥100, stop paving operations for the project as directed. Review and evaluate the operation and determine the cause of the problem. Do not resume paving until after the Representative reviews the proposed solution and authorizes paving to continue.

(k) Joints.

1. Longitudinal Joints.

1.a General. Offset joints in a layer from the joint in the layer immediately below by approximately 6 inches. Plan joint locations to ensure that the joint in the top layer is at the approximate pavement centerline for two-lane roadways and within 12 inches of the lane lines for roadways with more than two lanes. Avoid joint locations directly beneath planned pavement marking applications where possible.

Before placing abutting lanes, paint the entire area of the joint with a uniform coating of asphalt material, the PG-Binder used in the pavement course or PG 64S-22. Painting of the joint face is not required for scratch courses.

Place and compact the mixture at the joint according to the Paving Operation QC Plan. Ensure the surface across the joint and along the joint is within the surface tolerances specified in Section 413.3(l).

Adhere to the following additional requirements for the construction of longitudinal joints that will not be evaluated as specified in Section 405.

Assure a true line when paving. Place and closely follow lines or markings for this purpose. When compacting loose mixture at an unsupported edge, make the first roller pass with the edge of the roller drum extending beyond and overhanging the unsupported edge by 3 to 6 inches. Do not allow pneumatic-tire rollers to cause lateral movement at any unsupported edge.

When placing uncompacted mixture adjacent to a previously compacted lane, operate the paver so that the material overlaps the edge of the previously placed lane by 1 to 1 1/2 inches. Ensure that mixture behind the screed is tightly pushed against the free face of the existing lane. Maintain the uncompacted mixture uniformly higher than the existing lane by at least 1/4 inch per inch of material being placed to assure full compaction. When possible, use automated joint matchers when constructing joints between traveled lanes. Do not bump back or lute the overlapped material unless overlap inadvertently exceeds the specified tolerances. When compacting the loose mix at the longitudinal joint, keep the roller drum approximately 18 inches from the joint for the first pass forward, avoiding the roller edge of the drum operating directly above the bottom edge of any underlying notched wedge joint. On the backward and subsequent passes, overlap the joint 2 to 6 inches. Ensure that the joint receives at least as many roller passes as the rest of the mat.

If traffic or other cause distorts the lane edge, restore the lane edge to its original shape, using acceptable procedures.

Seal the longitudinal joint(s) for surface courses with hot PG 64S-22 asphalt binder at no additional cost to the Department. Heat and maintain asphalt binder sealant between 265F and 320F. Do not place sealant when the air temperature is below 40F, unless permitted by the Representative. Apply the sealant only to joints in pavement surfaces that are clean, dry and free of any loose material and debris. Clean with a power broom as required. Utilize a pressure applicator with a wand or nozzle capable of applying hot asphalt sealant in a straight and consistent width band of 4 inches +/-1 inch and thickness of 1/16 inch +/- 1/32 inch. Center the sealant band within 1 inch of the joint. Remove and dispose of excess sealant at no additional cost to the Department. Reseal areas of the joint that are inconsistently or not completely covered at no additional cost to the Department. Replace pavement markings that are marred by sealing operations at no additional cost to the Department.

1.b Vertical Joints.

- The Contractor may use vertical joints for base, binder, and wearing courses.
- If traffic or other cause distorts the lane edge, carefully saw a vertical lane edge before painting.
- Place the abutting lane on the same day, and if necessary, leave only short lane sections, normally less than 25 feet in length, where the abutting lane is not placed the same day.

1.c Notched Wedge Joints.

- The Contractor may use notched wedge joints for wearing and binder courses with NMAS mixtures of 19.0 mm or smaller.
- Remove and dispose of all loose and foreign material before opening the lane to traffic.
- Construct the joint as shown on the Standard Drawing.
- If the joint is next to opposing traffic, place the abutting asphalt mixture within 1 working day after placing the mixture. If the joint is next to traffic in the same direction, place the abutting asphalt mixture within 2 working days after placing the mixture.
- If both lanes that make the joint are not placed on the same day, amend the Maintenance and Protection of Traffic Plan and install additional signing for uneven lane at no additional cost to the Department. Install "Uneven Lane" signs according to Publication 212, Publication 213, and MUTCD and 1/2-mile before the notched wedge joint area and every 1/2-mile within the uneven pavement area.

2. Transverse Joints. Construct joints perpendicular to the pavement centerline. The Contractor may saw transverse joints. If used, install bulkheads straight and perpendicular to the surface. If a bulkhead is not used and the roller moves over the rounded edge of new mixture, locate the joint a sufficient distance from the rounded edge to provide a true surface and cross section. Paint the joint face with a thin coating of asphalt material, the PG-Binder used in the pavement course or PG 64S-22, before placing fresh mixture against the joint face. Painting of the joint face is not required for scratch courses.

3. Other Joints. Where placing a wearing course abutting to existing pavement at locations such as paving notches, lane additions, or utility openings, seal the joint with hot asphalt material of the class and type designated for the wearing course. Evenly apply the sealant a minimum of 6 inches on both sides of the joint. The Contractor may use emulsified asphalt, consisting of PennDOT Material Class TACK or NTT/CNTT, instead of hot asphalt material. Before sealing, clean and remove harmful material from the area to be sealed. Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint. If necessary, use two or more applications of emulsified asphalt. Remove excess asphalt material and immediately cover the sealed area with a light application of dry sand that is acceptable to the Representative.

(l) Surface Tolerance. Test the finished surface with a 12-foot straightedge at areas the Representative determines may be deficient or irregular, and at transverse joints (including bridge decks and pavement transition) and paving notches. Hold the straightedge in contact with the surface and in successive positions parallel to the road centerline to check the entire width of the pavement. Advance along the pavement in stages of not more than one-half the length of the straightedge until the entire area is tested. The pavement is defective if irregularities are more than 3/16 inch.

(m) Tests for Depth: Binder and Wearing Courses. Construct the pavement to the depth indicated and within the specified tolerances.

For courses with density acceptance by lots, the Inspector will measure the depth of each sublot according to PTM No. 737 using the density acceptance samples.

For courses with a designed course depth and density acceptance by non-movement or optimum rolling pattern, the Inspector will calculate the mass per square meter (weight per square yard) for verification of yield. If yield results indicate insufficient course depth, drill one 6 inch diameter core for each 500 tons of material placed to determine the extent of the deficient depth. Core locations will be determined according to PTM No. 1. For courses with density acceptance by lots, the inspector will measure the depth of each sublot according to PTM No. 737 using density acceptance samples.

Pavement deficient in depth by more than 1/4 inch is defective work. Pavement deficient in depth by more than 1/8 inch in three or more adjacent core locations is defective work. The extent of the defective work is the entirety of all sublots represented by the adjacent deficient core samples. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is within 1/4 inch of the design depth.

(n) Protection of Courses. Do not allow vehicular traffic or loads on newly compacted courses for 24 hours or until the course uniformly cools to a temperature of 140F or less. Provide alternate routes as indicated or as directed. If both lanes that form a longitudinal joint are placed on the same day and public safety is not restricted, do not allow vehicular traffic or loads on the lanes until adequate stability and adhesion is obtained and the material has uniformly cooled to 140F or less. Maintain the course, as specified in Sections 105.13, 107.15, and 901.

(o) Defective Work. As specified in Section 105.12 and as follows:

Department acceptance and QA testing shall not relieve the Contractor of responsibility for material or workmanship that the Representative determines is defective before the Department issues the acceptance certificate. Remove and replace or repair defective work as directed. The BOPD, CMD will review Representative determinations of defective material or workmanship.

Remove and replace pavement defective for pattern segregation as specified in Section 413.3(h)3, for flushing as specified in Section 413.3(h)4, surface tolerance as specified in Section 413.3(l) or Section 313.3(l) and depth as specified in Section 413.3(m), or Section 313.3(m). Remove and replace pavement defective for percent within limits or Payment Factor Percentages as specified in Tables H and I.

413.4 MEASUREMENT AND PAYMENT—

(a) Standard Asphalt Construction.

1. Asphalt Courses.

1.a Superpave Asphalt Mixture Design, Asphalt Wearing Course. Square Yard or Ton

1.b Superpave Asphalt Mixture Design, Asphalt Wearing Course (Scratch). Ton

1.c Superpave Asphalt Mixture Design, Asphalt Wearing Course (Leveling). Ton

1.d Superpave Asphalt Mixture Design, Asphalt Binder Course. Square Yard or Ton

1.e Superpave Asphalt Mixture Design, Asphalt Binder Course (Leveling). Ton

2. Asphalt Tack Coat. Section 460.4.

3. Mixture Acceptance by Certification and Density Acceptance by Non-Movement, Optimum-Rolling Pattern, or Pavement Cores. The Representative will pay at the contract unit price, adjusted according to Table H. The total payment factor percentage for pavements with density acceptance other than by pavement cores is the sum of adjustments for each test criterion subtracted from 100%. The adjustment for an individual test criterion is the payment factor percentage subtracted from 100%. The pavement will be considered defective if the payment factor for asphalt content, percent passing the 75 µm (No. 200) sieve, and percent passing the 2.36 mm (No. 8) sieve are all 85%.

For pavements with density acceptance by cores, the payment will be as specified in Section 413.4(a)4 with pay factors from Table H being applied. The pavement will be considered defective if the pavement density cores result in a percent within limits less than 50.

TABLE H
Contract Unit Price Adjustments - Mixture Acceptance by Certification

Mixture NMAS	Test Criteria	Test Value		Payment Factor Percentage
Asphalt Content				
All sizes	Printed Tickets	At least 90% of Daily Printed Tickets Within 0.2% of JMF		100
		Less than 90% of Daily Printed Tickets Within 0.2% of JMF		85
19.0 mm and smaller	QC Sample Testing**	Single Sample (n=1)	Multiple Samples (n≥2)	
		±0.7%	±0.5%	100
		±0.8% to 1.0%	±0.6%	85
		> ±1.0%	≥ ±0.7%	*
25.0 mm and larger	QC Sample Testing**	±0.8%	±0.6%	100
		±0.9% to ±1.2%	±0.7%	85
		> ±1.2%	≥ ±0.8%	*
Gradation				
		Single Sample (n=1)	Multiple Samples (n≥2)	
All sizes	QC Sample Testing for % Passing 75 µm (No. 200) Sieve**	±3.0%	±2.1%	100
		±3.1% to ±4.0%	±2.2% to ±2.7%	85
		> ±4.0%	≥ ±2.8%	*
All sizes	QC Sample Testing for % Passing 2.36 mm (No. 8) Sieve**	±6%	±4%	100
		±7% to ±8%	±5%	85
		> ±8%	≥ ±6%	*
Mat Density				

All sizes	Non-Movement	Section 413.3(j)2.	100
	Optimum-Rolling Pattern	Section 413.3(j)3.	100
Sizes from Table I	Acceptance Sample Testing of Pavement Cores	Table I	Section 413.4(a)4.a

* Defective pavement. Remove and replace or, when permitted by the District Executive in writing, leave in place and the Department will pay 70% of the contract unit price.

** For these test criteria, the daily Pay Factor will be determined by the single sample test result from the daily QC sample. If more than one QC sample test result is available for a day, the Payment Factor Percentage will be determined based on the average of the results using multiple sample tolerances. If corrective action is taken, Pay Factors will be independently determined for material placed before and after the corrective action.

4. Mixture Acceptance by Lot and Density Acceptance by Non-Movement, Optimum-Rolling Pattern, or Pavement Cores. The Department will pay on a lot-by-lot basis at the contract unit price, adjusted for Pay Factors (PF) as specified. For the PF based on Percent Within Limits (PWL), the Department will determine the individual PWL values for in-place pavement density (PWL_D), asphalt content (PWL_{AC}), percent passing the 75 µm (No. 200) sieve (PWL_{200}), and for percent passing the primary control sieve (PWL_{PCS}) as specified in Section 106.03(a)3, using the upper and lower specification limits in Table I. The Department will determine each PF for in-place pavement density, asphalt content, percent passing the 75 µm (No. 200) sieve, and for percent passing the primary control sieve as specified in Section 413.4(a)4.a. The Department will determine the Overall Lot Pay Factor (OLPF) as specified in Section 413.4(a)4.a.2.

4.a Pay Factors

4.a.1 Pay Factors for In-Place Pavement Density (PF_D), Asphalt Content (PF_{AC}), Percent Passing 75 µm (No. 200) Sieve (PF_{200}), and Percent Passing the Primary Control Sieve (PF_{PCS}). For lots with density acceptance by non-movement or optimum-rolling pattern, $PF_D = 100.00$.

The Department will determine PF_D, for lots with density acceptance by pavement cores and PF_{AC}, PF_{200}, and PF_{PCS} for all lots, according to the following:

4.a.1.a All PWL Parameters Greater Than or Equal to 50. When PWL_D, PWL_{AC}, PWL_{200}, and PWL_{PCS} are each greater than or equal to 50, the Department will determine the pay factor for each PWL as specified in one of the following equations as appropriate.

When PWL is ≥ 90, determine the pay factor for the specific pay parameter as specified in the following Equation:

$$PF_X = 100 + 0.4(PWL_X - 90)^*$$

Where,

PF_X = Pay Factor of the individual pay parameter (PF_D, PF_{AC}, PF_{200} or PF_{PCS})

PWL_X = Percent within Limits of the individual pay parameter (PWL_D, PWL_{AC}, PWL_{200} or PWL_{PCS})

* For 9.5 mm and 12.5 mm courses with average density < 93.0, the maximum $PF_D = 100$

When PWL is < 90 and ≥ 50, or when PWL_{200} is less than 50 and the average percent passing the 75 µm (No. 200) sieve is within ± 2.0% from the JMF, determine the pay factor for the specific pay parameter as specified in the following Equation:

$$PF_X = 70 + 0.75(PWL_X - 50)$$

Where,

PF_X = Pay Factor of the individual pay parameter (PF_D, PF_{AC}, PF_{200} or PF_{PCS})

PWL_X = Percent within Limits of the individual pay parameter (PWL_D, PWL_{AC}, PWL_{200} or PWL_{PCS})

4.a.1.b One PWL Parameter Less Than 50. When either one of PWL_D or PWL_{AC} is less than 50, the lot is defective. When PWL_{200} is less than 50, the lot is defective when the average percent passing the 75 µm (No. 200) sieve is greater than ± 2.0% from the JMF. When PWL_{PCS} is less than 50, the PF_{PCS} = 60.00. For defective lots, the DE will direct one of the following:

- Leave the lot in place. The DE will apply an OLPF of 70.
- Remove and replace the entire lot. The District Executive will direct removal and replacement of the entire lot at no additional cost to the Department with new lot acceptance sampling and testing.

4.a.1.c Two PWL Parameters Less Than 50. When two or more of PWL_D, PWL_{AC}, or PWL_{200}, with the average percent passing the 75 µm (No. 200) sieve greater than ± 2.0% from the JMF, are less than 50, the lot will be considered defective and the DE will direct removal and replacement of the entire lot with new acceptance sampling and testing.

4.a.2 Overall Lot Pay Factor (OLPF). The Department will determine the OLPF as specified in the following equation and then will round the resulting OLPF to the nearest whole number according to ASTM E29:

$$OLPF = (0.50 \times PF_D) + (0.30 \times PF_{AC}) + (0.10 \times PF_{200}) + (0.10 \times PF_{PCS})$$

Where,

PF_D = Pay Factor for In-Place Density

PF_{AC} = Pay Factor for Asphalt Content

PF_{200} = Pay Factor for Percent Passing the 75 µm (No. 200) Sieve

PF_{PCS} = Pay Factor for Percent Passing the Primary Control Sieve (PCS)

TABLE I
Upper and Lower Specification Limits for Calculating Percent Within Limits

	Testing Criteria	
Mixture NMAS	**Lower Specification Limit (L)**	**Upper Specification Limit (U)**
	Asphalt Content from JMF Value, %	
9.5 mm, 12.5 mm	-0.4	+0.4
19 mm	-0.5	+0.5
25 mm and 37.5 mm	-0.6	+0.6
	Percent Passing the 75 µm (No. 200) sieve from JMF Value, %	
All sizes	-1.5	+1.5
	Percent Passing the Primary Control Sieve from JMF Value, %	
9.5 mm (PCS = 2.36 mm (No. 8) sieve)	-5	+5
12.5 mm (PCS = 2.36 mm (No. 8) sieve)	-5	+5
19 mm (PCS = 4.75 mm (No. 4) sieve)	-8	+8
25 mm (PCS = 4.75 mm (No. 4) sieve)	-9	+9
37.5 mm (PCS = 4.75 mm (No. 4) sieve)	-9	+9
	Mat Density *	
All 9.5 mm, 12.5 mm	92.0	98.5
All 19 mm Courses, 25 mm Binder Courses	91.0	98.0
25 mm and 37.5 mm Base Courses	90.0	No Upper Limit

* Where Limits = Percent of Theoretical Maximum Density

4.a.3 Lot Payment. The Representative will compute the percent of the contract unit price paid as follows:

$$\text{Lot Payment} = C_P\,(\text{OLPF})/100$$

Where,

C_P = Contract unit price per lot (unit price times lot quantity)

OLPF = Overall Lot Pay Factor

4.a.4 Evaluation of Overall Lot Pay Factor and Payment of Incentive / Disincentive. Dollar.

The proposal will include a contract item and a predetermined amount of money for Evaluation of Overall Lot Pay Factor and Payment of Incentive. The contract item will have a unit of measure of DOLLAR, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the incentive status of the payment being made, the provisions of Section 110.02(d) are not applicable to this item.

The Evaluation of Overall Lot Pay Factor and Payment of Incentive contract item will be measured and paid as follows:

- **Incentive**. When asphalt pavement evaluation indicates that an incentive adjustment is applicable, the appropriate amount will be paid under this contract item.

- **Disincentive**. When asphalt pavement evaluation indicates that a disincentive adjustment is applicable, the appropriate amount will be deducted from money due or to become due to the Contractor through the processing of a Contract Adjustment.

4.b Dispute Resolution. For mixture acceptance testing or density acceptance testing performed by the LTS, the Contractor may request, in writing, that the Department retest a lot if the initial test results indicated a defective lot (remove and replace), a lot with an OLPF < 90.00, the asphalt content pay factor for the lot is < 80.00, or the density pay factor for the lot is < 80.00, except for density when one or more density acceptance cores in the lot were coated with paraffin wax as a result of PTM No. 716 during the original density acceptance testing. Provide written retest requests to the District Executive within 3 weeks of the date the LTS test results are released. Provide in the written request the preferred test method for asphalt content determination (PTM No. 757 or PTM No. 702, Modified Method D). Retests will not be allowed if a written retest request is not received within 3 weeks of the date the LTS test results are released. Provide quality control test results and control charts, companion sample test results (if available), test data trend evaluation, and any other pertinent information to justify the retest request. The Department will evaluate the information and may allow retesting if the information submitted provides a reasonable basis to conclude that the failing test results may not represent the in-place material. The LTS will perform the retest with the Contractor present, unless otherwise agreed to in writing with the Contractor.

For retesting of materials failing for asphalt content, percent passing 75 µm (No. 200) sieve, or percent passing the PCS, the Inspector will identify the locations where the original box samples were collected. The Inspector will select retest sample locations 24 inches from the original sample locations longitudinally in the direction of traffic. If the 24 inch offset causes the retest sample location to fall outside of the sublot, the Inspector will select the retest sample location 24 inches from the original sample locations longitudinally in the opposite direction from traffic.

With the Inspector present, provide appropriate traffic control and drill 6-inch diameter cores for retesting purposes according to the procedure for drilling in PTM No. 729. Ensure drilling procedures include washing off and towel drying the core samples immediately after drilling. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture. Provide traffic control, core, and backfill the core holes at no additional cost to the Department. The test method used for asphalt determination during the original acceptance testing (PTM No. 757 or PTM No. 702, Modified Method D, and PTM No. 739) will be used for the retest, unless the DME/DMM grants written approval for a change in test method. If required to separate the applicable pavement course lift from other pavement courses, the cores will be saw cut at the course lift line(s) as determined by the LTS. The results of the retest cores will be used to calculate payment for asphalt content, percent passing the 75 µm (No. 200) sieve, and percent passing the PCS for the lot.

For retesting of density acceptance, the original density acceptance cores will be utilized. The LTS will not retest a lot for density acceptance when one or more density acceptance cores in the lot were coated with paraffin wax

as a result of PTM No. 716 during the original density acceptance testing. The LTS will retest each original density acceptance core according to PTM No. 715 and PTM No. 716, as necessary, to determine the Gmb and bulk density values. The LTS will not perform Gmm testing for lots where the Contractor's Gmm value was previously considered verified as specified in Section 413.3(j) 4.d.1. After Gmb testing is completed, for lots where the Contractor's Gmm was not verified, the LTS will select one original density acceptance pavement core from each production or placement date represented by the density acceptance cores in the lot. Each core selected will be the core with the highest bulk density for that production or placement date from the retest results (e.g., if a lot was placed over 3 production days, and the lot density acceptance cores include at least one core from each production or placement day, the original density cores selected during a density retest to perform Gmm testing will be 3; one from each production or placement date). The LTS will perform Gmm testing on the selected cores according to AASHTO T 209 as modified in Bulletin 27, with the following exceptions:

- The samples will be obtained as specified in Section 413.3(j)4.c
- No conditioning, only drying, will be performed on the sample
- The minimum sample size will be waived, as necessary, to use the 6-inch diameter pavement core sample, and
- The supplemental procedure for mixtures containing porous aggregate will only be performed when either the coarse aggregate or fine aggregate in the mixture has a water absorption of ≥ 1.5% as indicated on the JMF and then only when the calculated percent of theoretical maximum density indicates any one individual failing sublot which results in a density pay factor less than 100.00.

The LTS Gmm value(s) determined will be the Gmm values used to determine the percent of theoretical maximum density for the cores represented by the applicable production or placement dates in the lot. Either the previously verified Contractor's Gmm values(s) or the newly tested LTS Gmm value(s) will be used for acceptance to determine the percent theoretical maximum density for each sublot core in the lot.

Upon completing the retesting of the original density acceptance cores, the LTS will evaluate testing repeatability for the bulk density results determined according to PTM No. 715 and PTM No. 716, if necessary, using both the bulk original density test values and the bulk density retest values according to PTM No. 5. After evaluating the testing repeatability, the density test values used to determine the final payment factor percentage for density will be as follows:

- If repeatable, the original test values will be used.
- If lack of repeatability (i.e., non-repeatable), the retest values will be used.

The Department will deduct from the payment the cost per lot associated with conducting a retest as follows in Table J:

TABLE J
Dispute Resolution Retest Cost Table

Test Method	**Mixture Acceptance Retest Cost if Retest Results Indicate ≥ 100% Pay Factor(s)***	**Mixture Acceptance Retest Cost if Retest Results Indicate <100% Pay Factor(s)**
PTM No. 702/739	$900	$3,500
PTM No. 757	$500	$2,000
	Density Acceptance Retest Cost if Retest Results Indicate a Lack of Repeatability	**Density Acceptance Retest Cost if Retest Results are Repeatable**
PTM No. 715, or PTM No. 716 only	$200	$750
PTM No. 715, or PTM No. 716, and AASHTO T 209 as specified in Section 413.3(j)4.d.1	$1,100	$4,000

* For lots where the original test results indicated a defective lot, only the pay factor(s) where original test results indicated a PWL < 50 for asphalt content, percent passing the 75 µm (No. 200) sieve, or density will be utilized to determine the retest cost. If no original test results indicated PWL < 50 for lots where OLPF < 90, then all pay factors will be utilized to determine the retest cost.

(b) Asphalt RPS Construction. Square Yard or Ton

1. Mixture Acceptance by Lot and Density Acceptance by Pavement Cores. Section 413.4(a)4, except for RPS, the Department will determine mat density by pavement cores only.

SECTION 419—STONE MATRIX ASPHALT MIXTURE DESIGN, RPS CONSTRUCTION OF PLANT-MIXED WEARING COURSES

419.1 DESCRIPTION—This work is the RPS construction of plant-mixed Stone Matrix Asphalt (SMA), on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor. The SMA is to be produced as WMA using an approved WMA technology.

419.2 MATERIALS— Do not incorporate material into the asphalt mixture that are not specified in Section 419.2 including additives, rejuvenators, or other materials.

(a) Asphalt Material

1. Virgin Mix. Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b) 1. Provide the Representative a copy of a Bill of Lading for asphalt material on the first day of paving and when the batch number changes.

When producing a mixture with a WMA technology, adhere to the following requirements:

1.a WMA Technology Additives or Modifiers Blended at the Asphalt Material Supplier's Refinery or Terminal. Provide refinery or terminal blended asphalt material blended with an approved WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15. Include in the asphalt material Producer QC Plan, the WMA Technology additive or modifier manufacturer name, WMA Technology name, and source, dosage rates, blending method, QC testing, corrective action points, disposition of failed material, storage, handling shipping, and bill of lading information following the applicable requirements as specified in Section 702. Include the WMA Technology additive or modifier and dosage rate on the bill of lading. Provide refinery or terminally blended asphalt material, that when blended with the WMA Technology additive or modifier, the final blend meets the requirements for the specified performance grade of the asphalt binder.

1.b WMA Technology Additives or Modifiers Blended at the Asphalt Mixture Producer's Plant. Provide a blended asphalt material consisting of an approved WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15 that is blended with a base asphalt material of the specified performance grade conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25 and from an approved source listed in Bulletin 15, Section 702. Prepare a Producer QC Plan as specified in Section 106 and conforming to the Producer QC Plan requirements in Section 413.2(e)1.a and the additional Producer QC Plan requirements within this specification.

(b) Aggregate.

1. General Requirements. Provide aggregate from sources listed in Bulletin 14. Provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends for SRL are 50% by weight of each aggregate. Blend the aggregates using an approved method.

2. Fine Aggregate. Section 703.1, except as follows: Determine Sand Equivalent Value according to AASHTO T 176 and meet requirements of 45% minimum sand equivalent. Do not exceed 15% sodium sulfate soundness loss in five cycles. Determine the uncompacted void content according to AASHTO T 304, Method A, or use the value listed in Bulletin 14. Provide a fine aggregate that meets 45% minimum uncompacted void content.

3. Coarse Aggregate. Type A, Section 703.2, except as follows: Meet the aggregate quality requirements of Table A.

TABLE A
Coarse Aggregate Quality Requirements

Characteristic	Test Method	Required Values
Abrasion Loss, %	AASHTO T 96	≤ 35
Flat and Elongated Particles, % 3:1 Ratio 5:1 Ratio	ASTM D4791 Method B (measured by mass, on material retained on and above the 4.75 mm (No.4) sieve)	 ≤ 20 ≤ 5
Absorption, %	AASHTO T 85	≤ 2.0
Crushed Fragments, % One Fractured Face Two or More Fractured Faces	ASTM D5821	 100 ≥ 90

(c) Mineral Filler. Furnish mineral filler consisting of finely divided mineral matter such as rock or crushed limestone dust free of organic impurities. Furnish material with a maximum plasticity index of 4 and conforming to the grading requirements of AASHTO M 17. Submit a hydrometer analysis performed according to AASHTO T 88 for mineral filler.

(d) Stabilizer. Provide mineral fiber, cellulose fiber, or crumb rubber (CR) stabilizers conforming to the requirements below and added at a rate specified in Table B. Use the dosage rate prescribed in the JMF.

1. Requirements for All Fiber Types. Fibers must prevent draindown in the mixture according to the tolerances in Table B. Use a fiber of the type and properties appropriate to the plant's metering and delivery system.

2. Cellulose Fibers. Fibers must be of sufficient quality to prevent mixture draindown.

3. Cellulose Pellets. Use cellulose fiber stabilizing additive in pellet form that disperses sufficiently at mixing temperature to blend uniformly into the asphalt mixture. Use pellets that do not exceed 0.25 inch average diameter. Pellets may contain binder ingredients such as asphalt binder, wax, or polymer. Do not use pellets if the binder ingredient exceeds 20.0% of the total weight of the pellets. Use binder that produces no measurable effect on the properties of the asphalt binder. Do not use fiber pellets which soften or clump together when stored at temperatures up to 122F.

Note: If the binder material constitutes more than 3% of the pellet weight, base the dosage rate on the net fiber content.

4. Mineral Fibers. Use mineral fibers made from virgin basalt, diabase, slag, or other silicate rock. Use an approved mineral fiber meeting the following requirements for shot content, as tested according to ASTM C612.

Sieve	Percent Passing
250 µm (No. 60)	85 - 95
63µm (No. 230)	60 - 80

5. Crumb Rubber (CR). Use CR derived from the processing of recycled tires. Rubber tire buffings produced by the retreading process qualify as a source of CR. Furnish processed, free flowing CR from a manufacturer listed in Bulletin 15, certified as specified in Section 106.03(b)3.

5.a Gradation. Meet the following gradation as determined according to ASTM D5461 using 200 mm diameter sized sieves and maintaining a maximum allowable loss after sieve analysis of 7.65%. As an alternative dry sieve analysis test method, perform the sieve analysis of the CR according to Florida Test Method, FM 5-559.

CR Gradation

Sieve Size	Percent Passing
4.75 mm (No. 4)	100
2.36 mm (No. 8)	98-100
75 µm (No. 200)	0-3

5.b Contaminants. Provide CR relatively free from fabric, wire, cord, and other contaminating materials to a maximum total contaminant content of 2.5% (maximum of 1.0% iron, 1.0% fiber, and 0.5% other contaminants by

weight of total CR sample components).

Remove rubber particles from the fiber balls before weighing. Determine the metal content by thoroughly passing a magnet through a 50.0 ± 0.1 g (1.76 ± 0.004 ounces) sample. Determine fiber content by weighing fiber balls, which are formed during the gradation test procedure.

(e) Mixture Composition.

1. Virgin Material Mixtures. Design and control SMA according to Bulletin 27, Chapter 2B. Size, uniformly grade, and combine aggregate fractions, asphalt material, and an approved WMA Technology in such proportions that the total aggregate and asphalt in the JMF conform to the material, gradation, and volumetric requirements for the SMA mixture according to Tables B and C. Do not use RAP in the mix.

For asphalt mixtures, the WMA Technology Manufacturer Technical Representative (Technical Representative) will address laboratory procedure modifications necessary to prepare, compact, and test ASPHALT mixtures and to achieve a uniform blend. Incorporate the WMA Technology additive, modifier, or process into that JMF during production. Do not develop a volumetric asphalt JMF based on incorporating the WMA Technology additive, modifier or process during the volumetric asphalt mixture design process. For all asphalt JMFs, perform moisture susceptibility analysis according to Bulletin 27. Ensure the WMA Technology additive, modifier, or process is not detrimental to the moisture resistance of the mixture. .

TABLE B
Mix Design Requirements for SMA Mixtures

AGGREGATE GRADATION REQUIREMENTS, PERCENT PASSING		
Sieve Size	**9.5-mm Mixture**	**12.5-mm Mixture**
19.0 mm (3/4 inch)	-	100
12.5 mm (1/2 inch)	100	90 – 99
9.5 mm (3/8 inch)	75 – 95	70 – 85
4.75 mm (No. 4)	30 – 50	28 – 40
2.36 mm (No. 8)	20 – 30	18 – 30
1.18 mm (No. 16)	-	-
600 μm (No. 30)	-	-
300 μm (No. 50)	-	-
150 μm (No. 100)	-	-
75 μm (No. 200)	8 – 13	8 – 11
VOLUMETRIC DESIGN REQUIREMENTS		
Design Gyrations (N_{design})	100	
Voids in Mineral Aggregate	18.0 % Minimum	
Voids in Course Aggregate (VCA)	$VCA_{mix} < VCA_{dry\ rodded}$	
Design air voids	3.5 - 4.0 %	
Minimum asphalt binder content	Table C	
Binder grade	PG 64E-22	
Stabilizer content	Cellulose: 0.2 to 0.4 % by total mix weight Mineral: 0.3 to 0.4 % by total mix weight CR: 0.3 to 1 % by total mix weight	
Draindown	0.3 % maximum	

TABLE C
Minimum Asphalt Binder Requirements for SMA Mixtures

Combined Aggregate Bulk Specific Gravity	Minimum Asphalt Content, % by Total Mix Weight
2.400 - 2.449	7.4
2.450 - 2.499	7.2
2.500 - 2.549	7.1
2.550 - 2.599	7.0
2.600 - 2.649	6.8
2.650 - 2.699	6.7
2.700 - 2.749	6.6
2.750 - 2.799	6.5
2.800 - 2.849	6.4
2.850 - 2.899	6.3
2.900 - 2.949	6.2
2.950 - 2.999	6.1
3.000 - 3.049	6.0

Perform draindown testing according to AASHTO T 305 using a 1 hour reading. Design a mix meeting the tolerances specified in Table B.

Design each SMA mix within the job-mix tolerances according to Tables B and C. Test the materials, proportions, and the mixture at the asphalt plant laboratory.

Submit a copy of each completed JMF, signed by a certified Asphalt Level 2 plant technician, to the DME/DMM at least 3 weeks before the planned start of mixture production. Include a list of all material sources and the asphalt producer in the JMF. Provide the calibration factors (C_f and 200 C_f) required by PTM No. 757 with the JMF. Do not start mixture production until after the DME/DMM reviews the JMF.

Submit a new JMF with a change in material sources or if a new JMF is necessary to produce an SMA mixture conforming to this specification.

1.a Producer QC Plan. Section 413.2(e)1.a , except RAP/RAS/RAM is not allowed in the mixture.

1.b Plant Technicians. Section 413.2(e)1.b

1.c Annual JMF Verification. During initial production of each JMF, verify, according to the QC Plan, that the mixture conforms to this specification. If the mixture does not conform to the single and multiple sample tolerances according to Tables D and E within 2 days of production, suspend shipping the mixture to the project. Do not ship the mixture to the project until after the Representative reviews and verifies that results conform to the single and multiple sample tolerances in Tables D and E. Perform annual verification of the asphalt mixture JMF.

1.d Production. Section 413.2(e)1.d, except as follows :

Produce and test mixtures, including Superpave Gyratory Compactor (SGC) specimens for quality control , except as modified by the Producer QC Plan. Maintain records of the testing of the asphalt mixture and make available for review by the Representative when requested.

1.d.3 Gradation. Section 413.2(e)1.d.3, except RAP and RAS are not allowed. Produce the mix within the tolerances of Table D.

1.d.5 Volumetric Analysis of Compacted Specimens. Sample the completed mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Prepare a minimum of two specimens from each sample according to AASHTO T 312.

Produce a mixture with volumetric properties conforming to the tolerances according to Table E. Determine the bulk specific gravity of the specimens as specified in AASHTO T 312 and calculate air voids (V_a) and Voids in Mineral Aggregate (VMA) at N_{design} according to AASHTO R 35 and as specified in Bulletin 27. Determine compliance with the multiple specimen tolerances using the average of the results for all specimens prepared from the sample.

1.d.6 Mixture Draindown. Sample the completed mixture according to PTM No. 1 a minimum of once daily. Perform draindown testing according to AASHTO T 305 along with the first mixture samples for each day's production. Produce a mixture that meets the tolerances of Table D.

1.d.7 Degree of Particle Coating. For all asphalt mixtures, sample the mixture according to PTM No. 1 and at the frequency in the Producer QC Plan. Determine the degree of particle coating of the completed asphalt mixture according to AASHTO T 195. Produce an asphalt mixture with percent coated particles ≥ 95.0%. Increase the plant mixing time or make other plant adjustments if the required percent of coated particles is not met. Produce an asphalt mixture capable of being handled, placed, and compacted without stripping the asphalt material from the aggregate.

TABLE D
Composition Tolerance Requirements of the Completed Mix

		Single Sample (n = 1)	**Multiple Samples (n ≥ 3)**
Gradation			
Passing 9.5 mm (3/8 inch) and Larger Sieves		±5%	±4%
Passing 4.75 mm (No. 4) to 150 µm (No. 100) Sieves (Inclusive)		±4%	±3%
Passing 75 µm (No. 200) Sieve		±3.0%	±2.0%
Asphalt Content			
% Asphalt by Weight		±0.7%	±0.4%
Draindown			
% by Weight		0.3 % maximum	
Temperature of Mixture (F)			
Class of Material	**Type of Material**	**Minimum**	**Maximum**
PG 64E-22	Asphalt Binder	260	330

TABLE E
Volumetric Tolerance Requirements of the Laboratory Compacted Mix

	Single Specimen (n = 1)	**Multiple Specimens (n ≥ 2)**
Air Voids at N_{design} (V_a)	±2.0% from JMF	±1.5% from JMF
Minimum VMA	17.0	_

1.e Corrective Actions. Immediately take corrective actions if one or more of the following occurs:

- QC test results on a single sample (n=1) for percent passing the 4.75 mm (No. 4) sieve, the 2.36 mm (No. 8) sieve, the 75 µm (No. 200) sieve, or asphalt content are not within the tolerances in Table D.
- The average of multiple samples (n≥ 3) for percent passing any sieve or asphalt content, as determined according to Section 419.2(e)1.d, are not within the tolerances according to Table D.
- QC test results on a single specimen (n=1) or on multiple specimens (n≥ 2) are not within the tolerances according to Table E.
- Draindown test result(s) are not within the tolerances according to Table D.

- Independent Assurance (IA) or QA sample results from testing at the producer's plant are not within the tolerances of Tables D or E.

After taking corrective actions, sample the completed mixture within 150 tons of production. After sampling, test the mixture and provide test results to the Representative within 500 tons of production. If less than three samples are tested for mixture composition, determine conformance with Table D by comparing each result to the multiple sample tolerances. If the mixture does not conform to the single and multiple sample tolerances in Table D and the single and multiple specimen tolerances in Table E, suspend production and shipping to the project and determine the cause of the problem. Provide a written explanation of the problem and a proposed solution to the Department. After the Representative reviews the proposed solution and authorizes production to continue, resume production and perform JMF verification according to the QC Plan.

(f) Mixture Acceptance.

1. General. The Department will accept the mixtures by lot acceptance as specified in Section 419.3(i)2.

2. Certification. SMA mixtures will not be accepted by certification. The only exception for SMA accepted by certification is small quantities of SMA mixture used for patches and miscellaneous placements equal to or less than 150 tons as specified in Section 419.3(i)2.a.

(g) WMA Technologies (Additive(s), Modifier(s), or Processes) and WMA Manufacturers. For WMA mixtures, Section 413.2(f)

(h) Anti-Strip Additives. For asphalt mixtures, Section 413.2(g)

(i) WMA Technology Manufacturer Technical Representative (Technical Representative). For asphalt mixtures, Section 413.2(h)

419.3 CONSTRUCTION—

(a) Preplacement Requirements. Provide asphalt mixtures as indicated for the entire project.

1. Paving Operation QC Plan. Prepare a paving operation QC Plan, as outlined on Form CS-409, for field control and evaluation of asphalt concrete paving operations. Submit the QC Plan to the Representative before or at the pre-construction conference. Include in the QC Plan a description of the construction equipment and methods necessary to construct and test the asphalt concrete courses as specified in Section 419.3. For asphalt mixtures, have the Technical Representative provide all recommendations and direction specific to the WMA technology in the paving operation QC Plan. Do not start paving until after the Representative reviews the QC Plan.

2. Preplacement Meeting. At least 2 weeks before placing asphalt paving mixtures, schedule an asphalt preplacement meeting with the Representative to review at a minimum the specification, paving operation QC Plan, sequence of paving operations, mixture acceptance, density acceptance, and the care and custody of asphalt acceptance samples.

(b) Weather Limitations. Do not place SMA paving mixtures from October 1 to March 31 in Districts 1-0, 2-0 (except Juniata and Mifflin Counties), 3-0, 4-0, 5-0 (Monroe and Carbon Counties only), 9-0 (Cambria and Somerset Counties only), and 10-0; and from October 16 to March 31 in Districts 2-0 (Juniata and Mifflin Counties only), 5-0 (except Monroe and Carbon Counties), 6-0, 8-0, 9-0 (except Cambria and Somerset Counties), 11-0 and 12-0. Exceptions require the written permission of the District Executive. Do not place asphalt paving mixtures when surfaces are wet or when the air or surface temperature is 50F or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are en route to the project.

(c) Asphalt Mixing Plant. Section 413.3(c), except the following requirements are for SMA mixes.
Obtain asphalt mixtures from a plant fully automated and recordated and currently listed in Bulletin 41. The necessary facilities for inspection include a plant office as specified in Section 714.5(a), except the minimum floor space is 120 square feet.

Ensure that both the aggregates and the completed mixture are free of unburned fuel oil and excess moisture as specified in Section 413.2(e)1.d.1.

For asphalt mixtures, make any plant modifications needed to introduce the WMA Technology additives, modifiers, or processes according to specific recommendations and direction from the Technical Representative or process manufacturer to achieve a uniform blend of the WMA Technology additive, modifier or foaming process and produce an asphalt mixture meeting these specifications. For batch plants, dry the aggregate according to the specific recommendations and direction from the Technical Representative.

1. Mineral Filler System. Follow the requirements listed in Chapter 1, Section 2.5 of Bulletin 27.

2. Stabilizer Supply System. Add stabilizer through specialized equipment that can accurately proportion and meter, by weight, the proper amount per batch for batch plants, or continuously and in a steady uniform manner for drum plants. Do not feed fiber, pelletized or loose, through the cold feed bins or through the RAP bins.

Provide proportioning devices that are interlocked with the plant system and controlled to ±10% of the weight of the fibers required. During the trial demonstration specified in Section 419.3(g), perform an equipment calibration to the satisfaction of the Representative to show that the fiber is being accurately metered and uniformly distributed into the mix.

Include the following on the stabilizer supply system:

- low level indicators
- no-flow indicators
- a printout of feed rate status in pounds/ minute
- a section of transparent pipe in the stabilizer supply line for observing consistency of flow or feed.

Have the Representative approve all stabilizer addition systems.

When a batch plant is used, add the stabilizer to the aggregate in the weigh hopper and increase both dry and wet mixing times. Ensure that the stabilizer is uniformly distributed before the injection of asphalt binder into the mixture. When a drum plant is used, do not allow the fibers to become entangled in the exhaust system. If there is any evidence of fiber in the bag-house or wet washer fines, relocate the liquid asphalt binder line and/or the fiber line so that the fiber is captured by liquid asphalt spray and incorporated into the mix. If there is any evidence of clumps of fibers or pellets at the discharge chute, increase the mixing time and/or intensity.

Store stabilizer in a dry environment.

3. Hot-Mixture Storage. Ship material within 2 hours of plant mixing. Stored SMA material that does not consistently meet the same quality as material discharged directly into hauling vehicles will be rejected.

(d) Hauling Equipment. Section 413.3(d)

(e) Asphalt Pavers. Section 413.3(e)1.

(f) Rollers. Use a minimum of three steel-wheeled rollers, each weighing a minimum of 10 tons and as specified in Section 108.05(c)3. Operate rollers according to manufacturer's recommendations. Use rollers equipped with a watering or soapy watering system that prevents material from sticking to the rollers. Do not use pneumatic wheeled rollers.

Do not use rollers in vibratory mode unless it can be demonstrated during the trial demonstration specified in Section 419.3(g) and to the satisfaction of the Representative that no breaking of aggregate or flushing of asphalt binder results from the vibration. Monitor pavement cores for aggregate breakage on every lot. Discontinue vibration if aggregate breakage or flushing of asphalt binder occurs.

(g) Demonstration. Before proceeding with the actual work, demonstrate to the Representative that the proposed SMA mix can be produced, placed, and compacted to meet the requirements of this specification. Place a minimum of 100 tons outside the project limits for each trial demonstration. Simulate the hauling time for the demonstration. Obtain and test three loose mixture samples at the plant for asphalt content, gradation, and draindown and three pavement cores from the demonstration pavement for density. Test one set of volumetric specimens for Air Voids at N_{design} (V_a) and test for one maximum specific gravity of the mixture value. If test results do not meet specification limits for both single and multiple sample tolerances for any parameter, perform another demonstration.

. If vibratory rolling is proposed, demonstrate to the satisfaction of the Inspector-in-Charge that no breaking of aggregate or flushing of asphalt binder results from the vibration.

(h) Preparation of Existing Surface. Section 413.3(g)

(i) Spreading and Finishing.

1. General Requirements.

1.a Placing. Unless otherwise allowed or indicated, deliver, place, and compact SMA paving mixtures during daylight hours. Ensure the mixture does not contain lumps of cold material. Deliver and place SMA mixtures at the temperatures specified in Table D.

Use a material transfer vehicle (MTV) as specified in Section 108.05(c)5 to apply the final surface course. Have the MTV perform additional mixing of the SMA material and then deposit the mixture into the paver at a uniform temperature and consistency.

1.b Spreading and Finishing. Section 413.3(h)1.b and as follows: Plan and schedule operations to minimize hand work of SMA. Do not allow the finished pavement surface to flush. Flushing is continuous or repeated areas of excessive asphalt on the pavement surface. Areas that are determined to be flushed will be considered defective work.

1.c Field Technician. Section 413.3(h)1. d

1.d Safety Edge. Construct the Safety Edge as the standard edge treatment on the outside edge of asphalt pavements and shoulders. Use the Safety Edge for both wearing and binder courses with a depth of 1.5 inches or greater. Do not place the Safety Edge at total depths greater than 5 inches. The Safety Edge is not required where curb or sidewalk are encountered or where the face of guiderail is directly over the edge of pavements. Do not place the Safety Edge for base, leveling, or scratch courses.

Construct the Safety Edge with the same material used to construct the roadway course being placed or, if specified, the paved shoulders. Attach a device to the paver to confine material at the end gate and extrude the asphalt material in a wedge shape. Use an adjustable device that allows the operator to vary the slope extruded at the paver to account for the angle becoming steeper during compaction (roll up). Before construction, the Safety Edge device must be approved by the Representative(s) (See Section 101.01).

Compact the roadway or paved shoulder as required by the specifications. Do not delay rolling of the mat adjacent to the Safety Edge. After compaction of the mat is complete, provide a Safety Edge meeting the final shape requirements as shown on the Standard Drawings. The completed angle of the Safety Edge must be 26 to 40 degrees measured from the pavement cross slope extended. At the beginning of each days paving, measure the angle of the Safety Edge from the pavement cross slope extended. Perform measurements after final compaction is complete. If the angle of the Safety Edge does not meet the slope requirements, stop paving and provide corrective action. Do not resume production paving until final shape requirements of Safety Edge are achieved.

Allow automatic transition to intersections, driveways, guiderail sections, and obstructions.

Use the device to constrain the asphalt head, reducing the area and increasing the density of the extruded profile. A single plate strike-off method is not allowed. Do not place the Safety Edge on organic material.

2. Mixture and Density Lot Acceptance (RPS Construction). Lot acceptance is required for RPS construction.

2.a Lots and Sublots. Material will be accepted in the field on a lot by lot basis. Lots will be established cumulatively and will be specific for each JMF. Each lot consists of five equal sublots (n=5). A completed sublot has a mixture acceptance box sample as specified in Section 413.3(h)2.b and a pavement core sample collected according to PTM No. 1 and PTM No. 729 as specified in Section 413.3(j)4.c.

A normal lot size is 2,500 tons with five, 500 ton sublots (n=5), unless operational conditions or project size dictate otherwise. If operational conditions or project size dictate, readjustment of the lot will be made as specified in section 413.3(h)2 Table D. Breakdowns or stoppages of short periods due to such causes as weather or equipment failure will not be considered as reasons to adjust the lot size. The original lot will be continued when work resumes after short stoppages of less than 5 calendar days. If a lot is ended due to a stoppage of 5 calendar days or more, adjust the lot size and number of sublots as specified in section 413.3(h)2 Table D. If the work stoppage is 5 calendar days or more, a new lot will be established.

For small quantities of SMA placements equal to or less than 150 tons, mixture acceptance will be based on certification as specified in sections 413.2(i)2.b and 419.2(f)2 and density acceptance will be accepted on optimum rolling pattern or non-movement as specified in section 413.3(j)

2.a.1 Partially Completed Lots (n=2 or less). When process conditions change to an extent that a partially completed lot cannot be combined with the most recently completed lot, samples will be independently evaluated on the partially completed lot. For asphalt content and percent passing the 75 μm (No. 200) sieve, mixture acceptance samples will be evaluated individually as specified in Section 419.4(a), Table G (n=1) criteria. For density, mat density acceptance samples will be evaluated individually using the criteria in Table F.

If samples tested for asphalt content and percent passing the 75 μm (No. 200) sieve meet the n=1 criteria of Table G, and samples tested for density meet the criteria in Table F, payment will be 100% of the contract unit price. If samples tested for asphalt content and percent passing the 75 μm (No. 200) sieve do not meet the n=1 criteria according to Table G, the material will be considered defective work. If samples tested for density are no more than 2.0% below the minimum or no more than 2.0% above the maximum limits according to Table F, payment will be 90% of the contract unit price. If samples for density are more than 2.0% below the minimum or more than 2.0% above the maximum limits of Table F, the pavement will be considered defective work.

Unless otherwise directed in writing by the District Executive, remove and replace defective work.

TABLE F
Density Limits for Partially Completed Lots

MIXTURE NMAS	DENSITY LIMITS
All RPS 9.5 mm, 12.5 mm Wearing Courses	≥ 93.0 and ≤ 98.0

2.a.2 For JMF's placed in quantities less than 2,500 tons. For JMFs placed in quantities of greater than 500 tons and less than 2,500 tons the tonnage will be considered a lot. The lot will be divided into five equal sublots.

For JMF's placed in quantities of 500 tons or less, the tonnage will be divided into three equal sublots and sampled as specified in 419.3(i)2.a.

2.b Mixture Acceptance and Theoretical Maximum Specific Gravity (Gmm) Verification Samples. The Representative will select different sample locations in each sublot according to PTM No. 1 and PTM No. 746. In the presence of the Inspector, obtain two loose mixture samples (One for acceptance and one for Gmm verification) for each sublot at each sample location and immediately package. Obtain the sample from uncompacted placed mixture or from the paver screed. One loose mixture sample at each location will be used to determine the mixture acceptance and the second loose mixture sample at each location will be used to determine the theoretical maximum specific gravity (Gmm) value. Both sets of mixture samples will be submitted to the testing laboratory on separate Form TR-447 sample identification forms.

Package individual loose mixture samples using interior lined cardboard boxes dimensioned approximately 3 3/4 inches x 4 3/4 inches x 9 1/2 inches. Do not package samples in cardboard boxes with any one dimension greater than 10 1/4 inches or any one dimension smaller than 3 1/2 inches. The lining is homogenously constructed within the interior portion of the cardboard box to prevent asphalt binder absorption/adhesion of the loose mixture sample.

Immediately after packaging and in the presence of the Representative, identify the samples by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as either mixture acceptance samples (Sample Class AS) or as Gmm verification samples (Sample Class FV). Leave at least one side of the cardboard sample box free of any writing or marking for LTS use in testing the samples.

Immediately after identifying, submit the samples to the Representative.

For quality control purposes, a maximum of one loose sample per sublot may be obtained. No loose mixture or core samples may be taken by the Contractor for mixture composition testing after the mixture acceptance samples and Gmm verification samples are obtained. Do not obtain any other pavement samples, except those which are directed by and surrendered to the Department, unless allowed in writing from the District Executive.

2.c Mixture and Density Acceptance Sample Testing. LTS Testing will be utilized unless otherwise indicated in the contract. The Contractor may elect to expedite delivery of the acceptance samples as specified in section 413.3(h) 2.b.

2.c.1 LTS Testing. The LTS will test the density acceptance samples according to PTM No. 715, and if necessary PTM No. 716, to determine the percent compaction. For individual increment test results outside of the individual mat density tolerances in Table G, the LTS will analyze the bulk density test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 419.3(i)2.a.1.

The LTS will then randomly select one of the Gmm verification loose mixture samples obtained as specified in Section 419.3(i)2.b from the lot according to PTM No. 1. The LTS will test the randomly selected Gmm verification loose mixture sample to determine the theoretical maximum specific gravity (Gmm) of the compacted mixture according to AASHTO T 209 as modified in Bulletin 27, with the following exception:

- The samples will be obtained as specified in Section 419.3(i)2.b.

The LTS will compare the randomly selected Gmm verification sample test result with the Contractor's daily Gmm value for that same production or placement date. If the LTS and Contractor Gmm values do not differ by more than ±0.030, the Contractor's daily Gmm values in the whole lot will be considered verified and the Contractor's daily Gmm values will be used to determine the percent of theoretical maximum density for each density acceptance sample placed on that date. If the initial randomly selected LTS Gmm verification sample test result differs from the Contractor's daily Gmm value for that same production or placement date by more than ±0.030, the LTS Gmm test result value will be used as the acceptance Gmm value to determine the percent of theoretical maximum density for the individual density acceptance cores produced or placed on that same date. The Department reserves the right to select more than one Gmm verification sample from the lot representing the same production or placement date and to select other Gmm verification samples from the lot representing different production or placement dates to verify the Contractor's daily Gmm values. When more than one Gmm verification sample is selected from the lot representing the same production or placement date, the LTS Gmm test results will be averaged and then rounded to the nearest 0.001 according to the rounding method of ASTM E29 and the average value used to verify to the Contractor's daily Gmm value for that same production and placement date.

The Department will accept density lots with three or more test results as specified in Section 419.4(a)3.

The LTS will test the mixture acceptance samples according to PTM No. 757 or PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, to determine asphalt content and the percent passing the 75 μm (No. 200) sieve. For PTM No. 757, the LTS will use the calibration factors (C_f and 200 C_f) provided with the JMF. For individual increment test results outside of the single sample (n=1) tolerances in Table D, the LTS will analyze the test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 419.3(i)2.a.1. The Department will accept lots as specified in Section 419.4(a).

Stop all paving operations if any of the following conditions exist:

- cores are not taken within 1 day after placing the mixture
- the density for two consecutive lots or a total of three lots does not meet the density payment factor percentage of 100
- asphalt content is not within the single sample (n=1) or multiple sample (n≥3) tolerances in Table D for two consecutive lots or a total of three lots
- the percent passing the 75 μm (No. 200) sieve is not within the single sample (n=1) or multiple sample (n≥3) tolerances in Table F for two consecutive lots or a total of three lots
- the pavement exhibits flushing as outlined in 419.3(i)1.b.

Determine the cause of the problem and provide a proposed solution to the Department. Do not resume paving until the Representative reviews the proposed solution and authorizes production to continue.

(j) Compaction. Begin rolling material immediately after placement. Compact the SMA mixture to achieve the density acceptance requirements and to eliminate all roller marks while not producing flushing of the asphalt binder. Compact the mixture while it is in proper condition and adjust roller speed, pattern, and roller size (and/or amplitude and frequency if vibratory rolling is approved by the Representative) to eliminate displacement, shoving, cracking, and aggregate breakage as specified in Section 419.3(f). Satisfactorily correct displacement resulting from reversing roller directions and other causes.

Without using excess water, maintain wheels of steel-wheel rollers moist and clean to prevent the mixture from adhering to the wheels.

For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

(k) Mat Density Acceptance. The Department will accept the mixtures by lot acceptance as specified in Section 419.3(i)2. The acceptance criteria will be as shown in Table F. The Department will determine acceptance with respect to density, as specified in Section 419.4(a)3.

The Representative will select different sample locations in each sublot according to PTM No. 1 and PTM No. 729. With the Representative present, drill 6-inch diameter cores as soon as possible but no later than the day following placement. The core at each location will be used to determine the bulk specific gravity (Gmb) and density (pounds per cubic foot) of the compacted mix. Do not compress, bend, or distort samples during cutting, handling, transporting, and storing. If samples are damaged, immediately obtain replacement samples, as directed by the Inspector, from within 12 inches of the original sample location. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

In the presence of the Representative, identify the samples by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as acceptance samples (Sample Class AS). Provide the daily theoretical maximum specific gravity value as specified in Section 419.2(e)1.d.4 for the density calculation of the lot. If density samples from the lot are taken from more than 1 day's placement, the daily theoretical maximum specific gravity values from each production day will be used to calculate the percent of theoretical density for each individual density acceptance core placed on that production day upon Gmm verification as specified in Section 419.3(i)2.c.1. Immediately deliver the samples to the Inspector and provide sample containers of sufficient strength to prevent samples from being damaged during transport and sufficient size to accommodate the density samples from one lot. The Representative will submit samples for one lot in one container.

For quality control purposes, a maximum of one pavement core per sublot may be obtained unless the Representative allows additional cores. No cores may be taken by the Contractor after the acceptance cores are obtained. Do not obtain any other pavement cores, except those which are directed by and surrendered to the Department, unless allowed in writing by the District Executive

(l) Joints. Section 413.3(k).

(m) Surface Tolerance. Section 413.3(l)

(n) Tests for Depth. Section 413.3(m)

(o) Protection of Courses. Section 413.3(n)

(p) Defective Work. As specified in Section 105.12 and as follows:

Department acceptance and QA testing does not relieve the Contractor of responsibility for material or workmanship that the Representative determines is defective before the Department issues the acceptance certificate. Remove and replace or repair defective work as directed. The CMD will review Representative determinations of defective material or workmanship.

Unless otherwise directed in writing by the District Executive, remove and replace pavement defective for flushing as specified in Section 419.3(i)1.b, surface tolerance as specified in Section 413.3(l) and depth as specified in Section 413.3(m). Remove and replace pavement defective for percent within limits or Payment Factor Percentage according to Table G.

419.4 MEASUREMENT AND PAYMENT—

(a) SMA RPS Construction.

1. SMA Wearing Course RPS. Square Yard or Ton

2. Asphalt Tack Coat. Section 460.4.

3. Mixture and Density Acceptance by Lot using Pavement Cores. The Department will pay on a lot-by-lot basis at the contract unit price, adjusted for Payment Factor Percentages as specified in Table G. For the payment factor percentages based on percent within limits, the Department will determine the percent within limits as specified in Section 106.03(a)3, using the upper and lower specification limits in Table H.

3.a Payment.

The Representative will compute the percent of the contract unit price paid as follows:

Lot Payment = $C_P(2P_D + P_B + P_A)/400$

C_P = Contract unit price per lot (unit price times lot quantity)

P_D = Payment Factor Percentage for density

P_B = Payment Factor Percentage for asphalt content.

P_A = Payment Factor Percentage for percent passing the 75 µm (No. 200) sieve

TABLE G
Contract Price Adjustments

Test Criteria	Test Value	Payment Factor Percentage
Asphalt Content		
Acceptance Sample testing of % Asphalt	All acceptance sample test results are within ±0.7% for n=1 and ±0.4% for n≥ 3 of the JMF	100
	Percent Within Limits if all acceptance sample test results are not within ±0.7% for n=1 and ±0.4% for n≥ 3 of the JMF	Table I
Gradation		
Acceptance Sample Testing of % Passing 75 µm (No. 200) Sieve	All acceptance sample test results are within +3.0% and -3.0% for n=1, and + 2.0% and -2.0% for n≥ 3 of the JMF	100
	Percent Within Limits if all acceptance sample test results are not within +3.0% and -3.0% for n=1, and + 2.0% and -2.0% for n≥ 3 of the JMF	Table I
Mat Density		
Acceptance Sample Testing of Pavement Cores	All individual results for the lot are ≥ 93.0 % and ≤ 98.0 % of the maximum theoretical density	100
	Percent Within Limits if any individual sublot test result for the lot is not ≥ 93.0 % and ≤ 98.0 % of the maximum theoretical density.	Table I

TABLE H
Upper and Lower Specification Limits for Calculating Percent Within Limits

Testing Criteria	
Lower Specification Limit (L)	**Upper Specification Limit (U)**
Asphalt Content from JMF Value, %	
-0.4	+0.4
Percent Passing the 75 µm (No. 200) sieve from JMF Value, %	
-2.0	+2.0
Mat Density*	
92.0	98.0
* The Percent of Theoretical Maximum Density	

TABLE I
Payment Factor Based on Percent Within Limits

Percent Within Limits	Payment Factor Percentage
99	97
98	97
97	97
96	96
95	96
94	96
93	95
92	95
91	95
90	95
89	93
88	91
87	90
86	88
85	86
84	84
83	83
82	81
81	79
80	78
79	76
78	74
77	72
76	71
75	69
74	67
73	66
72	64
71	62
70	60
69	59
68	57
67	55
66	54
65	52
64	50
Less than 64	Defective Lot**

**Remove and replace the lot. If only one lot characteristic has a percent within limits less than 64, the District Executive may allow the Contractor to leave the defective lot in place. The Department will pay for the defective lot at 50% of the contract unit price.

3.b Dispute Resolution. For mixture acceptance testing or density acceptance testing performed by the LTS, the Contractor may request in writing that the Department retest a lot if the initial test results indicated a defective lot (remove and replace) except for density when one or more density acceptance cores in the lot were coated with paraffin wax as a result of PTM No. 716 during the original density acceptance testing. Provide written retest requests to the District Executive within 3 weeks of the date the LTS test results are released. Retests will not be allowed if a written retest request is not received within 3 weeks of the date the LTS test results are released. Provide quality control test results and control charts, companion sample test results (if available), test data trend evaluation, and any other pertinent information to justify the retest request. The Department will evaluate the information and may allow

retesting if the information submitted provides a reasonable basis to conclude that the failing test results may not represent the in-place material. The LTS will perform the retest with the Contractor present, unless otherwise agreed to in writing with the Contractor.

For retesting of materials failing for asphalt content or percent passing 75 µm (No. 200) sieve, the Inspector will identify the locations where the original mixture acceptance samples were collected. The Inspector will select retest sample locations 24 inches from the original sample locations longitudinally in the direction of traffic. If the 24 inch offset causes the retest sample location to fall outside of the sublot, the Inspector will select the retest sample location 24 inches from the original sample locations longitudinally in the opposite direction from traffic.

With the Inspector present, provide appropriate traffic control and drill 6-inch diameter cores for retesting purposes according to the procedure for drilling in PTM No. 729. Ensure drilling procedures include washing off and towel drying the core samples immediately after drilling. Within 24 hours after coring, backfill the hole with SMA or Superpave mixture of the same NMAS and PG asphalt grade as the material sampled or with mixture used for subsequent courses and compact and seal the mixture. Provide traffic control, core, and backfill the core holes at no cost to the Department. The test method used for asphalt determination during the original acceptance testing (PTM No. 757 or PTM No. 702) will be used for the retest, unless the DME/DMM grants written approval for a change in test method. The results of the retest cores will be used to calculate payment for both asphalt content and percent passing the 75 µm (No. 200) sieve for the lot.

When a request is received for retesting of density acceptance, the original density acceptance cores will be utilized. The LTS will not retest a lot for density acceptance when one or more density acceptance cores in the lot were coated with paraffin wax as a result of PTM No. 716 during the original density acceptance testing. The LTS will retest each original density acceptance core according to PTM No. 715 and PTM No. 716, as necessary, to determine the Gmb and bulk density values. The LTS will not perform Gmm testing for lots where the Contractor's Gmm value was previously considered verified as specified in Section 413.3(j)4.d.1. After Gmb testing is completed, for lots where the Contractor's Gmm value was not verified, the LTS will select one original density acceptance pavement core from each production or placement date represented by the density acceptance cores in the lot. Each core selected will be the core with the highest bulk density for that production or placement date from the retest results (e.g., if a lot was placed over three production days, and the lot density acceptance cores include at least one core from each production or placement day, the original density cores selected during a density retest to perform Gmm testing will be 3; one from each production or placement date). The LTS will perform Gmm testing on the selected cores according to AASHTO T 209 as modified in Bulletin 27, with the following exceptions:

- the samples will be obtained as specified in Section 413.3(j)4.c,
- no conditioning, only drying, will be performed on the sample,
- the minimum sample size will be waived, as necessary, to use the 6-inch diameter pavement core sample, and
- the supplemental procedure for mixtures containing porous aggregate will only be performed when either the coarse aggregate or fine aggregate in the mixture has a water absorption value ≥ 1.5% as indicated on the JMF and then only when the calculated percent of theoretical maximum density indicates any one individual failing sublot which results in a density pay factor less than 100.00.

The LTS Gmm value(s) determined will be the Gmm values used to determine the percent of theoretical maximum density for the cores represented by the applicable production or placement dates in the lot. Either the previously verified Contractor's Gmm value(s) or the newly tested LTS Gmm value(s) will be used for acceptance to determine the percent theoretical maximum density for each sublot core in the lot. Upon completing the retesting of the original density acceptance cores, the LTS will evaluate testing repeatability for the bulk density results of PTM No. 715 and PTM No. 716, if necessary, using both the original bulk density test values and the bulk density retest values according to PTM No. 5. After evaluating the testing repeatability, the density test values used to determine the final payment factor percentage for density will be as follows:

- If repeatable, the original test values will be used.
- If lack of repeatability (i.e., non-repeatable), the retest values will be used.

The Department will deduct from the payment the cost per lot associated with conducting a retest as follows in Table J:

TABLE J
Dispute Resolution Retest Cost Table

Test Method	**Mixture Acceptance Retest Cost if Retest Results Indicate** **100% Pay Factor(s)**	**Mixture Acceptance Retest Cost if Retest Results Indicate** **<100% Pay Factor(s)**
PTM No. 702/739	$900	$3,500
PTM No. 757	$500	$2,000
	Density Acceptance Retest Cost if Retest Results Indicate a Lack of Repeatability	**Density Acceptance Retest Cost if Retest Results are Repeatable**
PTM No. 715, or PTM No. 716 only	$200	$750
PTM No. 715, or PTM No. 716, and AASHTO T 209 as specified in Section 413.3(j)4.d.1	$1,100	$4,000

4. Demonstration. Section 419.3(g) PDA

SECTION 420—PERVIOUS ASPHALT PAVEMENT SYSTEM

420.1 DESCRIPTION—This work is the construction of plant-mixed asphalt concrete pervious pavement on a prepared surface designed to allow the infiltration of storm water into the subsoil. The pervious asphalt surface layer is a horizontal plane that is permeable to water and air. The second layer of the storm water system is an open graded, angular stone layer that is used for temporary storm water detention.

420.2 MATERIAL—

(a) Aggregate. Section 703

1. Coarse Aggregate.

1.a For use in Asphalt JMF. Course Aggregate, Type A, Section 703.2, except Table C gradation does not apply and revise the following quality requirements of Table B.

- Abrasion, Maximum Percent as specified in Bulletin 27, Chapter 2A, Table 5A
- Thin and Elongated Pieces, Maximum Percent as specified in AASHTO M 323, Table 5, for Flat and Elongated
- Crushed Fragments, Minimum Percent, as specified in AASHTO M 323, Table 5, for Fractured Faces, Coarse Aggregate

1.b For use in Detention Basin. Either AASHTO No. 3 as the primary detention coarse aggregate topped with AASHTO No. 57 as a choker and leveling coarse; or AASHTO No. 57 only, as designed and specified.

2. Fine Aggregate.

2.a For use in Asphalt JMF. Section 703.1, except Table A gradation does not apply and as follows: Determine the un-compacted void content according to AASHTO T 304, Method A, or use the value listed in Bulletin 14, and conform to AASHTO M 323, Table 5. Determine the sand-equivalent value according to AASHTO T 176 and conform to AASHTO M 323, Table 5.

2.b For use in Detention Basin. Fine Aggregate, Type A or Type B.

(b) Fibers. Section 711.3(g)

(c) Geotextile, Class 4, Type A. Section 212

(d) Edge Restraints. Provide asphalt edge restraints (as a locally approved material as specified in Section 106.02(a)2.c) when specified and of sufficient strength to resist lateral roller forces where the pervious asphalt adjoins landscaped areas to provide a clean, durable edge for the pavement. Other edge restraints may be utilized with the approval of the Representative. For manufactured edge restraints, install in accordance with the manufacturer's guidelines. Provide black edge restraints when permanently incorporated into the project.

(e) Asphalt Binder Material.

1. Pervious 9.5 mm Wearing Course. Asphalt Cement, Class PG 64H-22 or PG 64E-22 as specified in Section 702. Approved polymer additives or ground tire rubber may be used to meet the PG grade.

2. Pervious 19.0 mm Binder Course. Asphalt Cement, Class PG 64S-22 as specified in Section 702.

(f) Recycled Asphalt Pavement. Limit RAP to a maximum of 10% of the mixture.

(g) Additives. Incorporate an anti-strip additive or hydrated lime for pervious mixes utilizing the same aggregates as approved 9.5 mm or 19.0 mm dense graded mixtures and with the same PG grade binder where an anti-strip additive

was required. If no history exists for an approved dense graded mixture, perform testing in accordance with ASTM D 3625 on the finished mix with a minimum of 90% coating to determine moisture susceptibility and an anti-strip additive is required.

1. Heat-Stable, Anti-Stripping Additive. Blend the additive with the asphalt cement before adding the additive and asphalt cement to the mixture. Use the manufacturer's recommended dosage of the additive, but not less than 0.25% by weight of the asphalt. Select an additive that does not harm the completed asphalt concrete mixture and that is compatible with the aggregate and asphalt supplied for the project.

2. Pervious Asphalt Stabilizer. Perform testing in accordance with AASHTO T 305 to determine whether a stabilizer is required. When required, provide cellulose fibers in the mixture according to the tolerances in Table B. Stabilizer dosage rate must be within 0.2% to 0.4% by weight of the total mix.

(h) Mixture Design and Production.

1. Design. Size, uniformly grade, and combine aggregate fractions according to Table A. Determine air voids using any method from Table B for bulk specific gravity. Determine the maximum theoretical specific gravity in accordance with AASHTO T 209. Gyrate two specimens in accordance with AASHTO T 312 and determine bulk specific gravity by averaging them, employing one of the methods in Table B to calculate air voids.

Test materials, proportions, and the mixture at the asphalt concrete plant laboratory. Verify conformance with the uniformity requirements of this specification. Verification testing may be performed by the LTS at the Department's discretion. Provide a JMF that conforms to all Department requirements. Submit a copy of the JMF to the DME/DMM at least 3 weeks before the scheduled start of producing the mixture for the project. If the Department has not used the JMF on a previous project, provide test results from previous mixture production that indicate the mixture conformed to all JMF production tolerances when submitting the design for initial review.

TABLE A
Composition of Mixture
(Total Percent by Mass (Weight) Passing Square Openings Based on Laboratory Sieve Tests)

	Pervious 9.5 mm Wearing	**Pervious 19.0 mm Binder**
Sieve Size	**Percent Passing**	**Percent passing**
25.0 mm (1-inch)		100
19.0 mm (3/4-inch)	100	85 - 100
12.5 mm (1/2-inch)	95 - 100	35 - 68
9.5 mm (3/8-inch)	70 - 100	
4.75 mm (No. 4)	20 - 40	10 - 25
2.36 mm (No. 8)	10 - 20	5 - 15
75 µm (No. 200)	0 - 4	0 - 4
Asphalt Content	5.5% - 7.0%	3.0% - 5.0%

TABLE B
Mixture Composition

Gyrations	$N_{initial}$	N/A
	N_{design}	50
	$N_{maximum}$	N/A
Air Voids	ASTM D 6752	16.0% - 20.0%
	AASHTO T 275	18.0% - 22.0%
	AASHTO T 269*	18.0% - 22.0%
Draindown	AASHTO T 305	≤ 0.3%

*When using AASHTO T 269 the height of the specimen will be determined by the gyratory compactor reading at N_{design}.

2. QC Plan. Prepare and submit a QC Plan, as specified in Section 106. Provide the QC plan to the Representative at the start of the project. Do not begin production until receiving approval of the QC Plan from the Representative.

3. Production. Perform QC Tests in accordance with Table C.

TABLE C
Production Testing

Property	Frequency	Range
Asphalt content	Daily	± 0.7%
Gradation	Daily	Table A
Air Voids	Daily	Table B
Draindown	Daily	≤ 0.3% at design compaction temperature

4. Acceptance of the Mixture. Obtain material certifications from the material producer using the results of QC tests for asphalt content, gradation, and air voids. Provide copies of the certifications to the Inspector-in-Charge within 1 working day after performing QC tests.

420.3 CONSTRUCTION—

(a) Test Sections. Produce two test sections using the approved JMF and placement and finishing operations to be used in production and construct at the project site on a prepared subgrade and base, using the material and construction requirements used in production. Each section must have an area of at least 225 square feet. Perform infiltration on both test sections in accordance with ASTM C 1701. The average of both infiltration values must exceed 200 inches per hour. Compacted thickness cannot be more than 1/4-inch less than the design thickness.

(b) Subgrade Preparation. Excavate subgrade to undisturbed soil without compaction, allowing the subgrade to be left as permeable as possible. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, remove the accumulated material using light equipment and scarify the underlying soil to a minimum depth of 6 inches using a spring tooth rake or equivalent and a light tractor. Avoid driving haul trucks or other heavy equipment through the installation area. Repair damaged areas to the satisfaction of the Representative. Do not compact or otherwise subject the existing subgrade under pavement areas to excessive construction equipment traffic before geotextile and stone bed placement. Satisfactorily correct and repair any damaged or compacted areas to the satisfaction of the Representative. Notify the Representative upon completion of subgrade work for final inspection and acceptance before proceeding with basin and choker course installation.

(c) Detention Basin. Prevent sediment from washing into beds during site development. Cover the bottom of the detention base with a minimum of 2 inches of fine aggregate to prevent soils from migrating into the storm water storage area. Wrap basin sides with a non-woven geotextile fabric. Install detention basin coarse aggregate in 8 inch maximum lifts. Compact the course in as specified in Section 360.3. Install aggregates to grades indicated on drawings. Place the specified depth(s) of coarse aggregate on top of the fine aggregate and roll as specified in Section 420.3(f). Remove temporary sediment control materials when the site is fully stabilized.

(d) Asphalt Treated Permeable Base Course. Section 360.3, where required for buses or light trucks.

(e) Weather Limitations. Do not place pervious pavement mixtures when the air or surface temperature is lower than 50F.

(f) Rollers. Use smooth steel-wheeled rollers in the static mode and seat with one to four passes. Do not use pneumatic tire rollers.

(g) Conditioning of Existing Surface. Before placing a wearing course, correct irregularities in the binder course. If practical, do not allow traffic on the binder course to prevent contamination. Remove and replace binder course that cannot be cleaned to the Representative's satisfaction.

Coat existing vertical surfaces of curbs, structures, gutters, and pavements that will be in contact with asphalt mixtures with a thin, uniform coating of emulsified asphalt (AASHTO SS-1, CSS-1, SS-1h, CSS-1h, or TACK) applied in two or more applications, or of the class and type designated for the asphalt course.

Do not use a tack coat between lifts of any pervious asphalt. Place the wearing course as soon as practical after the placement of the binder course.

(h) Spreading and Finishing. Use a track paver, as specified in Section 413.3(e), or a mechanical spreader. Spread or strike off the entire for the entire lane width or as much lane as practical. Place the mixture in maximum 4-inch compacted lifts. Adjust screed assemblies to provide the cross section and depth indicated. Construct the profile to the design grade line. Use fully automatic sensors to control profile and transverse grade. Allow the mixture to cool to 100F before placing subsequent layers or pavement courses. Perform handwork at locations directed by the Representative. For multiple lift construction, second lift may be placed and rolled perpendicular to the direction of placement and rolling of the first lift.

Do not use pervious pavement beds for storage of equipment, materials, or soils during construction.

(i) Compaction. Compact the pervious asphalt pavement when the surface is cool enough to resist a 10-ton steel-wheeled static roller or vibratory roller operated in the static mode. Limit compaction to not more than four passes to preclude a reduction in the surface porosity. One roller pass is defined as one trip of the roller in one direction over any one spot. Do not over compact the material to the point that it is not free draining or the aggregate is crushed.

(j) Joints.

1. Longitudinal Joints. Spread the pervious paving course to overlap the edge of the lane previously placed by 1 inch to 2 inches. Maintain the uniform un-compacted depth adjacent to a compacted lane necessary to provide a smooth joint after compaction.

2. Transverse Joints. At the end of each day's work and when more than a 30 minute interruption occurs in pervious paving operations, install a temporary vertical bulkhead to form a straight transverse construction joint. The joint must be the full depth and width of the pervious paving course. In lieu of a temporary bulkhead, a full depth transverse joint may be sawed before resuming paving.

(k) Surface Tolerance. Test the finished surface at locations the Representative suspects are irregular and at transverse joints and paving notches. Test the surface in stages using a 12-foot straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the road centerline and, in successive positions, test the pavement surface from one side to the other. Advance the test location to the next stage by moving the straightedge along the pavement centerline by not more than 5 feet.

Immediately correct irregularities of more than 3/8-inch by loosening surface mixture and removing or adding pervious paving course. For irregularities exceeding 3/8-inch that develop after compaction is completed, correct the irregularity by a method that does not produce contaminating fines or damage the base. Do not grind or mill the pervious paving course. The area is defective if irregularities or defects remain after final compaction. Remove and replace defective areas. If allowed, submit a corrective action plan to the representative for approval.

(l) Tests for Depth: Binder and Wearing Courses. Carefully dig or drill one 6-inch diameter test hole to the full depth of the pervious course for each 3,000 square yards or less of completed base course. The Representative may require additional test holes in areas the Representative suspects are deficient in depth. The Representative will measure the depth of the pervious course. Using material acceptable to the Representative, backfill the test holes and compact the material to fill the test hole flush with the completed course.

Remove and replace sections deficient in depth by 1/2-inch or more. Start correction at the point of determined deficiency and continue correction longitudinally and transversely until the depth is within 1/2-inch of the indicated depth.

(m) Infiltration Testing. Perform infiltration testing on three areas selected in accordance with PTM No. 1 for every 10,000 square feet of pervious asphalt pavement placed in accordance with ASTM C 1701. Remove and replace pervious asphalt pavement not meeting or exceeding a minimum average infiltration rate of 200 inches per hour. Document the average infiltration value from testing for use in future maintenance activities.

(n) Defective Work. Unless otherwise directed in writing by the District Executive, remove and replace pervious asphalt that is deficient in surface tolerance, depth, asphalt content, percent of coated aggregate particles is less than 95%, or when percent passing the 4% maximum for the No. 200 sieve for the composite mixture is exceeded.

Pervious courses are also considered defective if the ASTM C 1701 infiltration rate is less than 200 inches per hour.

With written permission from the District Executive, low areas may be filled during construction of the next pavement course.

420.4 MEASUREMENT AND PAYMENT—

(a) Pervious Asphalt Pavement System. Square Yard or Ton

1. Pervious Wearing Course. Square Yard or Ton

2. Pervious Binder Course. Square Yard or Ton

(b) Asphalt Treated Permeable Base Course. Section 360.4

SECTION 450—MANUAL ASPHALT PATCHING

450.1 DESCRIPTION—This work is preparing and patching of potholes, abrupt depressions, and deteriorated edges of pavement, and repatching temporarily patched potholes using asphalt plant mix material placed manually or with mechanical spreading and finishing equipment.

450.2 MATERIAL—

(a) Superpave Asphalt Mixture Design.

- **Asphalt Wearing Course.** Section 413.2

(b) Superpave Asphalt Mixture Design.

- **Asphalt Binder Course.** Section 413.2

(c) Asphalt Tack Coat. Section 460.2

450.3 CONSTRUCTION—As specified in Sections Section 413.3 and as follows:

(d) Manual Asphalt Patching, Type A. For potholes and abrupt depressions 3 inches and less in depth, perform the work manually with asphalt wearing course as indicated.

1. Preparation. Cut out and patch the outlined area as marked by the Representative. Ensure each patch has a minimum area of 1 square foot. Excavate outlined area to sound, stable material. The use of a milling or planing machine will be allowed. Cut all edges vertically.

After removal of the debris, thoroughly clean the area to be patched and the surrounding pavement of all loose and foreign material. Thoroughly dry all surfaces of the area to be patched.

Apply tack coat to the bottom and vertical surfaces of the area to be patched as specified in Section 460.3(b).

2. Patching. After the tack coat is cured, place asphalt wearing course. Compact with a steel wheeled roller or other approved compaction equipment. Ensure that, after compaction, the surface of the patch conforms to the grade of the surrounding pavement. Fill all excavated areas before the close of each work day.

Potholes which extend into the shoulder do not require excavation beyond the edge of roadway. If the existing shoulder has an asphalt base, fill the shoulder portion of the pothole with asphalt and compact in the same manner as the roadway.

For other shoulder types, fill the pothole with suitable material excavated from the roadway pothole and compact. Seal edges with emulsified asphalt, Class TACK or NTT, the PG-Binder used in the pavement course or PG 64S-22.

(e) Manual Asphalt Patching, Type B. For potholes and abrupt depressions over 3 inches in depth, perform the work manually with asphalt wearing course and asphalt binder course as indicated.

1. Preparation. Section 450.3(d)1.

2. Patching. After the tack coat is cured, place asphalt binder course in lifts not to exceed 3 inches in uncompacted depth. After leveling each lift, compact with an approved mechanical tamper. Place asphalt wearing course material in the topmost 1 1/2 inches of the patch. Ensure that, after compaction, the surface of the patch conforms to the grade of the surrounding pavement. Compact the last lift with steel wheeled roller or other approved compaction equipment. Fill all excavated areas before the close of each work day, except that the 1 1/2 inch wearing course may be placed on the following day.

Potholes which extend into the shoulder do not require excavation beyond the edge of roadway. If the existing shoulder has an asphalt base, fill the shoulder portion of the pothole with asphalt wearing course and compact in the same manner as the roadway.

For other shoulder types, fill the pothole with suitable material excavated from the roadway pothole and compact. Seal the edges with emulsified asphalt, TACK or NTT, the PG-Binder used in the pavement course or PG 64S-22.

450.4 MEASUREMENT AND PAYMENT—

(a) Superpave Asphalt Mixture Design.

- **Asphalt Wearing Course (Manual Patching).** Ton

(b) Superpave Asphalt Mixture Design.

- **Asphalt Binder Course (Manual Patching).** Ton

SECTION 460—ASPHALT TACK COAT

460.1 DESCRIPTION—This work is the conditioning and treating of an existing surface with an application of emulsified asphalt bonding material.

460.2 MATERIAL

(a) Emulsified Asphalt Material. One of the following as specified in Section 702. Submit a Certificate of Compliance as specified in Section 106.03(b)3 and a Bill of Lading as specified in Section 702.1(c) to the Representative indicating the asphalt residue content (ARC) of the material being used. If the emulsified asphalt material is stored for 30 days or longer after certification, resample and retest the emulsified asphalt material at no additional cost to the Department to determine if it meets Bulletin 25 specification requirements.

TABLE A
Emulsified Asphalt Materials

Class of Material	Type of Material	Application Temperature F	
		Minimum	Maximum
TACK	Anionic or Cationic Emulsified Asphalt	90	150
NTT/CNTT	Anionic or Cationic Emulsified Asphalt	140	180

(b) Fine Aggregate (For Blotting). Section 703.1

460.3 CONSTRUCTION—

(a) Conditioning Existing Surface. Section 413.3(g).

(b) Application of Emulsified Asphalt Material. Use a distributor designed, equipped, calibrated, maintained, and operated to apply material uniformly on surfaces with varying widths and up to 15 feet wide. Provide a distributor capable of maintaining a uniform distributing pressure and controlling the application rate (AR) within a tolerance of 0.02 gallon per square yard. Provide a distributor equipped with a tachometer, pressure gauges, accurate volume-measuring devices or a calibrated tank, a thermometer for measuring temperatures of tank contents, a power-operated pump, and full circulation spray bars with lateral and vertical adjustments. Provide nozzles sized according to the manufacturer's recommendations for the material selected for application. In the field, determine the distributor's application rate according to PTM No. 747.

The Contractor may use hand-spraying equipment in areas inaccessible to the distributor.

Apply tack coat at an application rate, approved by the Representative, to leave a uniform asphalt residual rate within the ranges per surface type according to Table B. Identify the application rates and the residual rates on the Paving Operation QC Plan and review the QC plan application rates and residual rates with the Representative at the Preplacement Meeting.

TABLE B
Uniform Asphalt Residual Rates by Surface Type

Surface Type	Uniform Asphalt Residual Rates (RR) (gallons per square yard)
New Asphalt Paving	0.03 to 0.05
Existing Asphalt Paving	0.04 to 0.07
Milled Surface (Asphalt & Portland Cement Concrete)	0.04 to 0.08
Portland Cement Concrete	0.04 to 0.07

The application rate to achieve a uniform asphalt residual rate can be determined using the following equation:

AR = (RR / ARC)

AR = Application Rate, (gallons per square yard); the amount of emulsified asphalt sprayed by the distributor truck.

RR = Residual Rate; (gallons per square yard); the amount of emulsified asphalt remaining on the surface after it has broken and set.

ARC = Asphalt Residue Content; (% divided by 100); the percentage amount of asphalt in the emulsified asphalt. Provided on the Bill of Lading and expressed as a decimal.

When paving operations begin, apply tack coat on a 100-linear foot minimum test section on the project for each paving course. Apply tack coat at the distributor's application rate to achieve the proposed residual rate within the ranges listed in Table B. Adjust distributor application rate and spray bar height to obtain a uniform surface coverage. Review adequacy of the tack coat coverage with the Representative before continuing with the tack coat application.

Apply the tack coat only when the air temperature is 40F and rising and when the existing surface is dry. Before each paving course, apply the tack coat at an application rate to be within ranges of the uniform asphalt residual rate for the surface type according to Table B. Uniformly distribute the tack coat over the entire surface. Extend the tack coat a minimum of 6 inches beyond the longitudinal joint of the paving course being placed.

Correct all uncoated or lightly coated areas as directed to the Representative's satisfaction. At designated locations, correct areas with an excess of emulsified asphalt material by covering the area with sufficient dry fine aggregate to blot up or remove excess tack coat.

Allow the tack coat to break and set, without being disturbed. Do not begin paving until the Representative determines the tack coat has cured to the point that tracking is minimized.

(c) Protection of Treated Surface. Maintain and protect the treated surface against damage. Repair damaged areas to the Representative's satisfaction before placing the next pavement course.

460.4 MEASUREMENT AND PAYMENT—

(a) Area Basis. Square Yard

(b) Material Used Basis. Gallon

SECTION 461—ASPHALT PRIME COAT

461.1 DESCRIPTION—This work is the conditioning and treating of an absorbent non-asphalt base course or an absorbent existing surface with an application of emulsified asphalt and, if required, a blotter material.

461.2 MATERIAL—

(a) Emulsified Asphalt Material. One of the following, as specified in Section 702:

Class of Material	Type of Material	Application Temperature °F Minimum	Application Temperature °F Maximum
AE-P	Emulsified Asphalt	90	150
E-1 Prime	Emulsified Asphalt	100	170

(b) Fine Aggregate (for Blotting). Section 703.1

461.3 CONSTRUCTION—

(a) Conditioning Existing Surface. Section 413.3(g), except delete emulsified asphalt painting of existing surfaces and the application of a tack coat.

(b) Application of Emulsified Asphalt Material. Use a distributor as specified in Section 460.3(b). Within the specified temperature range, select application rates for AE-P and E-1 Prime emulsified asphalt from 0.30 gallon per square yard to 0.70 gallon per square yard. Obtain approval of the application rates.

Uniformly distribute the tack coat at the junction of adjacent applications.

Following application, do not disturb the prime coat. Allow the emulsified asphalt to penetrate the treated surface and the treated surface to absorb the emulsified asphalt until the Inspector-in-Change determines the emulsified asphalt is completely cured.

Apply additional emulsified asphalt to uncoated or lightly coated areas.

Twenty-four hours after applying the prime coat, cover areas the Representative identifies as showing an excess of prime coat material with sufficient dry fine aggregate to blot up or remove excess prime coat material.

(c) Protection of Treated Surface. Maintain and protect treated surface against damage. Repair damaged areas to the Representative's satisfaction before placing succeeding construction.

461.4 MEASUREMENT AND PAYMENT—

(a) Area Basis. Square Yard

(b) Material Used Basis. Gallon

SECTION 466 – ASPHALT PAVING FABRIC

466.1 DESCRIPTION– This work is furnishing and placing a geotextile paving fabric on an existing pavement surface and prior to an overlay or construction of pavement layer as a waterproofing and stress relieving membrane interlayer**.**

466.2 MATERIAL –

(a) Geotextile Paving Fabric. As listed in Bulletin 15, meeting the requirements of AASHTO M 288, Paving Fabrics Type II. Provide a stable fiber, needle-punched, nonwoven material consisting of at least 85% by weight polyolefins, polyesters or polyamides. The paving fabric shall be resistant to chemical attack, rot and mildew and have no tears or defects that will adversely alter its physical properties. The fabric shall be specifically designed for pavement applications and be heat-set on one side to reduce tack coat bleed-through and to minimize fabric pick-up by construction equipment during installation. Identify each geotextile paving fabric roll according to ASTM D4873.

(b) Asphalt Material. Performance-Graded Asphalt Binder (PGAB), meeting the requirements of AASHTO M 322, PG 64S-22 as modified in Bulletin 25 as specified in Section 702.

466.3 CONSTRUCTION–

(a) General/Manufacturer Technical Representative. Provide a copy of the geotextile paving fabric manufacturer's installation instructions to the Representative before installation. Ensure that a trained Manufacturer's Technical Representative is present during every phase of installation, unless applied by a factory trained licensed installer, as indicated by written approval from the material supplier. The Manufacturer's Technical Representative will provide training and technical assistance on surface preparation, equipment, method of application and finish. The paving fabric shall be labeled according to AASHTO M288, "Standard Guide for Identification, Storage and Handling of Geotextiles."

(b) Shipping and Storage. Keep geotextile paving fabric dry and wrapped so it is protected from outdoor weather elements during shipping and storage. Store geotextile paving fabric elevated off the ground and covered to protect it from damage, ultraviolet light, precipitation, chemicals and sparks. The paving fabric shall be labeled according to ASTM D4873, "Standard Guide for Identification, Storage, and handling of Geosynthetic Rolls and Samples."

(c) Weather Limitations. Place as specified in Section 413.3(b). Do not place asphalt material and geotextile paving fabric when weather conditions are not suitable for installation according to the fabric manufacturers recommendations and the Representative.

(d) Surface Preparation. Dry and clean pavement surface of dirt and oil. Seal cracks as specified in Section 469.3(d). Allow crack-filling material to cure before placement of the geotextile paving fabric. Repair potholes and other pavement distresses as specified in Section 450. Perform repairs identified by the Representative. The geotextile paving fabric must be placed on a drainable surface with no depressions which may hold water in the overlying asphalt concrete.

(e) Asphalt Material Application. Apply asphalt material using a calibrated distributor truck spray bar. Hand spraying, squeegee and brush application may only be used in locations where the distributor truck cannot reach. Make every effort to keep hand application to a minimum. Apply asphalt material uniformly to the prepared, clean, dry pavement surface. The application rate must saturate the geotextile paving fabric to ensure bonding of the geotextile fabric to the existing pavement surface. Apply asphalt material at a rate of 0.22 to 0.28 gallons per square yard as required to completely cover the roadway and as approved by the Manufacturer's Technical Representative. Maintain the temperature of the asphalt material to allow a uniform spray pattern. For performance grade asphalt binders, the minimum temperature will be 290F. Asphalt material temperature must not exceed 350F to avoid

damage to the geotextile paving fabric. The target width of the asphalt material application will be equal to the paving fabric width plus 6 inches.
Asphalt material application must be wide enough to cover the entire width of geotextile fabric overlaps. Apply asphalt material only as far in advance of geotextile paving fabric installation as is appropriate to ensure a tacky surface at the time of geotextile paving fabric placement. Do not allow traffic on the tack coat. Clean excess tack coat from the pavement.

(f) Geotextile Paving Fabric Placement: Place the paving fabric onto the asphalt material using mechanical or manual laydown equipment capable of providing a smooth installation with a minimum amount of wrinkling or folding. Place geotextile paving fabric before the asphalt cement cools and loses its tackiness. Do not install geotextile paving fabric in areas where the overlaid asphalt tapers to a minimum compacted thickness of less than 1.5 inches. Slice and lay flat wrinkles severe enough to cause folds. Brooming and/or rubber-tire rolling will be required to maximize geotextile paving fabric contact with the pavement surface. Apply additional hand-placed asphalt material at overlaps and repairs identified by the Representative. Turning of the paver and other vehicles must be done gradually and kept to a minimum to avoid movement and damage to geotextile paving fabric. Avoid abrupt starts and stops to avoid damage to paving fabric. Remove damaged geotextile fabric and replace with same type of geotextile fabric.

(g) Fabric Joints and Overlaps: At joints, overlap fabric rolls by a 1 inch minimum. End joints and joints from repair of wrinkles must be made to overlap or "shingle" in the direction that the pavement overlay will be placed. Overlaps of adjacent rolls may vary due to variations between the width of the roadway and paving fabric. Apply asphalt material between all fabric overlaps. Apply asphalt material between all fabric overlaps. Overlaps that do not have asphalt material will be corrected by manual placement of asphalt material or trimmed to a 1 inch overlap before overlay construction. No traffic except necessary construction traffic will be allowed to drive on the paving fabric.

(h) Overlay Placement: Asphalt overlay construction will closely follow fabric placement. Verify minimum asphalt material temperature with Manufacturer's Technical Representative and as identified in field QC Plan. All areas in which paving fabric has been placed shall be paved during the same day. Blot excess tack coat that bleeds through the paving fabric by broadcasting sand on the paving fabric. Remove loose sand before beginning the paving operation. In the event of rainfall on the paving fabric before the placement of the asphalt overlay, the paving fabric must be allowed to dry before the asphalt overlay is placed. Overlay asphalt thickness must meet the requirements for the contract drawings and documents. The minimum compacted thickness of the first lift of overlay asphalt will not be less than 1.5 inches in areas of paving fabric installation.

466.4 MEASUREMENT AND PAYMENT –

(a) Geotextile Paving Fabric. Square Yard

(b) Manual Asphalt Patching. Section 450.4

(c) Crack Filling and Sealing. Section 469.4

SECTION 467—HEAVY DUTY MEMBRANES

467.1 DESCRIPTION—This work is placing heavy duty membranes over transverse and longitudinal joints and random cracks in existing concrete pavements at locations indicated or directed by the Representative.

467.2 MATERIAL—

(a) Heavy Duty Membrane. As listed in Bulletin 15 and include the certification specified in Section 106.03(b)3 with each shipment.

(b) Asphalt Cement, Class PG 64S-22 or PG 58S-28. Section 702

467.3 CONSTRUCTION—

(a) General. Provide a copy of the manufacturer's written installation instructions.

(b) Surface Preparation. Remove dirt and debris from all joints and cracks that will be under the membrane. Fill joints or cracks over 1/4 inch wide flush to the surface with PG 64S-22 or PG 58S-28. Before placing the membrane, ensure the pavement is sound, dry, and free of any debris or deteriorated and loose materials and prepare the surface according to the manufacturer's recommendations.

(c) Primers or Binders. Apply a primer or binder material to milled surfaces according to the manufacturer’s recommendations.

(d) Membrane Placement. Place the membrane according to the manufacturer's recommendations including temperature and equipment requirements. Unless otherwise specified by the manufacturer, place the membrane approximately centered over the joints and cracks. Slit the membrane and overlap the edges of wrinkles over 3/8 inch in width that cannot be smoothed out. Securely bond the edges and corners of the strips to the surface. Before placing the overlay, re-bond or replace strips with loose edges or corners.

(e) Traffic Control. Before paving, the Contractor may only allow traffic on the membrane during the 7 calendar-day period immediately after placing the membrane.

(f) Manufacturer Technical Representative. Ensure that a trained manufacturer’s technical representative is present during every phase of application, unless applied by a factory trained licensed installer providing written approval from the material supplier.

The manufacturer’s technical representative will provide training and technical assistance on surface preparation, equipment, mixing of components, type and method of placement and finish.

467.4 MEASUREMENT AND PAYMENT—Square Yard or Linear Foot for the width indicated.

SECTION 469—ASPHALT JOINT AND CRACK SEALING

469.1 DESCRIPTION—. This work is the cleaning and sealing of longitudinal and transverse joints and random cracks in existing pavement surfaces.

469.2 MATERIAL—

(a) Asphalt Rubber Sealing Compound. Section 705.4(g)

(b) Rubberized Joint Sealing Material. Section 705.4(c)

(c) Asphalt Wearing Course 4.75 mm. Section 413.2

469.3 CONSTRUCTION—

(a) General. Obtain material from a source listed in Bulletin 15 or Bulletin 41 as applicable.

(b) Heating Procedures. Heat the material within the safe heating temperature range and recommended pouring temperatures found on the label on the manufacturer's shipping container. Place the material according to the manufacturer’s recommendations e. Do not maintain batches of material at the pouring temperature for more than 6 hours. Reheat according to the manufacturer's recommendations.

(c) Surface Preparation. Clean, dry, and remove debris and loose material from cracks, joints, and adjacent pavement surfaces. If required, rout cracks to create a reservoir 1/2 inch deep. Clean the pavement for 4 inches to 6 inches on either side of the joint or crack. Immediately before sealing, use a compressed air stream of at least 100 pounds per square inch measured at the source, or a hot compressed air lance to clean and dry damp cracks in asphalt pavements. If using the hot compressed air lance, do not damage the surrounding pavement area from overheating. Clean, dry, and remove debris and loose material from cracks, joints, and adjacent pavement surfaces.

(d) Sealing. Seal joints and cracks from 1/4 inch to 1 inch wide with asphalt sealant and fill joints and cracks over 1 inch wide with Asphalt Wearing Course 4.75 mm.

If using asphalt sealant, fill prepared joints and cracks level with the pavement surface. Wipe the sealant flush with the pavement surface, leaving a thin film of sealant from 1/32 inch to 1/16 inch thick and from 1 inch to 3 inches wide. After wiping the joint or crack, remove and dispose of excess sealant. Unless allowed with written approval by the Department, do not place sealant when the air temperature is below 40F or above 90F.

469.4 MEASUREMENT AND PAYMENT—

(a) Asphalt Joint and Crack Sealing. Linear Foot or Gallon
For the type specified.

(b) Asphalt Wearing Course 4.75 mm. Ton Section 413.4(a)3

SECTION 470—ASPHALT SEAL COAT

470.1 DESCRIPTION—This work is the application of emulsified asphalt, immediately followed by application of coarse aggregate.

470.2 MATERIAL—

(a) Emulsified Asphalt Material. One of the following, as specified in Section 702.

Class of Material	Type of Material	Application Temperature F Minimum	Application Temperature F Maximum
RS-2PM	Polymer-Modified Emulsified Asphalt	140	175
CRS-2PM	Polymer-Modified Cationic Emulsified Asphalt	140	175
HFRS-2PM	Polymer-Modified High Float Emulsified Asphalt	140	175
RS-2(1)	Emulsified Asphalt	140	175
CRS-2(1)	Cationic Emulsified Asphalt	140	175
HFRS-2(1)	High-Float Emulsified Asphalt	140	175

(1) Only for use on municipal projects and State projects approved by the District Executive in writing.

(b) Coarse Aggregate. Type A, No. 8, or on roadways with less than 1,000 ADT No. 89, Section 703.2 or a gradation listed in Table A and with the SRL designated in the Contract Item. Supply aggregate from a source listed in Bulletin 14. The Contractor may use an aggregate or blends of aggregates with an SRL equal to or better than that specified. Blends are 50% by weight of the two aggregates. Mix the aggregates using an approved method.

Table A
Aggregate Gradations for Seal Coats

Sieve Size	Total Percent Passing Type SC-1(1)
12.5mm (1/2 inch)	100
9.5mm (3/8 inch)	90-100
6.25mm (1/4 inch)	0-70
4.75mm (No. 4)	0-25
2.36mm (No. 8)	0-5
75µm (No. 200)	0-1.0
Note: Material finer than 75µm (No. 200) sieve will be determined according to PTM No. 100. Aggregate is to meet the requirements of Table B, Type A specified in Section 703.2, except 703.2(c)3 flat and elongated particles must have a ratio of 1:3 (3:1) conforming to ASTM D4791, Method A.	

470.3 CONSTRUCTION—At least 2 weeks before the scheduled start work, submit a seal coat design for the Representative's review. Design the seal coat according to the method in Appendix E of Bulletin 27. If the source or gradation of aggregate changes or if type of asphalt changes, submit a new seal coat design.

(a) Preparing Existing Surface. Remove and dispose of all unsuitable material. Where indicated, seal cracks as specified in Section 469.

(b) Application of Emulsified Asphalt. Apply emulsified asphalt when the entire surface is in condition to allow satisfactory material penetration and adhesion and when the air, surface, and aggregate temperatures are above 60F.

Do not apply emulsified asphalt if, in the Representative's opinion, rain is imminent or if freezing temperatures are expected within 24 hours after application.

Except when approved by the District Executive in writing, do not apply RS-2PM(, or CRS-2PM from September 15 to May 1 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, 10-0, 11-0, 12-0, and 5-0 (Monroe, Carbon, and Schuylkill Counties only); and from October 1 to May 1 in Districts 6-0, 8-0, and 5-0 (Berks, Lehigh, and Northampton Counties only).

Use a distributor as specified in Section 460.3(b). Use a rate of application within ±10% of the design rate. Determine the distributor application rate in the field according to PTM No. 747. If the Representative determines that the design application rate for the emulsified asphalt is too low or too high, the emulsified asphalt application rate may be adjusted in the field to account for unforeseen or changing conditions.

For inaccessible areas, uniformly spread the emulsified asphalt over the surface using portable pressure units. The quantity of material placed at one time shall be consistent with the facilities for handling, spreading, and rolling coarse aggregate, as well as the temperature of the surface and emulsified asphalt.

Uniformly spread the emulsified asphalt at the junction of separate applications.

(c) Spreading and Rolling Coarse Aggregate. Use dry aggregates or damp aggregates for seal coats. Avoid aggregates with excessive free moisture. Before spreading aggregate, verify the calibration of the spreader using a method acceptable to the Inspector-in-Charge.

Immediately after applying the emulsified asphalt, uniformly spread a single layer of coarse aggregate at the design rate using a mechanical spreader capable of spreading 15 pounds per square yard to 25 pounds per square yard.

Within 5 minutes after application of the emulsified asphalt begin rolling the aggregate with pneumatic-tire rollers, as specified in Section 108.05(c)3.f. Provide a sufficient number of rollers to roll the width of stone spread within 5 minutes after the start of rolling. Overlap each pass by 1 foot with the adjacent roller pass. Make a minimum of two roller passes over the aggregate between the wheel paths. Roll each pass at a speed of less than or equal to 10 miles per hour to prevent turning over aggregate. Use a contact pressure from 40 pounds per square inch to 50 pounds per square inch.

(d) Protection of Surface. Do not allow vehicular traffic or loads on the newly completed surface until the material obtains adequate stability and adhesion and the material is sufficiently cured to prevent distortion, flushing of emulsified asphalt to surface, and loss of aggregate. Check the surface to ensure that the emulsified asphalt has set in shaded areas. Shaded areas may require longer set times.

Provide sufficient flaggers and pilot vehicles to move traffic through the work zone or over the completed work at speeds that prevent aggregate distortion or pick-up. If needed, sweep the surface with a power broom to remove surplus aggregate before and after opening the road to traffic. Provide a shadow vehicle for sweeping operations after opening the road to traffic.

Utilize only Waterborne Pavement Markings as specified in Section 962 on asphalt seal coats.

(e) Evaluation of Completed Seal Coat Surface. The Representative will evaluate the completed seal coat surface 1 day after completion of the seal coating operations and after final sweeping has been completed. If the surface of the seal coat aggregate is less than 50 percent embedded in the asphalt, the Representative may require the application of a fog seal as specified in Section 472.

470.4 MEASUREMENT AND PAYMENT—

(a) Area Basis. Square Yard

(b) Crack Filling and Sealing. Section 469.4

SECTION 471—ASPHALT SEAL COAT USING PRECOATED AGGREGATE

471.1 DESCRIPTION—This work is application of asphalt material immediately followed by an application of asphalt precoated aggregate.

471.2 MATERIAL—

(a) Asphalt Precoating Material. One of the following, as specified in Section 702:

Class of Material	Type of Material	Application Temperature °F Minimum	Application Temperature °F Maximum
MC-30	Cut-back Asphalt	70	120
MC-70	Cut-back Asphalt	100	150
SS-1h (E-8A)	Emulsified Asphalt	70	150
CSS-1h (E-8C)	Cationic Emulsified Asphalt	70	150
PG 64S-22	Asphalt Cement	275	350
PG 58S-28	Asphalt Cement	250	325

(b) Asphalt Material. One of the following, as specified in Section 702:

Class of Material	Type of Material	Application Temperature °F Minimum	Application Temperature °F Maximum
RS-2 (E-2)	Emulsified Asphalt	140	175
CRS-2 (E-3)	Cationic Emulsified Asphalt	140	175
PG 46S-40	Asphalt Cement	240	300

Only use PG 46S-40 on shoulders.

(c) Coarse Aggregate. Section 470.2(b)

(d) Preparation of Pre-Coated Aggregate. Use free-flowing, pre-coated aggregate so it can be stocked, handled, and uniformly spread by a self-propelled spreader. Prepare pre-coated aggregate as follows:

1. Asphalt Cement. Use an asphalt cement to pre-coat the aggregate only if it pre-coats the aggregate to the Representative's satisfaction. Provide a pre-coating with 0.6% to 1.2% residual asphalt binder (by weight of the mix). Dry the aggregate in a batch or continuous type asphalt plant conforming to the requirements of Bulletin 27. Precoat the aggregate in the pug mill. Mix the materials at a mixing temperature not exceeding 350F. Stock mixed material on a suitable base area and no higher than 4 feet.

2. Other Asphalt Materials. The Contractor may use damp aggregate and a stabilization plant. Provide a pre-coating with 0.4% to 1.0% residual asphalt binder. If using damp aggregate with cut-back asphalts, sufficiently cure the pre-coated aggregate before use to prevent pickup. Do not exceed an aggregate temperature of 150F if using cutback asphalts.

Select an application rate sufficient to provide a thin, brownish, and translucent film on the aggregate. Cover at least 90% of the total visible surface area of the aggregate. Before producing the pre-coated aggregate, prepare a sample of the pre-coated aggregate for the Representative's inspection.

The Representative will use the sample to establish the visual inspection standard associated with at least 90% of the visible surface area covered.

During production, the Representative will determine if less than 90% of the visible surface area is covered. If the Representative determines less than 90% of the visible surface area is covered, the Contractor may determine the percent of uncoated material passing the 75 µm (No. 200) sieve after dry sieving for 10 minutes. The

Representative will accept the pre-coated aggregate if the percent passing does not exceed 0.5%. Stock mixed material on a suitable base area and, if using heated aggregates, no higher than 4 feet.

471.3 CONSTRUCTION—Section 470.3 and as follows:

(d) Protection of Surface. If required, sweep the surface with a power broom to remove loose chips before and after opening the road to traffic. For emulsified asphalt, allow sufficient time for the seal coat to completely cure before opening the road to all traffic.

471.4 MEASUREMENT AND PAYMENT—

(a) Area Basis. Square Yard

(b) Material Used Basis.

1. Coarse Aggregate. Square Yard
The unit price includes the asphalt precoating material.

2. Other Asphalt Material. Gallon

(c) Crack Filling and Sealing. Section 469.4

SECTION 472—ASPHALT FOG SEAL FOR ASPHALT SEAL COATS

472.1 DESCRIPTION—This work is the treatment of an asphalt seal coat with an application of asphalt material and an application of fine aggregate.

472.2 MATERIALS—

(a) Emulsified Asphalt Material. One of the following, as specified in Section 702:

TABLE A
Fog Seal Materials

		Application Temperature (F)	
Class of Material	**Type of Material**	**Minimum**	**Maximum**
CSS-1h(1)	Cationic Emulsified Asphalt	70	150
SS-1h(2)	Emulsified Asphalt	70	150
SS-1hPM	Polymer-Modified Emulsified Asphalt	70	150
CSS-1hPM	Cationic Polymer-Modified Emulsified Asphalt	70	150

Dilute Material using 1 part emulsion to 1 part water. All dilution must be done by the emulsified asphalt supplier at the emulsified asphalt supplier plant location. Provide a Bill of Lading from the emulsified asphalt supplier certifying the base emulsified asphalt properties before dilution, the quantity of emulsified asphalt, and the water added for dilution, or certify the diluted product. Diluted emulsified asphalt must be applied within 48 hours after dilution. Dilution of asphalt emulsion in the field is not allowed.

Notes:
Material selection for the Fog Seal application:
1. Use a Cationic Emulsified Asphalt material CSS-1h when a Cationic Emulsified Asphalt was used for the Asphalt Seal Coat.
2. Use an Anionic Emulsified Asphalt material SS-1h when an Anionic Emulsified Asphalt was used for the Asphalt Seal Coat.

(b) Fine Aggregate (Cover Sand). Type A, Type B1, or B3, Section 703.1

472.3 CONSTRUCTION—Place the fog seal on an asphalt seal coat constructed as specified in Section 470, or as directed by the Representative. Allow the seal coat to cure a minimum of 1 day before fog sealing. Place the fog seal application within 1 to 45 days after the last day of the seal coat placement.

(a) Weather Limitations. Apply fog seal when the air, surface, and aggregate temperatures are above 60F. Do not apply emulsified asphalt if, in the Representative's opinion, rain is imminent or if freezing temperatures are expected within 8 hours after application. The fog seal will normally cure within 2 hours under dry conditions and temperatures above 60F.

(b) Surface Preparations. The road surface must be clean and dry prior to placing the fog seal. If needed, lightly sweep the pavement with a motorized broom to remove excess seal coat aggregate. If the seal coat surface aggregate is damaged by the sweeping operation stop sweeping. Cover manholes, valve covers, sensors, etc. to prevent adherence of the emulsified asphalt. Remove protective coverings prior to opening the road to traffic.

(c) Emulsified Asphalt Application. Apply the emulsified asphalt with a distributor meeting the requirements of Section 460.3(b). Place emulsified asphalt on all completed seal coated areas.

Construct a 100-foot test strip. Review the application of diluted (1:1) emulsified asphalt and adjust the application rate as needed. Apply between 0.1 to 0.2 gallons per square yard, diluted. Determine the distributor's application rate in the field according to PTM No. 747. Apply the emulsified asphalt to minimize the amount of overspray.

(d) Fine Aggregate (Cover Sand) Application. Apply fine aggregate uniformly over the surface treatment within 5 minutes of applying the emulsified asphalt. The fine aggregate application rate is 2 to 5 pounds per square yard. Lightly cover remaining spots of excess emulsified asphalt with fine aggregate, before opening to traffic. Sweep the pavement with a motorized broom prior to opening to traffic.

(e) Pavement Markings. Interim pavement markings can be placed after the fog seal cures. Do not place permanent pavement markings on the fog seal until 3 days after the last day of fog seal placement.

(f) Opening to Traffic. Check shaded areas to ensure the fog seal has cured fully before opening fog sealed roadways to traffic. Do not allow traffic on the emulsified asphalt until it has cured.

472.4 MEASUREMENT AND PAYMENT—

(a) Area Basis. Square Yard

(b) Material Used Basis.

1. **Fine Aggregate.** Ton

2. **Emulsified Asphalt Material.** Gallon

SECTION 473—ASPHALT SEAL COAT USING AGGREGATE FROM RAP

473.1 DESCRIPTION—This work is an application of emulsified asphalt immediately followed by application of seal coat aggregate made from RAP.

473.2 MATERIAL—

(a) Emulsified Asphalt Material. One of the following, as specified in Section 702.

Class of Material	Type of Material	Application Temperature (F) Minimum	Maximum
RS-2P	Polymer-Modified Emulsified Asphalt	140	175
CRS-2P	Polymer-Modified Cationic Emulsified Asphalt	140	175
HFRS-2P	Polymer-Modified High Float Emulsified Asphalt	140	175
RS-2	Emulsified Asphalt	140	175
CRS-2	Cationic Emulsified Asphalt	140	175
HFRS-2	High-Float Emulsified Asphalt	140	175

(b) Coarse Aggregate.

1. Seal Coat Aggregate from RAP. Crush, screen, and grade RAP material that is free of deleterious construction debris to meet the gradation requirements of Table A. Provide documentation certifying that the unprocessed RAP material was obtained from a source that required the use of only Bulletin 14 approved aggregates.

TABLE A
Gradation Requirements of Seal Coat Aggregate from RAP

Sieve Size	% Passing by Weight*
12.5 mm (1/2 inch)	100
9.5 mm (3/8 inch)	85 – 100
4.75 mm (No. 4)	0 – 30
2.36 mm (No. 8)	0 – 15
1.18 mm (No. 16)	0 – 10
75 µm (No. 200)*	0 - 1

* Determined by PTM No. 100 (Material finer than 75 µm (#200) by wash)

The requirements of Section 703.2 do not apply to Seal Coat Aggregate from RAP.

2. Acceptance of Seal Coat Aggregate from RAP. Section 703.5(b) with the following modifications and additions:

2.a QC. Replace Section 703.5(b)1 with the following:

Section 106.03(b)2 and as follows:

- Submit for annual review a QC plan according to POM B.7.14 except the minimum testing frequency is as follows:

- During processing of the seal coat aggregate from RAP, sample and test the gradation of the finished seal coat aggregate from RAP the first day of production and a minimum of once every 1,000 tons of seal coat aggregate from RAP produced.

Before shipment, the Representative will inspect the stockpile and truck loading of seal coat aggregate from RAP for clumps and oversized material. If clumps or oversized material retained on the 12.5 mm (1/2 inch) sieve are detected in the stockpile or during loading of vehicles, reprocess the seal coat aggregate from RAP to remove clumped or oversized material. Processed seal coat aggregate from RAP stored in uncovered stockpiles and not used within one month after production, or processed seal coat aggregate from RAP stored in covered stockpiles and not used within three months of processing must be reprocessed to remove clumps and oversized material retained on the 12.5 mm (1/2 inch) sieve.

2.b Source Verification Samples. Section 703.5(b)3. With the following addition:

Department force projects are not required to obtain project verification samples as required in Section 703.5(b)3.

473.3 CONSTRUCTION—Section 470.3, with the following additions:

Placement of seal coat aggregate from RAP on routes over 1,000 ADT must be approved in writing by the District Executive. Provide documentation of the SRL of the unprocessed RAP material. All documentation must be signed by the DME/DMM certifying that the unprocessed RAP is from a Bulletin 14 approved source and is the SRL level indicated. Do not use seal coat aggregate from RAP on roads over 5,000 ADT.

(b) Application of Emulsified Asphalt. Add the following:
Apply seal coat aggregate from RAP when the temperature of the existing roadway surface exposed to direct sun light is below 120F. If material starts to stick to the tires of reclaimed seal coat aggregate delivery trucks, stop seal coat placement operations until the existing roadway temperature is below 120F.

473.4 MEASUREMENT AND PAYMENT—

(a) Area Basis. Square Yard

(b) Material Used Basis.

1. Coarse Aggregate. Square Yard or Ton
The square yard unit price includes the production and placement of seal coat aggregate from RAP. The tonnage item only includes the seal coat aggregate from RAP.

2. Other Asphalt Material. Gallon

(c) Crack Filling and Sealing. Section 469.4

SECTION 480—ASPHALT SURFACE TREATMENT

480.1 DESCRIPTION—This work is two applications of emulsified asphalt, with each application of emulsified asphalt immediately followed by an application of coarse aggregate.

480.2 MATERIAL—

(a) Emulsified Asphalt. Section 470.2(a)

(b) Coarse Aggregate. Type A, No. 8 and No. 67, Section 703.2.

Provide aggregate to achieve at least the SRL designation indicated in the Contract Item and from sources supplying aggregate for use in wearing courses. The Contractor may provide a blend of two aggregates if the blend has an SRL equal to or better than that specified. Blends are 50% by weight of each aggregate. Mix the aggregates by an approved method.

480.3 CONSTRUCTION—At least 2 weeks before the scheduled start of work, submit a surface treatment design for the Representative's review. Design the surface treatment according to Appendix E of Bulletin 27.

(a) Conditioning Existing Surface. Section 470.3(a)

(b) Application of Emulsified Asphalt and Coarse Aggregate. Section 470.3(b) and (c), except apply at the following rates and according to the following sequence:

FIRST APPLICATION

Apply emulsified asphalt at a rate of 0.25 gallon per square yard to 0.50 gallon per square yard. Use a mechanical spreader to spread 25 pounds per square yard to 45 pounds per square yard of No. 67 coarse aggregate. Roll the aggregate as specified below and then sweep off the loose material. Allow the first application to cure to the Representative's satisfaction before spreading the second application.

SECOND APPLICATION

Apply emulsified asphalt at a rate of 0.25 gallon per square yard to 0.50 gallon per square yard. Use a mechanical spreader to spread 15 pounds per square yard to 30 pounds per square yard of No. 8 coarse aggregate. Roll the aggregate as specified below.

(c) Rolling. Provide pneumatic-tire rollers as specified in Section 108.05(c)3.f and with a contact pressure from of 40 pounds per square inch to 50 pounds per square inch. Use a sufficient number of rollers to cover the width of stone spread during the first pass. When the emulsified asphalt has a tacky surface, backroll the aggregate with a pneumatic-tire roller or a steel-wheel tandem roller until the aggregate adheres to the emulsified asphalt. If directed, eliminate backrolling. Do not roll in the vibratory mode.

(d) Protection of Surface. Section 470.3(d)

480.4 MEASUREMENT AND PAYMENT—

(a) Area Basis. Square Yard

(b) Material Used Basis.

1. **Coarse Aggregate.** Square Yard

2. **Emulsified Asphalt.** Gallon

(c) Crack Filling and Sealing. Section 469.4

SECTION 481—ASPHALT SURFACE TREATMENT USING PRECOATED AGGREGATE

481.1 DESCRIPTION—This work is two applications of asphalt material, each immediately followed by an application of precoated aggregate.

481.2 MATERIAL—

(a) Asphalt Precoated Material. Section 471.2(a)

(b) Asphalt Material. Section 471.2(b)

(c) Coarse Aggregate. Section 480.2(b)

(d) Preparation of Precoated Aggregate. Section 471.2(d)

481.3 CONSTRUCTION—Section 480.3

481.4 MEASUREMENT AND PAYMENT—

(a) Area Basis. Square Yard

(b) Material Used Basis.

1. Coarse Aggregate. Square Yard
The unit price includes the asphalt precoating material.

2. Asphalt Material. Gallon

SECTION 482—SLURRY SEAL

482.1 DESCRIPTION—This work is construction of an emulsified asphalt slurry seal course of the type designated.

482.2 MATERIAL—

(a) Emulsified Asphalt Material. Emulsified Asphalt, Class SS-1h(E-8A), or CSS-1h(E-8C), Section 702.

(b) Fine Aggregate. Section 703.1
Provide aggregate with the SRL designation in the Contract Item. Supply the aggregate from an acceptable source for use in wearing courses. The Contractor may supply an aggregate or aggregate blend with an SRL equal to or better than in the Contract Item. Blends are 50% by weight of each aggregate. Mix aggregates by an approved method.

(c) Filler. Section 703.1(c)1

(d) Water. Section 720.2, and free from harmful soluble salts. If water exceeds 150 ppm (9 grains) hardness, lower to below 150 ppm (9 grains) by adding water softener.

(e) Mixture Composition. Design and test the slurry seal mixture according to ASTM D 3910.
Provide fine aggregate, asphalt emulsion, water, and, if required, filler conforming to the Representative directed composition by weight percentages that are within the limits of Table A.

TABLE A
Composition by Weight Percentages
Combined Aggregate Gradations

	Percentages by Weight		
Passing Sieve	**Type I**	**Type II**	**Type III**
3/8-inch	100	100	100
No. 4	100	90 - 100	70 - 90
No. 8	90 - 100	65 - 90	45 - 70
No. 16	65 - 90	45 - 70	28 - 50
No. 30	40 - 60	30 - 50	19 - 34
No. 50	25 - 42	18 - 30	12 - 25
No. 100	15 - 30	10 - 21	7 - 18
No. 200	10 - 20	5 - 15	5 - 15
Asphalt Residue Percent by Weight of Dry Aggregate	10.0 - 16.0	7.5 - 13.5	6.5 - 12.0

1. Type I. Use to seal cracks, fill voids, and correct surface erosion. Apply dry aggregate at a rate from 6 pounds per square yard to 10 pounds per square yard.

2. Type II. Use to fill surface voids, correct severe surface erosion conditions, and provide a minimum wearing surface. Apply dry aggregate at a rate of 10 pounds per square yard to 15 pounds per square yard.

3. Type III. Use to provide a new moderate wearing surface or to build up a crown. Apply dry aggregate at a rate of 15 pounds per square yard or more.

482.3 CONSTRUCTION—

(a) Weather Limitations. As specified in Section 413.3(b), except do not place mixture if the air temperature is 50F or lower, or if the pavement temperature is 50F or lower.

(b) Equipment Requirements. Produce the mixture in a self-propelled, continuous-flow mixing apparatus capable of accurately proportioning, combining, and mixing the materials into a homogeneous mixture with an asphalt film of sufficient thickness to furnish the desired binding properties.

Use an apparatus that contains bins, tanks, and receptacles of sufficient size and volume; proportioning feeders; liquid measuring meters or devices; and a mechanical mixer and distributor for placing the finished mixtures. Materials are to be delivered to the mixer simultaneously and in time-adjusted sequence by integrated, mechanized, and synchronized components.

(c) Mixer. A mixer of the spiraled, multi-blade type, or other acceptable type, with the following components, is required:

- mixing chamber having a stated capacity (not to be exceeded);
- mechanical equipment to regulate mixing time up to, but not exceeding, 4 minutes;
- equipment to pre-wet the aggregate before aggregate contact with asphalt emulsion; and
- a gate for controlling discharge of mixture into the distributor spreader.

(d) Spreading Equipment.

1. Distributor. A mechanically-operated, squeegee-type distributor is required, one which is integrally assembled with the slurry mixer and which includes the following:

- a strike-off, lined with flexible material to prevent loss of slurry mixture during spreading;
- a strike-off, with vertical adjustment available for changing grade and cross slope to ensure uniform spreading of mixture; and
- a pressure system and a fog-type spray bar, adequate for placing a complete fog coat of water over pavement surface immediately preceding spreading of mixture, with a maximum 0.05 gallon per square yard application rate of water.

2. Auxiliary Equipment. Provide hand squeegees, shovels, surface-cleaning machines, and other hand equipment, as necessary.

(e) Conditioning of Existing Surface. Section 413.3(g)1, except:

- Seal open joint and cracks with an acceptable crack sealer or emulsion.
- In addition to the surface cleaning specified, also remove heavy paint build-up.
- Cover and satisfactorily protect existing raised pavement markers.
- Replace damaged markers.

(f) Placement. Control the temperature of the components of the completed mixture so application temperature of the slurry seal is within the range designated, but not less than 50F or more than 125F.

(g) Joints.

1. Transverse Joints. Construct by either overlapping previously cured slurry with 10 feet to 15 feet of fresh slurry, or by lightly wetting the area the spreader box will touch, while the slurry is in a completely uncured, semi-fluid condition.

2. Longitudinal Joints. Construct as follows:

Do not wet the slurry if it is completely uncured. Pull a burlap bag, or other suitable device, along the joint seam, to cause fresh slurry from the spreader box to distribute itself evenly over the joint.

Wet the slurry with the spring bar, if the slurry is completely cured.

(h) Curing. Do not allow traffic on the surface until directed, to allow the slurry seal to completely cure to a firm condition that will prevent pick-up of the mixture.

482.4 MEASUREMENT AND PAYMENT—Square Yard

SECTION 483—POLYMER-MODIFIED EMULSIFIED ASPHALT PAVING SYSTEM (MICRO SURFACING)

483.1 DESCRIPTION—This work is the construction of a polymer-modified emulsified asphalt paving system, commonly known as micro-surfacing, to fill ruts and/or resurface existing pavements.

Micro-surfacing material is classified into three mix types as follows:

(a) Type A. Used to seal cracks, fill voids and shallow (less than 1/2 inch) ruts, and provide a scratch course or surface seal. Use a double application, when specified, to meet total design pounds per square yard for surface courses.

(b) Type B. Used to fill moderate (1/2 inch to 1 1/4 inch) ruts; and provide a scratch course, a leveling course, a seal coat, or a surface treatment. Use a double application, when specified, to meet total design pounds per square yard for surface courses.

(c) Type Rut Fill (RF). Used to fill deep (2 inch) ruts in a single pass.

483.2 MATERIAL—

(a) Emulsified Asphalt Material. Class CQS-1hPM as specified in Bulletin 25. Obtain material from an approved producer and source listed in Bulletin 15 and provide quality control testing and certification as specified in Sections 106.03(b) and 702.1(b)1.

1. Polymer Modifier. Provide a latex based modifier capable of making a micro-surfacing mix which cures fast enough to allow traffic to be placed on the pavement within 1 hour, without damaging the surface.

(b) Aggregate. Provide coarse or fine aggregates from sources listed in Bulletin 14. Provide fine aggregate Type B or better meeting the quality requirements of Table A, Section 703.1(c) and coarse aggregates meeting the quality requirements of Table B, Section 703.2(a). The final gradation must meet the final gradation specified in Table A of this specification. For wearing courses, provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends are 50% by weight of each aggregate. Blend the aggregates using an approved method.

(c) Filler. Supply filler, when required to maintain the percent by weight passing the 75 µm (No. 200) sieve, as specified in Section 703.1(c)1 consisting of any approved, non-air entrained, Type 1, Portland cement free of lumps or hydrated lime as specified in Section 723.1.

(d) Water. Section 720.2 and free of harmful soluble salts.

(e) Other Additives. Supplied by the manufacturer to control mix set time in the field due to varying ambient environmental conditions.

(f) Mixture Composition. Size, uniformly grade, and combine aggregate fractions in such proportions that the total aggregate and filler in the JMF conform to the composition by weight percentages specified in Table A. Perform the tests identified in Table B for each mix design and provide the test results to document each mix design's characteristics.

Submit a certified mix design(s) using a Micro-Surfacing Mix Design and Materials Analysis Form TR-483 to the DME/DMM at least 2 weeks before its use in the work. Clearly show for each mix design the proportions of aggregate, filler, percent polymer-modified emulsified asphalt and asphalt residue, based on the dry weight of the aggregate, and the design cure time. Ensure all the materials used in the mix design represent the materials proposed for use on the project. If minor adjustments are required during construction, based on field conditions, provide the changes in writing to the Representative.

1. QC Plan and JMF. Prepare a QC Plan, as specified in Section 106, and submit it for review at the start of the project and at least annually thereafter. Include the number of applications and the mix design used with each

application in the QC Plan. Do not start work until the QC Plan has been reviewed and the JMF has been submitted.

When unsatisfactory results or other conditions make it necessary, a new JMF may be required. If a change in sources of materials is made, submit a revised JMF to the DME/DMM before using any new material.

2. Uniformity. Produce each mix type within the ranges specified in Table C.

TABLE A

SIEVE SIZE	COMPOSITION, TOTAL PERCENT BY MASS (WEIGHT PASSING)		
	TYPE A	TYPE B	TYPE RF
12.5 mm (1/2 inch)	100	100	100
9.5 mm (3/8 inch)	100	95 - 100	90 - 100
4.75 mm (No. 4)	85 - 100	65 - 85	55 - 75
2.36 mm (No. 8)	50 - 75	46 - 65	40 - 55
1.18 mm (No. 16)	40 - 65	28 - 45	24 - 40
600 µm (No. 30)	25 - 45	19 - 34	19 - 34
300 µm (No. 50)	13 - 25	10 - 23	10 - 20
75 µm (No. 200)	5 - 15	5 - 15	5 - 15
Note: Material finer than the 75 µm (No. 200) sieve will be determined as per PTM No. 100.			

TABLE B

MICRO-SURFACING MIX DESIGN PROPERTIES		
Property	**Test Method**	**Test Requirements**
Wet Cohesion:	ISSA TB 139 30 Minutes ISSA TB 139 60 Minutes	12 kg-cm min 20 kg-cm min or near spin
Wet Track Abrasion Loss:	ISSA TB 100 1 Hour Soak ISSA TB 100 6 Day Soak	50 g/ft^2 max 75 g/ft^2 max
Mix Time:	ISSA TB 113	120 seconds min
Classification of Compatibility:	ISSA TB 144	11 grade points min
Wet Stripping:	ISSA TB 114	Pass (90% min)
Loaded Wheel Test:	ISSA TB 147	Vertical 10% max, Lateral 5% max
Note: Provide aggregate with a minimum sand equivalency of 65 as determined by AASHTO T 176. If the sand equivalency is < 65, the aggregate may be approved as long as the Plasticity Index (PI) is zero. Test the PI as per AASHTO T 89 and AASHTO T 90 and meets the methyl blue test.		

TABLE C

MIX TYPE	MINIMUM SURFACING APPLICATION THICKNESS (inch)	ASPHALT RESIDUE (% by Weight of Aggregate)	SINGLE APPLICATION RATE (Pounds per Square Yard)	DOUBLE APPLICATION RATE (Pounds per Square Yard)
A	1/4	6.0 - 8.5	25-30	35-40
B	3/8	5.5 - 7.5	35- 40	40- 55
RF	N/A	5.5-7.5	22-38	
Note A: Provide mix set additive for each mix type as required. Note B: Filler for each mix type to be from 1% to 2%± 0.5% by weight of dry aggregate depending on weather conditions. Note C: It is permissible to increase asphalt content for slag and other absorptive aggregates at the discretion of the DME/DMM.				

(g) Mixture Acceptance. Provide a certified calibration sheet for the mixing equipment for each mix design to be used within 60 days before its use on the project. Record mixing equipment meter readings of material control devices

on a Run Sheet, daily, for each mix design. Calculate the percent cement or hydrated lime, total emulsion, asphalt residue based on the dry weight of the aggregate, and the yield square yard.

Certify the mixture composition and application rate based on quality control tests and Run Sheet calculations. Send certifications to the Inspector-In-Charge within 1 working day following any quality control testing. Certify mixtures and each shipment of material delivered to the job site as specified in Section 106.03(b)3.

(h) Asphalt Tack Coat. Section 460.2

(i) Certification. Section 106.03(b)3.
Certify each shipment of material delivered to the job site.

483.3 CONSTRUCTION—

(a) Preplacement Meeting. Hold a preplacement meeting on site or at a location that is acceptable to the Representative with both Contractor and PennDOT personnel present before placing any material on the project. Identify any areas of concern in the pavement that may show any signs of fatigue or excessive rutting at the pre-placement meeting. Also review the Specification, QC Plan, source of supply list, and the Aggregate Delivery Plan. It may be necessary to hold more than one preplacement meeting on larger projects with multiple State Routes.

(b) Weather Limitations. Apply when entire surface is in a condition to allow satisfactory penetration and adhesion and the atmospheric temperature is 50F minimum during the entire placement. Under no circumstances will the 50F minimum temperature requirement to be waived even for night work. Do not apply mixture if rain is imminent or if freezing temperatures are expected within 24 hours after application. Remove and replace rained on mixture before it sets. Do not apply from September 16 to April 30 in Districts 1-0, 2-0, 3-0, 4-0, 10-0, and 5-0 (Monroe, Carbon, and Schuylkill Counties only) and from October 1 to April 30 in Districts 6-0, 8-0, 9-0, 11-0, 12-0, and 5-0 (Berks, Lehigh, and Northampton Counties only). No exceptions to weather limitations will be allowed, unless directed in writing by the District Executive.

(c) Aggregate Delivery Plan. Before the start of work, submit an Aggregate Delivery Plan to the DME/DMM for approval. Include in the plan the number of trucks that will be used to haul aggregates to the micro-surfacing machine in order to keep it moving continuously to limit starting and stopping.

All aggregates being delivered to the micro-surfacing machine must be screened directly into the truck.

All screening plants must be equipped with a scalping screen with a 3/8 inch maximum square opening for Type A and with a 1/2 inch maximum square opening for Type B and Type RF.

(d) Mixing Equipment. Produce mixture in a self-propelled, front feed, continuous-loading mixing machine equipped with a chain-dragged conveyor belt aggregate delivery system interconnected with a positive displacement, water-jacketed gear pump to accurately proportion ingredients. Truck mounted units may be allowed on projects less than 20,000 square yards except for limited access highways and for all municipal projects. Locate filler feed so that the proper amount of cement is coating the aggregate before charging into the mixer. Provide a spray bar to completely wet the aggregate dropping down into the pug mill with additive and water.

Provide a continuous-flow, twin shafted, multi-bladed pug mill at least 50 inches long. Introduce polymer-modified emulsified asphalt beyond the first quarter point of the mixer to ensure thorough mixing of aggregate, cement, additive, and water before polymer-modified emulsified asphalt is added. Meet manufacturer's recommendations for blade size and side clearance. Provide readily accessible material control devices, placed so that the Inspector is able to determine the amount of each material being used at any time. Calibrate each material control device before production of each mix type. Equip the machine with a water pressure system and nozzle spray bar to provide a water spray ahead of and outside the spreader box, when required.

(e) Spreading Equipment. Spread the mixture uniformly by means of a mechanical type squeegee box attached to the mixer and equipped with paddles mounted on adjustable shafts to continually agitate and distribute the material throughout the box. Provide sufficient turbulence to prevent the mix from setting up in the box, forming excessive side build-up, or forming lumps. Attach flexible front and rear seals, in contact with the road, to prevent loss of mixture from the box. Furnish rut filling equipment with movable steel strike-off bar. Operate spreading equipment to prevent loss of the mixture on super elevated curves and to leave a uniform, skid-resistant application of aggregate and asphalt on the surface. Operate spreading equipment to achieve a uniform consistency without skips, lumps, or

tears in the finished surface.

(f) Conditioning of Existing Surface. Section 413.3(g)1 and as follows:

Immediately before placing mixture, clean the surface of vegetation, loose materials, dirt, mud, and other objectionable items. Ensure all pavement markings and legends are completely removed before placing any mixture. Before placing mixture on existing concrete surfaces, apply tack coat over the entire area as specified in Section 460. Do not apply tack coat on existing asphalt surfaces. Apply water to dampen entire surface immediately before placing mixture.

(g) Spreading and Finishing. Section 413.3(h) and as follows:

Spread the mixture to seal cracks, fill voids, and to leave a uniform surface. When filling ruts, take care to restore the designed profile of the pavement cross section. Avoid excess crowning (over filling) of rutted areas. Use squeegees and lutes in areas inaccessible to the spreader box.

Carry a sufficient amount of material at all times, in all parts of the spreader box, to obtain complete coverage. Water may be sprayed into the spreader box, to facilitate spreading, without harming the mix. Lumps, balls, or unmixed aggregate in the finished surface is not allowed.

Adjustments to the additive may be required to slow mixture set time where hand spreading is needed. When hand spreading, pour mixture in a small windrow along one edge of the surface to be covered and spread uniformly by hand squeegee or lute.

Make a neat seam where two passes join. Immediately remove excess material from the ends of each run.

1. General Requirements. Ensure mixture properly sets within one hour of placement. If mixture takes longer than one hour to properly set, the Representative will give the Contractor a warning and an opportunity to immediately correct mixture application and set time. If the mixture takes longer than one hour and twenty minutes to properly set, stop placement operations immediately.

2. Mixture Set Time. Remove and replace mixture if mixture set time takes longer than one hour and twenty minutes.

(h) Compaction. Before opening to traffic, compact using a pneumatic-tire roller as specified in Section 108.05(c)3.f, except having tire pressures of 40 pounds per square inch to 60 pounds per square inch. Roll the entire surface area of the placed mixture. On a double application, roll the entire surface area of the placed mixture for each application.

(i) Sampling and Testing. At least 2 weeks before the start of work, under the direction and supervision of the Representative, obtain samples of the aggregates from stockpiles designated and constructed for each mixture type and each project. Obtain a minimum sample size of 3 pounds using guidelines for stockpile sampling specified in PTM No. 607. Immediately deliver the samples to the Representative for testing. Passing aggregate acceptance test results are required before placement of the mixture. All acceptance samples will be obtained and all acceptance tests will be performed by the Representative according to PTM No. 616 and PTM No. 100 using the following frequency:

- **When the projected quantity of aggregate for the specified mixture type is less than 500 tons.** The entire quantity will be designated as one lot and divided into three equal sublots for sampling. Under the direction and supervision of the Representative obtain a sample from each sublot and immediately deliver the samples to the Representative for testing. One of the three sublot samples will be randomly selected and tested according to PTM No. 1 by the Representative and tested for compliance with Table A. If the sample tested meets the specification, the entire lot will be considered acceptable for delivery to the designed project. If the sample fails, the remaining two samples will be tested and the Representative will determine the percent within limits (PWL) according to Section 106.03(a)3. If results indicate a PWL for the material less than 90, the Representative will reject the stockpile. After the entire rejected lot has been blended, screened, or replaced, retesting for acceptance of the aggregate will be performed. If retesting is performed, all sublot samples will be tested as specified in Section 703.5(b)2. All acceptance testing will be performed by the Representative. All test results will be recorded on a TR-4126A aggregate report form.

- **When the projected quantity of aggregate for the specified mixture type is 500 tons or greater.** The aggregates will be divided into equal lots at the discretion of the aggregate supplier, but in no case will the lot exceed 1000 tons. Each lot will be divided into three equal sublots. Under the direction and supervision of the Representative obtain a sample for each sublot. All three samples for each lot will be tested and the Representative will determine the percent within limits (PWL) according to Section 106.03(a)3. If results indicate a PWL for the material less than 90, the Representative will reject the stockpile. If the test results for each lot meets the specification and are in compliance with Table A, the entire lot is acceptable for shipment to the project. If the test results fail to meet the specifications, the lot will be rejected. Retesting for lot acceptance will be performed as described above. All acceptance testing will be performed by the Representative. All test results will be recorded on a TR-4126A aggregate report form.

(j) Blending Aggregates on the Project. Requests to blend aggregates on the project to meet gradation requirements from Table A and the method of blending must be approved in writing by the DME/DMM before the start of work. Include on the QC Plan a detailed description of equipment used to blend aggregates, a list of supplier codes for aggregates being blended, and the percentages of each aggregate being blended. Set up a portable laboratory at the blending site equipped to perform PTM No. 616 and PTM No. 100 tests for acceptance of aggregates on the project. The Contractor's aggregate technician must be a PennDOT certified aggregate technician before performing any aggregate testing at the staging area in the presence and direction of the Representative. Aggregates will be accepted as specified in Section 483.3(i). Provide aggregate for use in all mixture Types including each application of a double application of a mixture Type having the SRL designation indicated in the bid proposal. An aggregate designation or blends, equal to or better than that specified, may be supplied.

(k) Test Strip. On the first day of work the Representative will identify a location to perform the test strip. The test strip will be prohibited on a limited access highway. Construct a test strip to demonstrate the mixture's ability to be laid in multiple stone thicknesses and to be opened to traffic within one hour after placement. Construct the test strip in the same manner and condition as required on the project. Construct the test strip over one-full lane width and between 100 feet and 550 feet long. Apply the mixture at an application rate representative of the application rate for the project. Test the mixture according to ISSA Test Method TB 102 in the presence of the Representative. The Representative will evaluate and approve the test strip based on its ability to be opened to traffic within one hour and on its ability to have a set time of 10 minutes, maximum, as determined by ISSA Test Method TB 102.

Do not continue with work until the Representative has approved the test strip. The Representative does not have the authority to waive or eliminate the test strip requirement. If this work is to be performed a test strip is mandatory. The test strip will be payable as specified in Section 483.4.

(l) Defective Work. As specified in Section 105.12 and as follows:

Unless otherwise directed in writing by the District Executive, satisfactorily correct pavement not meeting the following criteria:

1. Application Rate. Calculate yield at the end of each day's application. Areas where application rates deviate from the acceptable ranges in Table C will be considered defective work. Failure to meet the acceptable ranges in Table C will require an additional minimum 15 pounds per square yard application or the District Executive, with the concurrence of the Director of the Bureau of Project Delivery, may allow the Contractor to leave the defective lot in place. The Department will pay for the defective lot at 50% of the contract unit price.

2. Finished Surface. Provide a finished, uniform surface texture meeting the following requirements**:**

- No areas of excess emulsified asphalt (flushing) greater than 5% of the finished surface area. Areas of excess emulsified asphalt are characterized by a smooth, shiny surface that may be tacky to the touch. Bleeding at joints is not allowed.

- No tear and/or drag marks greater than 1 inch wide and 3 inches long.

- No more than 12 tear and/or drag marks greater than 1/2 inch wide and 4 inches long per 10 feet of a lane.

- No clumps and/or other foreign objects greater than 1 1/2 inch in diameter.

- No completed sections of micro-surfacing which exhibit washboard or ripple patterns exceeding 100 linear feet. If these areas exist they will be considered defective work, as determined by the Representative, and will require surface correction.

- No longitudinal streaks with greater than a 1/4 inch ridge, bump or depression, as measured with a 10 foot long straightedge.

3. Longitudinal Joints. Make a neat seam where two longitudinal passes join with no greater than a 1/4 inch bump, ridge, or depression as measured with a 12 foot straightedge. Do not overlap longitudinal joints more than 4 inches, except on irregular roadway widths when approved by the Representative.

4. Longitudinal Edges. Place material to the final widths specified. Make a neat longitudinal edge along the roadway lane, shoulder, and/or curb lines. Place edges flush with curbs. Place edges with no more than ±3 inches horizontal variance in any 100 feet of roadway.

5. Transverse Profile. Fill ruts to have no depressions as measured with a 12 foot long straightedge.

(m) Opening to Traffic. Do not allow traffic on newly completed surface course until mix has set sufficiently to prevent pick-up and until directed by the Representative.

483.4 MEASUREMENT AND PAYMENT—

(a) Micro-Surfacing.

1. Area Basis. Square Yard

2. Weight Basis. Ton

Under the direction and supervision of the Representative complete measurements based on the combined tonnages of aggregate, filler, and polymer-modified emulsified asphalt actually used; computed as follows:

- **Aggregate.** Measure aggregate quantity using the calibrated, dry weight from the aggregate control device. Make a deduction for moisture naturally occurring in the aggregate by using PTM No. 513.

- **Filler.** Compute filler quantity from the fines feeder control device.

- **Polymer-modified emulsified asphalt.** Compute polymer-modified emulsified asphalt quantity by weight used.

(b) Asphalt Tack Coat. Section 460.4

SECTION 489—ULTRA-THIN BONDED WEARING COURSE

489.1 DESCRIPTION—This work is the construction of a polymer-modified emulsified asphalt membrane (UTFCEM – Ultra-Thin Friction Course Emulsified Asphalt) immediately overlaid with an ultra-thin bonded wearing course of hot-mix asphalt concrete (UTWC – Ultra-Thin Wearing Course) in one pass of a single paving machine.

489.2 MATERIAL—

(a) Asphalt Material.

1. Asphalt Binder. Provide material as specified meeting the requirements of the Standard Specification for Performance-Graded Asphalt Binder, AASHTO M 332, except as revised in Bulletin 25. Obtain material from an approved producer and source listed in Bulletin 15 for the specified grade and provide quality control testing and certification as specified in Sections 106.03(b) and 702.1(b)1.

2. Emulsified Asphalt. Class UTFCEM as specified in Bulletin 25. Obtain material from an approved producer and source listed in Bulletin 15 and provide quality control testing and certification as specified in Sections 106.03(b) and 702.1(b)1.

(b) Aggregate.

1. Fine Aggregate. Manufactured sand from an approved source, listed in Bulletin 14 and meeting the requirements in Table A.

TABLE A

FINE AGGREGATE PROPERTIES			
TEST	**TEST METHOD**	**MINIMUM**	**MAXIMUM**
Sand Equivalent	AASHTO T 176	45	-
Methylene Blue	AASHTO T 330	-	10
Uncompacted Void Content	AASHTO T 304	40	-

2. Coarse Aggregate. Coarse aggregate from an approved source, listed in Bulletin 14 and meeting the requirements in Table B.

TABLE B

COARSE AGGREGATE PROPERTIES				
TEST	**TEST METHOD**	**AVERAGE DAILY TRAFFIC (ADT)**		
		< 5,000	**5,000 < 20,000**	**> 20,000**
Abrasion Max. %	AASHTO T 96	35	30	30
Micro-Deval (MD)* Max. %	AASHTO T 327	18	18	18
Skid Resistance Level (SRL) .	Bulletin 14	G or higher	H or higher	E
Absorption Max. %	AASHTO T 85	2	2	2
Thin and Elongated Pieces Max. %	ASTM D4791	10	10	10
Soundness Max. %	PTM No. 510	10	10	10
Min % Crushed, 1 Face	ASTM D5821	95	95	100
Min % Crushed, 2 Face	ASTM D5821	85	85	85
*MD > 18, requires approval of DME/DMM.				

(c) Filler. Do not use fly ash if the design traffic is greater than or equal to 3 million Equivalent Single Axle Loads (ESALs).

(d) Mixture Composition. Provide a wearing course of plant mixed asphalt concrete consisting of fine aggregate, coarse aggregate, filler, and asphalt binder. Size, uniformly grade, and combine aggregate fractions in such proportions that the total aggregate and the asphalt in the JMF conform to the composition specified in Table C, and meet the mixture characteristics of Table D.

TABLE C

COMPOSITION, TOTAL PERCENT BY MASS (WEIGHT) PASSING			
SIEVE SIZE	**TYPE A**	**TYPE B**	**TYPE C**
19.0 mm (3/4 inch)	100	100	100
12.5 mm (1/2 inch)	100	100	85 - 100
9.5 mm (3/8 inch)	100	75 - 100	65 - 85
6.3 mm (1/4 inch)	75 - 100	28 - 45	28 - 45
4.75 mm (No. 4)	40 - 60	23 - 37	23 - 37
2.36 mm (No. 8)	15 - 30	21 - 31	21 - 31
1.18 mm (No. 16)	12 - 20	15 - 23	15 - 23
600 µm (No. 30)	8 - 15	10 - 18	10 - 18
300 µm (No. 50)	6 - 12	8 - 14	8 - 14
150 µm (No. 100)	5 - 10	5 - 10	6 - 10
75 µm (No. 200)	4.0 – 6.5	4.0 – 6.5	4.0 – 6.5
Asphalt % by mass (weight)	4.5 - 5.8	4.5 - 5.7	4.5 - 5.7
Note: Material finer than the 75 µm (No. 200) sieve will be determined as per PTM No. 100.			

TABLE D

MIXTURE CHARACTERISTICS			
MIXTURE CHARACTERISTIC	**TEST METHOD**	**MINIMUM**	**MAXIMUM**
Moisture sensitivity, % TSR	AASHTO T 283*	80	-
Average % Draindown	AASHTO T 305	-	0.1
Apparent Asphalt Film Thickness, microns	Bul. 27, Sec 12.4.1	10.0	-

*Prepare specimens according to Department's modified procedures for Superpave Mix Design, detailed in Bulletin 27, Chapter 2A referencing AASHTO R 35 Section 11, with the following exceptions:

1. Condition the mixture according to Bulletin 27.
2. Compact to 100 gyrations.
3. Extrude as soon as possible without damage to the sample.
4. Use AASHTO T 269 to determine void content.
5. Record the void content of the specimens. (Maintain the range from the lowest to the highest air void content of all specimens at a maximum difference of 1.0%)
6. Condition specimens, compute the Tensile Strength Ratio, and evaluate the specimens according to Bulletin 27.
7. Visual stripping will require modification or readjustments or both as directed by the Representative.

1. Producer QC Plan and JMF. Prepare a QC Plan, as specified in Section 106, and submit it for review at the start of the project and at least annually thereafter. Do not start work until the QC Plan has been reviewed and the JMF has been submitted.

When unsatisfactory results or other conditions make it necessary, a new JMF may be required. If a change in sources of materials is made, submit a revised JMF to the DME/DMM before using any new material.

2. Uniformity. Produce the asphalt mixture to meet the requirements as specified in Table C. Produce the mixture within the JMF tolerances specified in Table E.

TABLE E

JMF TOLERANCE REQUIREMENTS OF COMPLETED MIX (n≥1)			
Percent Passing 9.5 mm (3/8 inch) and larger sieves		±5%	
Percent Passing 6.3 mm (1/4 inch) to 2.36 mm (No. 8) sieves		±4%	
Percent Passing 1.18 mm (No. 16) to 0.3 mm (No. 50) sieves		±3%	
Percent Passing 150 µm (No. 100) sieve		±2%	
Percent Passing 75µm (No. 200) sieve		±1.5%	
Asphalt % by mass		±0.5%	
TEMPERATURE OF MIXTURE (F)			
CLASS OF MATERIAL	**TYPE OF MATERIAL**	**MINIMUM**	**MAXIMUM**
PG 64S-22	Asphalt Binder	285	330
PG 64E-22	Asphalt Binder	295	340

(e) Mixture Acceptance. Obtain material certification from the material producer. Send certification to the Inspector-In-Charge within 1 working day following any QC tests for asphalt determination and sieve analysis of the mixture.

The mixture will be accepted by certification at the plant when quality control tests conform to the JMF within the tolerances specified in Table E. Acceptance by certification may be suspended if QC tests or QA samples obtained by QA Teams from the BOPD deviate from the tolerances in Table E for acceptance values. The acceptance values are:

- Asphalt Content by mass (weight),
- Percent passing the 75µm (No. 200) sieve,
- Percent passing the 2.36 mm (No. 8) sieve, and
- Percent passing the 6.3 mm (1/4 inch) sieve.

If at any time during the course of the work any acceptance values deviate from the tolerances in Table E in consecutive tests, immediately make necessary changes to comply with the JMF. If the material cannot be brought into compliance within 150 tons of production, suspend operations and notify the Inspector-In-Charge. Do not resume production for the project until the Representative has reviewed any corrective action.

If the asphalt content or the percent passing the 75µm (No. 200) sieve deviates from the tolerances specified in Table E, the material represented will be considered defective and acceptance will be determined as specified in Section 413.3(o).

(f) Certification. Section 106.03(b)3.

Certify each day's shipment of material delivered to the job site.

489.3 CONSTRUCTION—Section 413.3 with additions and modifications as follows:

(a) Preplacement Requirements. Add the following

Address in the QC plan material delivered to the paver as it relates to paver speed. Provide calculations to support material production, haul units used for delivery and paver speed to eliminate placement stoppages during laydown.

(b) Weather Limitations. Replace with the following:

Do not place asphalt paving mixtures containing PG 64S-22 from November 1 to March 31 and asphalt paving mixtures containing PG 64E-22 from October 15 to March 31, unless allowed in writing by the District Executive. Do not place asphalt paving mixtures when the surfaces are wet or when the air or surface temperature is below 50F. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are en route to the project.

(e) Paving Equipment.

1. Asphalt Pavers. Add the following:

Use pavers that include a built-in spray bar placed in front of the variable-width heated screed unit, so that the operations of spreading UTFCEM and the UTWC are performed in succession, within a period of less than 5 seconds.

(g) Preparation of Existing Surface.

1. Conditioning of Existing Surface. Replace with the following:

At least 24 hours before paving operations, seal longitudinal and transverse joints and cracks 1/4-inch and wider as specified in Section 469. Use rubberized sealant as specified in Section 469 and minimize the sealant over-band thickness and width. Do not exceed Section 469 over-band tolerances. Remove thermoplastic and tape traffic markings greater than 0.2 inches thick. Thoroughly clean pavements impregnated with grease, oil, or fuel. Immediately prior to applying the UTFCEM and the UTWC, clean the surface by sweeping or other means necessary to remove all loose particles and unsuitable material.

(h) Spreading and Finishing.

1.b Spreading and Finishing. Replace with the following:

Apply UTFCEM with a metered mechanical pressure sprayer, at a temperature of 120F to 180F. Continuously monitor the rate of spray, ensuring a uniform application rate over the entire width to be overlaid. Determine the spray rate given the existing pavement porosity, and apply between 0.15 and 0.25 gallons per square yard. Do not allow wheels or other parts of the paving machine to come in contact with the UTFCEM before the UTWC is applied. Within 5 seconds of applying the UTFCEM, lay the UTWC within the temperature range specified in Section 489.2 Table E for the class and type of material used, and at the placement rate specified in Section 489.3 Table F.

Continuously adjust operations to obtain a quality surface free from drags marks, open areas or suspect quality. If adjustments do not obtain a quality surface free from visual surface segregation the Representative may direct work to stop. Areas identified by the Representative to have visual surface segregation are to be removed and replaced at no additional cost to the Department. Do not begin spreading and finishing until the Representative is satisfied with proposed corrective actions to provide a satisfactory surface.

TABLE F

TYPE	NMAS	PLACEMENT RATES FOR UTWC
A	6.3 mm (1/4 inch)	45 to 65 pounds per square yard
B	9.5 mm (3/8 inch)	55 to 80 pounds per square yard
C	12.5 mm (1/2 inch)	60 to 85 pounds per square yard
Note: Placement rates are intended as a guide and additional material may be required to obtain a quality surface. In no case should material yield be below the lower limits of the placement rate range.		

(i) Compaction. Replace with the following:

Roll the UTWC immediately after placement and before the material temperature has fallen below 185F. Roll using a minimum of two passes with a steel double-drum asphalt roller having a mass of not less than 8 tons. Do not allow roller(s) to remain stationary on the freshly placed UTWC. Maintain roller(s) in reliable operating condition and equipped with functioning water system and scrapers to prevent adhesion of the fresh mix onto the roller drums. A release agent (added to the water system) may be required. Compact in the static mode, with the exception of joints where vibration may be necessary. A pneumatic-tire roller may be used to prevent the "bridging" effect of the steel drum roller.

(j) Mat Density Acceptance. Density testing is not required.

(k) Joints. Replace with the following:

1. Longitudinal Joints. Form butt joints only and compact with rollers. Seal the longitudinal joint(s) for surface courses with hot PG 64S-22 asphalt cement at no additional cost to the Department. Heat and maintain asphalt cement sealant between 265F and 320F. Do not place sealant when the air temperature is below 40F, unless otherwise allowed by the Representative. Apply the sealant only to joints in pavement surfaces that are clean, dry and free of any loose material and debris. Clean with a power broom as required. Utilize a pressure applicator with a wand or nozzle capable of applying hot asphalt sealant in a straight and consistent width band of 4 inches +/-1 inch and thickness of 1/16 inch +/- 1/32 inch. Center the sealant band within 1 inch of the joint. Remove and dispose of excess sealant at no additional cost to the Department. Re-seal areas of the joint that are inconsistently or not completely covered at no additional cost to the Department. Replace pavement markings that are marred by sealing operations at no additional cost to the Department.

2. Transverse Joints. Minimize the number of transverse joints. Maintain continuous forward paving wherever possible. Construct joints perpendicular to the direction of traffic and compact. If the QC plan proves ineffective for minimizing the number of transverse joints, stop paving and submit a plan for corrective action to the Representative. Do not begin paving until the Representative has reviewed the plan and authorizes paving to resume.

(m) Tests for Depth. Loose depth or compacted depth tests are not required. However, control the depth of courses by the weight per square yard.

489.4 MEASUREMENT AND PAYMENT—

(a) Ultra-thin Bonded Wearing Course. Square Yard.
For the type indicated.

(b) Crack Filling and Sealing. Section 469.4

SECTION 490—REMOVAL OF EXISTING SURFACE COURSE

490.1 DESCRIPTION—This work is removal of an existing surface course.

490.3 CONSTRUCTION—Carefully remove the existing asphalt surface course, within limits shown on the plans or as directed. Use an acceptable removal method. Neatly trim the edges of remaining asphalt surface to a vertical line. At locations determined by the Representative, clean the surface of the existing base course and repair damage to the adjacent surface or underlying base.

490.4 MEASUREMENT AND PAYMENT—Square Yard

SECTION 491—MILLING OF ASPHALT PAVEMENT SURFACE

491.1 DESCRIPTION—This work is the milling of an existing asphalt pavement surface.

491.3 CONSTRUCTION—

(a) Equipment. Provide a milling machine designed and built for milling existing asphalt pavements with an automatic grade and slope control system and be capable of milling concrete patches.

(b) Milling Operation. Mill to provide a finished surface that is free from gouges, grooves, and ridges and that conforms to the surface tolerance requirements of Section 413.3(l). Immediately after milling, remove milled material. Carefully remove the existing asphalt material around utility facilities within work areas. Repair or replace utility facilities that are damaged by the milling operation to the satisfaction of the utility owner. Control the rate of milling to avoid tearing of the mat, which causes chunky and non-uniformly milled material. If directed, separate oversized and chunky milled material. Maintain the milled pavement surface free of all loose materials and dust.

Do not allow traffic to drive on any milled surface for more than 6 calendar days. Place the first overlaying asphalt course within 7 calendar days from the start of the milling operation. Failure to overlay a milled section of roadway within 7 calendar days after it has been milled will constitute a failure to comply with a contract traffic control requirement for which work zone liquidated damages, as specified in section 108.07(c), will be assessed. Work stoppages caused by the Department, Utilities, and documented weather delays will not count towards the 7 calendar days for calculating Work Zone Liquidated Damages. Maintain all milled surfaces and repair or replace any areas damaged due to the asphalt overlay not being placed within 7 calendar days of the milling operation methods accepted by the Representative at no additional cost to the Department.

If the first course of the asphalt overlay is not placed on the same day of the milling operation, install ROUGH ROAD (W8-8) signs according to Publication 212, Publication 213, and MUTCD 1/2- mile in advance of the project and at a minimum of 1/2- mile intervals throughout the project before the end of the day. Eliminate vertical edges around utilities and inlets within all open travel lanes at the end of each day. If this is not feasible, install a BUMP (W8-1) sign in advance of the appurtenance, and consider a reduced regulatory speed limit sign. Install these signs at no additional cost to Department.

(c) Disposition of Milled Material. The proposal/contract will indicate which one of the following conditions will apply with regard to the disposition of milled material.

1. Milled Material Retained by Contractor. When indicated that milled material is to be retained by the Contractor, satisfactorily dispose of milled material immediately after milling.

2. Milled Material Retained by Department (Delivered to Stockpile). When indicated that milled material will be retained by the Department, deliver milled material to the designated stockpiling location immediately after milling. The proposal/contract will include a special provision that identifies where milled material is to be stockpiled, as well as the approximate distance (miles) from the project site to the designated stockpiling location. Advance notification of a scheduled delivery of milled material to the designated stockpile is to be provided to the individual whose name and telephone number are listed in the special provision.

491.4 MEASUREMENT AND PAYMENT—

(a) Milling of Asphalt Pavement Surface, Milled Material Retained by Contractor. Square Yard

(b) Milling of Asphalt Pavement Surface, Milled Material Retained by Department (Delivered to Stockpile). Square Yard

The cost of delivering milled material to the designated stockpiling location is incidental to this item of work.

SECTION 492—PROFILE MILLING OF ASPHALT PAVEMENT SURFACES

492.1 DESCRIPTION— This work is profile milling of existing asphalt pavement surface with parameters to control surface tolerances in both longitudinal and transverse directions.

492.3 CONSTRUCTION—

(a) Equipment. Provide a self-propelled milling machine capable of milling a full-lane width up to 12-feet wide in one pass.

Equip the milling machine with a built in automatic grade control system to control the longitudinal profile and the transverse cross-slope. Provide longitudinal controls capable of operating from a longitudinal grade reference, including string line, ski 30 feet minimum, mobile string line 30 feet minimum, or matching shoe. Provide the transverse controls with an automatic system for controlling cross-slope at a given rate.

Mount profiler cutters to the carrier in order to adjust and control them according to depth of cut and cross-slope. Longitudinal milling action may be produced either by a suitable carrier wheelbase or use of an automatic control system having an external reference. Produce either a variable or a constant cross-slope with cross-slop adjustments or automatic controls.

Design, maintain, and operate milling cutters to produce a surface free from grooves, ridges, gouges, or other irregularities detrimental to the safe operation of vehicles in traffic routed onto the profiled surface.

Suitable supplemental equipment or methods, approved by the Representative, may be used in small or confined areas and around utility facilities. Complete adjustment of utility facilities before the milling operation, when pavement is not to be resurfaced. Repair or replace utility facilities that are damaged by the profiling operation to the satisfaction of the utility owner at no additional cost to the Department.

(b) Profiling Operation. Remove irregularities such as bumps, corrugations, and wheel ruts, and establish the specified pavement surface elevation or cross-slope with one or more passes over the designated area, operating the milling machine in automated mode.

Remove milled material from the surface following each pass of the equipment. Before opening the completed area to traffic, thoroughly clean the surface of all loose material that would create a hazard, a nuisance, or would be redeposited into the surface texture.

Maintain the milled surface free of all loose material and contaminants during milling and cleaning operations.

Repair areas where sound pavement has been damaged by milling operations at no additional cost to the Department, in a manner satisfactory to the Representative. The repaired area must conform to the adjacent pavement in smoothness and durability.

Do not allow traffic to drive on any milled surface for more than 6 calendar days. Place the first overlaying asphalt course within 7 calendar days from the start of the milling operation. Failure to overlay a milled section of roadway within 7 calendar days after it has been milled will constitute a failure to comply with a contract traffic control requirement for which work zone liquidated damages, as specified in section 108.07(c), will be accessed. Work stoppages caused by the Department, Utilities, and documented weather delays will not count towards the 7 working days for calculating Work Zone Liquidated Damages. Maintain all milled surfaces and repair or replace any areas damaged due to the asphalt overlay not being placed within 7 calendar days of the milling operation methods accepted by the Representative at no additional cost to the Department.

If the first course of the asphalt overlay is not placed on the same day of the milling operation, install ROUGH ROAD (W8-8) signs according to Publication 212, Publication 213, and MUTCD 1/2- mile in advance of the project and at a minimum of 1/2- mile intervals throughout the project before the end of the day. Eliminate vertical edges around utilities and inlets within all open travel lanes at the end of each day. If this is not feasible, install a BUMP (W8-1) sign in advance of the appurtenance, and consider a reduced regulatory speed limit sign. Install these signs at no additional cost to Department.

(c) Surface Patching. Areas of the milled surface to be patched due to spalling or dislodgement of unsound pavement during profile milling operation will be designated by the Representative. Excavate to match depth of existing surface. Clean the areas of loose material, coat with Emulsified Asphalt Tack Coat (TACK), and fill with asphalt mixture of the same type. Level and compact the asphalt mixture to conform to the adjacent pavement.

(d) Surface Tolerances. Profile the surface to a smoothness of 1/8 inch in 12 feet, and match the surface at the

edge of adjacent passes within 1/8 inches. Conform the cross-slope of the profiled surface to the specified cross-slope within 1/8 inch in 12 feet. Provide a positive cross slope, as shown in the plans, such that the pavement drains.

(e) Disposition of Milled Material. The proposal/contract will indicate which one of the following conditions will apply with regard to the disposition of milled material.

1. Milled Material Retained by Contractor. When indicated that milled material is to be retained by the Contractor, satisfactorily dispose of milled material immediately after milling.

2. Milled Material Retained by Department (Delivered to Stockpile). When indicated that milled material will be retained by the Department, deliver milled material to the designated stockpiling location immediately after milling. The proposal/contract will include a special provision that identifies where milled material is to be stockpiled, as well as the approximate distance (miles) from the project site to the designated stockpiling location. Advance notification of a scheduled delivery of milled material to the designated stockpile is to be provided to the individual whose name and telephone number are listed in the special provision.

(f) Defective Work. Profile milling that fails to meet the surface tolerances in Section 492.3(d) will be considered defective. Payment for defective work will be made at 50% of the Contract Unit Price (CUP) for the full-lane width of the defective area.

492.4 MEASUREMENT AND PAYMENT—

(a) Profile Milling, Milled Material Retained by Contractor. Square Yard

(b) Profile Milling, Milled Material Retained by Department (Delivered to Stockpile). Square Yard
The cost of delivering milled material to the designated stockpiling location is incidental to this item of work.

(c) Surface Patching. The Department will separately measure and pay for the following item(s), when indicated or required:

1. Class 1 Excavation. Section 203.4

2. Patching. Section 450.4

SECTION 496—ASPHALT CONCRETE PAVEMENT, 60-MONTH WARRANTY

496.1. DESCRIPTION—This work is construction of a plant-mixed, asphalt concrete pavement on a prepared surface with a 60 month warranty and includes the furnishing of a warranty bond. Acceptability of this work will be determined by construction end-result and the warranty performance criteria.

496.2. MATERIAL—Provide material which ensures that the asphalt concrete pavement meets the warranty performance criteria. Select the type and class of asphalt material, type of aggregate, and, when necessary, type of filler to be used in the constructed pavement. For wearing courses, use aggregate, having the specified SRL designation, from a source listed in Bulletin 14. An aggregate designation or blends, equal to or better than that specified, may be supplied. Blends are 50% by weight.

(a) Composition of Mixtures. Establish the JMF(s) using a volumetric mix design procedure with the Superpave Gyratory Compactor (SGC).

Submit mix design(s) on the most current version of the TR-448A form, signed by a Certified Asphalt Level 2 Plant Technician, to the DME/DMM at least 7 calendar days before its use in the work. The submitted mix design(s) will be used for information only and will become part of the as-built project files. Submission of the mix design(s) will not relieve the Contractor from responsibility for meeting the specified construction end-result or warranty performance criteria. Stone Matrix Asphalt (SMA) wearing course mixes may be submitted for consideration. For each mix design, provide the following information:

- Date of Submission
- Project S.R., Section, and County
- Project Contract No.
- Asphalt Concrete Producer: Name and Location
- Asphalt Plant Type
- Aggregate Producer: Supplier Code, Material Code/Class, Percent in Mix, Bulk Specific Gravity and Percent Absorption
- Asphalt Cement Producer: Supplier Code, Material Code/Class, Percent in Mix and Bulk Specific Gravity
- Volumetric Mix Design Method
- Other JMF Materials: Source, Material Code/Class, Percent in Mix, Bulk Specific Gravity and % Absorption (if applicable)
- JMF: Design and Upper and Lower Tolerances for production control
- SGC Gyrations at Nini, Ndes, and Nmax
- Combined Aggregate Bulk Specific Gravity (Gsb)
- Theoretical Maximum Specific Gravity (Gmm) or Density
- Laboratory Specific Gravity at Ndes (Gmb) or Density
- Voids in Mineral Aggregate (VMA), percent by volume
- Voids in Total Mixture (VTM), percent by volume
- Voids Filled with Asphalt (VFA), percent by volume
- Ignition Furnace Correction Factors for Asphalt Binder and 0.75 µm (No. 200) Sieve
- Moisture Sensitivity Data (Tensile Strengths, Tensile Strength Ratio, Date Performed) or (Hamburg Wheel Tracking Results)
- Combined Aggregate Consensus Properties (Sand Equivalency, Fine Aggregate Angularity, Coarse Aggregate Angularity, Flat & Elongated Pieces)
- Gradation Chart (FHWA 0.45 Power Type) with JMF plotted
- Types and results of additional mixture testing, if performed
- Designer's signature

Ensure all component materials shown in the mix design are representative of the materials that will be used on the project. If, for any reason, a change in material source or other adjustments are necessary during construction, before using any new material notify the DME/DMM in writing, explaining the need for the change. Submit a copy of the revised JMF with the written notification.

1. QC Plan. Prepare a QC plan, as specified in Section 106, and submit it at the start of the project. Do not start work until the QC plan and the JMF have been submitted. The submitted QC plan will be used for information only and will become part of the as-built project files.

Provide certified results of QC testing to the Representative within 48 hours of material sampling. The submitted test results will be used for information only and will become part of the as-built project files.

(b) Warranty Bond and Liability Insurance. When awarded the contract, in addition to the required bonds specified in Section 103.04, furnish a Warranty Bond, with sufficient surety or sureties, in an amount equal to 50% of the total contract amount for all pavements to be constructed under the pavement warranty item(s). Have the bond specify that remediation work will be completed in a manner satisfactory to the Secretary. Have the bond state that the State is to be saved harmless from any expense or damage incurred through the failure of the Contractor to complete remediation work, as specified, or from any damages growing out of the carelessness of the Contractor, the Contractor's employees, or subcontractors in performing remediation work.

Have a corporate surety, legally authorized to transact business in the State and satisfactory to the Secretary, execute the bond. If the Secretary decides the bond surety is unsatisfactory, promptly furnish any additional required security to protect the State's interests and the interests of all persons, firms, or corporations who/which have furnished material, provided equipment on rental, or supplied/performed labor services on, or in connection with, the performance of the remediation work for this contract.

The Warranty Bond is to be effective beginning on the date of physical work completion, established by the Representative for the whole project or any substantial project section, as specified in Section 110.08(a). The Warranty bond is to remain in effect for a period of 60 months from the effective date or until completion of all remediation work identified in the final annual performance surveys, whichever is later. If a substantial section of the project is completed in advance of the whole, the Contractor may request that a final inspection of that section be conducted. If the Department accepts the work on the section of the project, in writing, and the section is opened to normal traffic, the warranty period for that section will start in advance of the date of physical work completion for the entire project. The Warranty Bond, however, must remain in effect until all criteria established in Section 496.3(c)6 are satisfied, and the Warranty Acceptance Notification has been issued. The amount of the warranty bond will be reduced proportionately if the warranty period for a portion of the work expires in advance of the warranty period for the remainder of the work.

Maintain insurance to indemnify and save harmless the Commonwealth, the Department, and all of its officers and employees from all suits, actions, or claims of any character, name, and description, brought for or on account of any injuries or damages received or sustained by any person, persons, or property related to the performance of any work by the Contractor, these pavement items, or to remedial actions taken throughout the warranty period, whether the same is due to the use of defective material, defective work, neglect in safeguarding the work or public interests, or by or on account of any act, omission, neglect or misconduct of the Contractor.

496.3. CONSTRUCTION—Provide an asphalt concrete pavement meeting the requirements specified herein and capable of meeting the warranty performance based criteria specified herein.

Construct the pavement as a combination of two or more different asphalt concrete pavement courses to achieve the total depth indicated.

(a) Tests for Depth of Binder and Wearing Courses. Within 24 hours after final compaction, in the presence of the Inspector, drill one, 4-inch diameter or larger core through all lifts and courses placed under this item of work to the top of the existing pavement or base, for each 2,000 linear feet of pavement lane. The Inspector will determine core locations using PTM No. 1, excluding any transitional areas indicated.

The Inspector will measure the depth of each core according to PTM No. 737. When any one core depth measurement indicates the pavement is deficient in depth by more than 1/4 inch, which cannot be satisfactorily corrected, the affected pavement area will be considered defective work. When core depth measurements indicate that the pavement is uniformly deficient in depth by more than 1/8 inch in any three consecutive core locations and the deficiency cannot be satisfactorily corrected, the affected pavement area will be considered defective work. After the Inspector completes depth measurements, backfill, compact, and seal core holes with mixture used to construct the wearing course. After depth measurement, the cores may be used for QC testing.

Immediately correct pavement that is deficient in depth starting at the point of the determined deficiency, and proceed longitudinally and transversely until the depth within the limits of the entire repair area is within 1/4 inch of the required depth. Drill additional cores as needed, both forward and back of the cores determined to have deficient

depth, to determine the actual starting and ending point of the deficiency. Coring operations will not exclude pavement from the warranty performance criteria.

(b) Information Samples for the Department. The Department reserves the right to direct the Contractor to obtain loose mixture box samples and/or pavement core samples at random locations selected by the Inspector according to PTM No. 1 for testing at the LTS for informational purposes only.

If directed and in the presence of the Inspector, obtain n=1 loose mixture box samples from directly behind the paver before the material is compacted. Immediately package loose mixture samples in individual cardboard boxes sized no larger than 240 cubic inches and identify each sample by number, location (lane, direction, and station), date of placement, mixture type, and as Information Samples (Sample Class IF). Immediately deliver the packaged loose mixture box samples to the Inspector.

If directed and in the presence of the Inspector, drill and obtain n=1 6-inch diameter pavement core samples for each 1,000 tons of material placed. Do not bend, compress, or distort samples during cutting, handling, transporting, and storing. If core samples are damaged, immediately obtain replacement samples, as directed by the Inspector, from within 12 inches of the original sample location. Obtain samples no later than 24 hours after placement. Identify the samples by number, location (lane, direction, and station), date of placement, mixture type, and as Information Samples (Sample Class IF). Immediately package and deliver the samples to the Inspector. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

(c) Warranty.

1. Performance Criteria. Performance results will be determined by automated surveys. These distresses will be identified, measured, and reported using the survey techniques, rating procedures, and extent estimation procedures in accordance with Publication 336. Surveys will be performed by the Department or a designee. Manual surveys, when necessary, will be performed according to Publication 336. Performance results for flushing and potholes will be determined by manual surveys.

For each Segment, or partial Segment, performance criteria limits for distresses are indicated in Table A. A segment is defined as a division of the State Route approximately one-half mile in length with termini designated by the Department typically beginning and ending at physical features. The segment beginning points will be designated on the plans.

If the last performance survey (year 5) determines that 30% of segment area has two or more distresses with low severity, then remedial action is required by microsurfacing, or other treatment approved by the Department.

TABLE A
Performance Criteria Distress Limits

PERFORMANCE CRITERION	THRESHOLD LEVEL	REMEDIAL ACTION
FATIGUE CRACKING	All medium or greater severity*	Remove and replace distressed layers full lane width to a depth necessary to correct observed distress but not to exceed warranted pavement and length not less than 10 feet beyond the distressed area.
CRACKING	All low to medium severity*	Crack seal as specified in Section 469.
(Transverse Cracking & Miscellaneous Cracking)	All high severity*	Remove and replace distressed layers full lane width to a depth necessary to correct observed distress but not to exceed warranted pavement and length not less than 10 feet beyond the distressed area.
RAVELING / WEATHERING	All medium or greater severity*	Remove and replace distressed layers full lane width to a depth necessary to correct observed distress but not to exceed warranted pavement and length not less than 10 feet beyond the distressed area.
RUTTING	> 3/8 inch	Remove and replace distressed layers full lane width to a depth necessary to correct observed distress but not to exceed warranted pavement and length not less than 10 feet beyond the distressed area.
FLUSHING	ALL	Remove and replace distressed layer full depth and full or half lane width (longitudinal joint at center of lane for half lane width) and a minimum of 24 inches beyond distressed pavement in all longitudinal directions.
POTHOLES (INCLUDING SLIPPAGE AREAS)	ALL	Remove and replace distressed layers full lane width to a depth necessary to correct observed distress but not to exceed warranted pavement and length not less than 10 feet beyond the distressed area.
LONGITUDINAL JOINT DETERIORATION	All medium severity*	Crack seal as specified in Section 469.
EDGE DETERIORATION (shoulder joint)	All high severity*	Remove and replace distressed layer one foot either side of the joint transversely and a minimum of 24 inches beyond distressed pavement in all longitudinal directions.
LONGITUDINAL JOINT DETERIORATION	All medium severity*	Crack seal as specified in Section 469.
LEFT EDGE JOINT (lane joints)	All high severity*	Remove and replace distressed layer one foot either side of the joint transversely and a minimum of 24 inches beyond distressed pavement in all longitudinal directions.

*The Threshold Level as defined in Publication 336.

NOTE: Should deviations beyond the threshold levels indicated in Table A in combination total a remedial action area greater than 20% of the surface area of any segment of pavement as defined herein, (except that, for this determination, a medium severity crack referenced above will be considered to be a deviation affecting 6 inches on either side of the crack for the entire length of the crack) remove and replace the entire segment.

Should the distance between repair areas be less than 100 feet, make one continuous repair.

All repairs must meet the surface tolerance as specified in Section 413.3 (l).

2. Remediation Work under the Pavement Warranty.

2.a Department's Responsibility. To determine compliance with specified performance criteria the Department will be responsible for conducting an annual performance analysis, the basis of which will be the distress criteria established in Table A.

The Department will schedule and perform annual surveys, and additional surveys if needed, of the warranted pavement for flushing and potholes. When needed, Rut Depth measurements will be verified using a 12 foot straight edge, across the lane width, to determine the severity and extent. Surveys will be conducted annually throughout the warranty period. The Contractor will be notified at least 14 calendar days in advance of all scheduled manual surveys. In addition, the Department will routinely schedule and perform traffic classification counts to confirm that Equivalent Single Axle Load (ESAL) estimates remain within the projected values included in the contract documents.

The Department reserves the right to schedule and perform additional or more frequent performance surveys if, at any time during the warranty period, evidence exists that performance criteria are not being met. The Department will provide the Contractor with access to the results of all performance surveys and traffic counts. Performance survey results will be reported for each individual State Route Segment as established under the Department's Location Reference System (LRS) or partial Segment within the limits of the warranty project. Within 14 calendar days after completion, the Department will notify the Contractor, in writing, of the results of performance surveys, identifying the Segment (location) and the performance criterion, and indicating whether specified distress limits have been met or exceeded. After performance surveys are completed, if the Department determines remedial action is necessary, the Contractor will be notified within 5 calendar days, from the date of that determination, that remediation work is required.

During the warranty period, the Department will not perform routine pavement maintenance, such as crack sealing and base repairs, on the warranted pavement. If the Department determines emergency repair work is necessary, the Contractor will be notified immediately of the emergency repair work that is required. The Contractor will be given 24 hours to review the emergency repair work that is needed and notify the Department if they will perform the required repairs. When the Contractor notifies the Department agreeing to make the required emergency repairs, they must begin repair work within 48 hours of the Department’s initial notification. If the Contractor does not notify the Department within 24 hours or begin the repair work within 48 hours of the Department’s initial notification, the Department reserves the right to make emergency repairs to the warranted pavement during the warranty period. If the pavement condition is determined to be potentially harmful or unsafe, the Department reserves the right to make immediate emergency repairs to the warranted pavement during the warranty period. The Department will then notify the Contractor of the location of all emergency repairs performed. The costs expended by the Department for any emergency repair work needed to correct deficiencies covered under the terms of this warranty specification will be the responsibility of the Contractor.

2.b Contractor's Responsibility. The Contractor’s obligation to perform required remediation work shall survive acceptance of the work and final settlement of the Contract.

The Contractor may witness all manual performance surveys. Where survey results for a given Segment indicate that performance criteria distress limits for one or more distress types have been exceeded, perform the remediation work described in Table A. If proposing to utilize a method of testing, measurement, or remedial action other than that prescribed, submit a plan that includes a detailed description of the proposed testing, measurement, or remedial action to the Representative for review and approval. The Department will review and approve or disapprove the submitted testing, measurement, or remedial action plan within 5 calendar days of receipt of the submission.

Complete remediation work required as part of the pavement warranty, at the location(s) indicated, within 60 calendar days after receipt of the Department's written notification that remediation work is required. Perform remediation work to meet the material and performance criteria requirements contained herein. Notify the District Executive of the tentative start date for remediation work and submit a schedule for remedial repairs within 5 calendar days of that notification. If remediation work does not begin by the start of the 61st calendar day after the date of the Department’s written notification, the Contractor will be responsible to pay an amount equivalent to the Construction Engineering Liquidated Damages as specified in Section 108.07. This cost will accrue until the required remedial work ends. In addition to the continuing cost equivalent to the Construction Engineering Liquidated Damages, costs equivalent to Road Users Liquidated Damages as specified in Section 108.07 will be assessed no sooner than the 61st calendar day after the date of the Department’s written notification, for each calendar day that the roadway is not open

to unrestricted traffic. If inclement weather prohibits quality repairs, the Contractor will be responsible for placing and maintaining temporary repairs until permanent remediation work can be properly completed. Charges equivalent to Road Users Liquidated Damages will not be assessed following temporary repair work, provided the temporary repairs are properly maintained. Permanent repairs are to be constructed as soon as weather permits. The Department will notify the Contractor in writing when weather conditions permit permanent repairs. Charges equivalent to Construction Engineering Liquidated Damages and Road Users Liquidated Damages will resume beginning 5 calendar days beyond this notification until permanent repairs are completed. In the final year of the warranty period, segments with distresses that cannot be repaired due to inclement weather will have the warranty period extended for these segments only until permanent repairs are satisfactorily completed. The warranty bond can be reduced proportionately to cover only the distressed segments. All charges equivalent to Liquidated Damages as referenced herein will be determined from original contract documents.

Furnish all materials, equipment, and labor needed to perform remediation work required as part of the pavement warranty, including traffic control, at no cost to the Department. When the remedial action specified in Table A calls for removal and replacement, use only plant-mixed, asphalt concrete unless other materials are accepted, in writing, by the District Executive. Under adverse weather conditions**,** temporary repair methods and materials may be used in remediation work, provided traffic safety and normal traffic patterns are maintained**.** Remove temporary repairs and perform permanent remediation work as soon as weather conditions permit.

The Department’s notice to perform required remediation work, or the Department’s approval of the Contractor’s written proposal to perform elective or preventative maintenance work, shall serve as a right-of-entry that authorizes the work to be done, subject to time and location limitations contained in that notification, or those agreed to by the Contractor and the Department. Perform remediation work, including replacements, to meet the specified performance criteria indicated in Table A. Restore, according to Department specifications, all features removed and/or damaged during remediation work.

Except for allowable crack sealing, as indicated in Table A, repair distress areas to the limits specified with square or rectangular patches using materials meeting the requirements of this specification and constructed to meet the construction end-result and performance criteria of this specification.

Provide and maintain traffic control for operations involved in remediation work performed as part of the pavement warranty. Use the traffic control plan (TCP) provided in the original contract for remediation work, or submit an alternate TCP to the District Executive for approval. Submit alternate TCPs at least 14 calendar days before the start of remediation work. Alternate TCPs are to comply with the provisions of Publications 212 and 213, the MUTCD, and the contract special provisions.

If the Department's written notification indicates that remedial action is required as part of the pavement warranty and the Department's performance survey results are disputed, notify the Department, in writing, within 30 calendar days from the date of the Department's written notification. Base disputes on appraisals of the performance survey results supplied by the Department. The Contractor may base a dispute on a third party appraisal of the performance results. If the Department and Contractor cannot resolve a dispute over remediation work within 14 calendar days from the date of the Contractor's written notification, the dispute will be submitted to the Conflict Resolution Team identified in Section 496.3(c)3.

Remove material placed by the Department, during emergency repair work within warranted pavement areas and perform required remediation work if it is determined that the emergency repair was required due to faulty work or construction.

The Contractor may monitor or test warranted pavement course(s), using nondestructive methods, at any time during the warranty period. Notify the District Executive at least 7 calendar days in advance of any nondestructive testing. Provide all nondestructive test results to the Department for information. Obtain written authorization from the Department before conducting nondestructive Testing.

Do not perform any remediation work without prior written notification from the Department. Submit a written proposal, to the District Executive, setting forth the reason(s) for performing elective or preventative remediation work not directed by the Department. The Department will review and approve or disapprove elective or preventative remediation work initiated by the Contractor within 5 calendar days from receipt of the written proposal.

3. Conflict Resolution Team. The Conflict Resolution Team (Team) will consist of two representatives selected by the Contractor, two representatives selected by the Department (District and Bureau of Project Delivery), and a fifth person mutually agreed upon by both the Department and the Contractor. Any costs incurred for the fifth Team member will be shared equally by the Department and the Contractor. The Team members, who will be identified at the pre-construction meeting, must be knowledgeable in the terms and conditions of the warranty specification and the methods used in the measurement and calculation of pavement distress. Each Team member

will have an equal vote and the decision of the majority will be final. If a change in the team is required the same selection procedure will be used as stated above.

The Team will resolve disputes concerning defective work, warranted pavement performance, survey results, required remediation work, proposed alternate repair methods and material selection, and disputes over probable causes.

The Team will meet and resolve disputes within 30 calendar days from the date of submission.

4. Probable Cause. The Department will furnish the Contractor with the results of performance surveys and traffic counts, noting those distresses considered to be caused by factors beyond the control of the Contractor. The Contractor will not be held responsible for meeting specified performance criteria or performing remediation work within these distress areas, which will be calculated by multiplying the maximum transverse width of the distress by the maximum longitudinal length. The area of non-responsibility will be defined as a square or rectangular area centered over and equal to 150% of the distress area, but extending no more than 10 feet on either side of the distress area.

The Department may repair distresses determined to be caused by factors beyond the control of the Contractor using routine repair techniques.

Factors beyond the control of the Contractor include the following:

4.a Base Condition. If performance surveys detect fatigue cracking or other distresses which might indicate an unacceptable base condition, a series of 6-inch diameter cores will be drilled within the distress area, as necessary, at locations directed by the Department. The Inspector will measure the depth of each core. The cores will be tested according to PTM No. 715 and AASHTO T-209 to determine the percent of unfilled voids, PTM No. 702 or other approved test methods to determine the percent asphalt, and PTM No. 739 to determine gradation. Have a Representative witness the testing. Test results will be provided to the DME/DMM. If the warranted pavement meets the specified minimum thickness, the density is $\geq$ 92% of theoretical maximum density and test results for percent asphalt and gradation are within the tolerances indicated in the Contractor's mix design(s), or if field evaluation clearly indicates base failure beyond the Contractor's control, the Contractor will not be held responsible for repair of the distress and will be reimbursed, by the Department, the total cost of the testing. Should these criteria not be achieved, further investigation may be necessary to determine the cause of the distress.

4.b Traffic Loadings. If, during the warranty period, the Department's traffic counts indicate that estimated cumulative ESALs have exceeded 100% of the estimated 20-year design life ESALs or if the ESAL's increase enough to warrant a change in the mix design in the number of gyrations, the Contractor will not be held responsible for repair of rutting or base condition distresses for the remainder of the warranty period.

4.c Routine Maintenance by the Department. During the warranty period, the Department will perform routine maintenance such as snow removal, application of anti-skid material and/or de-icing chemicals, repairs to safety appurtenances, application and maintenance of pavement markings, mowing, and sign maintenance. Routine pavement maintenance activities, such as crack sealing, pothole patching, or milling, will not be performed by the Department during the warranty period.

4.d Destructive Procedures by the Department. The Contractor will not be held responsible for repair of distresses caused by coring, milling or other destructive procedures performed by the Department.

4.e Uncontrolled Forces of Nature. The Contractor will not be held responsible for repair of distresses caused by floods, earthquakes, tornadoes, brush or forest fires, landslides, sinkholes, or other natural disasters.

4.f Traffic Accidents. The Contractor will not be held responsible for repair of distresses caused by traffic accident-related fuel or chemical spills, vehicle fires, and/or gouging or goring of the pavement surface unless the Contractor or its representative is the cause of the distress.

5. Final Warranty Inspection. At the end of the warranty period, and when any remediation work, if required, is substantially complete (at least 90%), make arrangements for a mutual final warranty inspection. At the time of final warranty inspection, the Representative, along with the Contractor, will establish the following:

- The list of all physical work items requiring completion and/or correction; and
- A list of all documents requiring submission, completion, and/or correction.

As established during the final warranty inspection, perform work as necessary for required correction or completion of all physical work items, and complete, correct, and submit all outstanding documents.

6. Release from Warranty. To be released from warranty responsibility, satisfy all of the following:

- Meet minimum requirements for each of the specified performance criteria through the end of the warranty period,
- Complete all required remediation work identified during the warranty period at no additional cost to and to the satisfaction of the Department, and
- Submit all required warranty documents.

When the warranty period has expired, all physical remediation work has been satisfactorily completed, and all required warranty release criteria have been met, the Representative will establish the date of physical warranty work completion; the date on which the Contractor will be relieved of responsibility for further physical remediation work and maintenance on the project or any substantial project section.

Upon receipt and verification, the Representative will establish the date that all required warranty documents are satisfactorily furnished.

When all physical remediation work has been satisfactorily completed and all contractually required warranty documents have been properly furnished, the date of warranty project acceptance will be established.

If the warranty period for a substantial project section expires in advance of the whole, a final warranty inspection will be made of that section, as specified for the entire project, and the Contractor notified, in writing, that the warranty terms for the specific section of the project have been satisfied. No further remediation work will be required on the section as specified in Section 108.04(b). The Contractor will then be allowed to reduce their warranty bond proportionately.

7. Warranty Acceptance Notification. Upon completion of the requirements of Section 496.3(c)6, a Warranty Acceptance Notification will be issued indicating that the project warranty has been satisfactorily completed and certifying that the project is accepted as of that date.

8. Warranty Default and Termination of Contract. As specified in Section 108.08 and as follows:

- Failure of the Contractor to perform remediation work within the time specified.

496.4. MEASUREMENT AND PAYMENT—

(a) Asphalt Concrete Pavement, 60-Month Warranty. Square Yard

Payment will be made, as specified in Section 110.05, as work progresses, based on the quantity of each separate pavement course placed meeting specified construction criteria.

The Inspector will measure the quantity of each pavement course placed, on a daily basis, and compute the payable quantity by multiplying the measured area by a factor equal to the depth of the pavement course being placed divided by the total, indicated pavement depth. The placement depth will be determined as indicated in Section 496.3(a). No additional payment will be made for pavement depths in excess of the total, indicated depth.

(b) Asphalt Concrete Pavement, 60-Month Warranty, Warranty Bond and Liability Insurance. Lump Sum

SECTION 500—RIGID PAVEMENTS

SECTION 501—REINFORCED OR PLAIN CEMENT CONCRETE PAVEMENTS

501.1 DESCRIPTION—This work is construction of normal strength, accelerated strength, or High Early-Strength (HES) cement concrete pavement, plain or reinforced, on a prepared surface, as indicated.

501.2 MATERIAL—

(a) Class AA Cement Concrete, Modified.-Section 704, except as follows:

- Section 704.1(b) revise the third bullet completely to read:

  - Coarse Aggregate, Type A, Section 703.2, except as follows: AASHTO No. 467, No. 57, No. 67, or No. 8. Do not exceed 3.0% absorption for gravels and 2.0% absorption for all other aggregates. Coarse aggregates with higher absorption may be allowed provided mix design specimens meet 300 freeze-thaw cycles according to ASTM C666 with less than 0.04% dilation and/or durability factor greater than 80.

Revise Section 704 **TABLE A – Cement Concrete Criteria** and referenced Notes to read as follows:

Class of Concrete	Use	Cement Factor (lbs./cu.yd.)		Water Cement Ratio(1)(2)		Minimum Mix Design Compressive Strength (psi)			Proportions Coarse Aggregate Solid Volume (cu.ft./cu.yd.)	28-Day Structural Design Compressive Strength (psi)
		Min.	Max.	Min.	Max.	3	7	28(3)		
AA	Slip Form Paving	517	611	0.37	0.42	—	3,000	4,000	—	3,500
AA	Form Paving	517	611	0.37	0.45	—	3,000	4,000	—	3,500
AA	Accelerated Paving(4)	517	752	0.37	0.45	—	3,000	4,000	—	3,500
HES	Paving	517	752	0.37	0.42	2,000		4,000	—	3,500

(1) Where the cement is replaced by supplementary cementitious material, use a water to cement plus supplementary cementitious material ratio by weight.
(2) Lower Cement Factor can be permitted by DME/DMM if the mix design is demonstrated to perform adequately.
(3) DME/DMM may accept mix designs based on the 56-day strength based on qualification testing.
(4) For accelerated cement concrete, submit a mix design as specified in Section 704.1(c) having a minimum target value compressive strength of 1,500 pounds per square inch at 7 hours when tested according to PTM No. 604. The minimum required compressive strength for opening an accelerated strength pavement to traffic is 1,200 pounds per square inch as specified in Section 501.3(q).

- Section 704.1(c) Design Basis. Revise to read as follows:

  - Section 704.1(c)1. Add the following to the first paragraph:

Provide concrete pavement mix designs according to PTM No. 529, to determine the optimized aggregate gradation, and coarse and fine volumes of the fine aggregate portion of the optimized gradation, for the mix design. The coarse and fine volumes of the fine aggregate portion of the mix design gradation must be within

the limits in PTM No. 529. Gradations less than 5% outside of the limits of PTM No. 529 on one sieve may be allowed by the DME/DMM on a case by case basis.

- Section 704.1(c)1. Add the following after the first paragraph:

Design the cement concrete for paving applications to meet the following requirements:

- Permeability – Design the concrete mixture to meet a target chloride ion penetration of Low, Very low, or Negligible after a 56 day or less curing period according to AASHTO T 277 or AASHTO T 358; and

- Shrinkage (Microstrain) – The maximum 28-day shrinkage according to ASTM C157, after 28-day air storage method, does not exceed 0.05%.

- The DME/DMM has the option of accepting mix designs with a chloride ion penetration of Moderate, however, the chloride ion penetration must meet one of the following:

  AASHTO T 277, Table 1, not to exceed 2,800 coulombs; or

  AASHTO T 358, Table 1, not to exceed 15.6 kΩ-cm for 4-inch by 8-inch cylinders and 12.3 kΩ-cm for 6-inch by 12-inch cylinders.

- Section 704.1(c)1. Revise the second paragraph to read:

Provide a concrete pavement mix design having an overdesign compressive strength of 500 pounds per square inch.

- Section 704.1(c)3. Revise the first sentence to read:

Design cement concrete to have an air content of 7.0% +/- 1.5% in the plastic state.

- Once material control is established, as specified in Section 704.1(d)4.a, the frequency of testing may be reduced to a minimum of one set of tests every 50 cubic yards or 30 minutes, whichever is greater.

(b) Class AA Cement Concrete, Accelerated, Modified. Use only where indicated or directed and is prohibited for use in long-term lane closures except to accommodate local traffic. Section 704, except as follows:

- Section 704.1(b) revise the third bullet to read:

  - Coarse Aggregate, Type A, Section 703.2, except as follows: AASHTO No. 467, No. 57, No. 67, or No. 8. Do not exceed 3.0% absorption for gravels and 2.0% absorption for all other aggregates. Coarse aggregates with higher absorption may be allowed provided mix design specimens meet 300 freeze-thaw cycles according to ASTM C666 with less than 0.04% dilation and/or durability factor greater than 80.

- Section 704.1(c)3. Revise the first sentence to read:

Design cement concrete to have an air content of 7.0% +/- 1.5% in the plastic state.

- Once material control is established, as specified in Section 704.1(d)4.a, the frequency of testing may be reduced to a minimum of one set of tests every 50 cubic yards or 30 minutes, whichever is greater.

(c) HES Cement Concrete, Modified. Use only where indicated or directed and is prohibited for use in long-term lane closures except to accommodate local traffic. Section 704, except as follows:

- Section 704.1(b) revise the third bullet to read:

    - Coarse Aggregate, Type A, Section 703.2, except as follows: AASHTO No. 467, No. 57, No. 67, or No. 8. Do not exceed 3.0% absorption for gravels and 2.0% absorption for all other aggregates. Coarse aggregates with higher absorption may be allowed provided mix design specimens meet 300 freeze-thaw cycles according to ASTM C666 with less than 0.04% dilation and/or durability factor greater than 80.

- Section 704.1(c)3. Revise the first sentence to read:

Design cement concrete to have an air content of 7.0% +/- 1.5% in the plastic state.

- Once material control is established, as specified in Section 704.1(d)4.a, the frequency of testing may be reduced to a minimum of one set of tests every 50 cubic yards or 30 minutes, whichever is greater.

(d) Reinforcement. Sections 709.3 and 709.4

(e) Expansion Joint Filler. Section 705.1

(f) Longitudinal Joint Material. Section 705.2

(g) Load-Transfer Units (LTU). Sections 705.3(a), (b) and (g)

(h) Joint Sealing Material. Section 705.4(a), (b), or (d)

(i) Bond Breaker Lubricant. Provide a commercially available bond-breaking lubricant with a flash point of not less than 149F, and recommended for contact with steel materials according to manufacturer's recommendations. Do not use graphite-based lubricants.

(j) Concrete Curing Material. Sections 711.1, 711.2(b) and 711.2(c)

(k) Intermediate Curing Compound. Section 711.2(d)

(l) Concrete Admixtures. Section 711.3

(m) Mortar. Section 705.7(b)

(n) Tape Bond Breaker. An acceptable self-adhesive tape the width of the sealant reservoir.

(o) Joint Backing Material. Section 705.9

(p) Anchor Material.

1. General. An approved adhesive anchoring material listed in Bulletin 15 and meeting the requirements for unbonded area.

2. Unbonded Area. Furnish adhesive anchoring material that results in an average percentage of unbonded area, for n=3 test unit assemblies, of less than or equal to 10% when tested according to PTM No. 634.

(q) Epoxy Bonding Compound. Section 706.1

(r) Preformed Cellular Polystyrene. ASTM C578

(s) Fiberglass Dowel Sleeve. An approved type as listed in Bulletin 15.

(t) Pre-mixed Nonshrink Grout. Section 1080.2(c)

501.3 CONSTRUCTION—

(a) General. Construct pavements in one or two traffic lane widths as shown on the Standard Drawings, unless otherwise directed. Use one-lane construction if two-lane construction interferes with traffic. For projects with more than 15,000 square yards of mainline concrete paving, monitor aggregate gradations during concrete production by performing sieve analysis using plant stockpiled aggregate before beginning daily production and when restocking bins, but no more than daily. From the results of the sieve analysis, generate the cumulative percent retained chart. Verify that the daily production plots within the limits defined by the Combined Gradation Percent Retained Chart according to PTM No. 529.

If necessary, adjust aggregate proportions during production to maintain the combined gradation percent retained within limits according to PTM No. 529. Adjustments to aggregate proportions that also require adjustments to cementitious material or water content will require the development of new mix designs, including trial concrete batches. The DME/DMM may allow combined gradations during production that are less than 5% outside of the required percent retained according to PTM No. 529.

1. Field Operation QC Plan. At least 2 weeks prior to the start of paving operations, submit a comprehensive paving operation QC Plan for field control and evaluation of concrete paving operations for review. Do not start paving until the QC Plan is accepted. At a minimum, include the following:

- Personnel and responsibilities for controlling the concrete paving operations;
- QC sampling and testing frequencies and action points to initiate corrective measures;
- Method requested for determining opening to traffic strength;
- Method requested for determining pavement depth;
- Procedures addressing cool and hot weather placements;
- Procedures for monitoring and controlling the rate of evaporation;
- Procedures for subgrade and subbase/treated base course control and maintenance;
- Procedures to ensure proper placement and consolidation;
- Procedures to ensure proper joint construction;
- Procedures to prevent edge slump;
- Procedures to ensure proper grade and depth control;
- Procedures for straightedge testing and to ensure proper final texture;
- Procedures to ensure proper curing application and temperature monitoring;
- Procedures to ensure timely sawing and proper sealing of joints; and
- Procedures to eliminate damage to pavement prior to opening to traffic.

(b) Weather Restrictions. Do not place concrete when the evaporation rate exceeds 0.20 pounds per square foot per hour unless mitigation measures are employed. The use of windbreaks and fog misting are acceptable methods to mitigate an excessive evaporation rate. When fog misting is employed, use equipment that atomizes droplets in the air surrounding the concrete without causing water deposits.

1. Cold Weather. Unless otherwise permitted in writing, discontinue concreting operations when the descending air temperature, away from artificial heat, falls to 40F (45F for accelerated strength concrete). Do not resume operations until the air temperature, away from artificial heat, rises above 40F (45F for accelerated strength concrete). Do not allow water above 90F to come in direct contact with the cement, until the cement has been mixed with the aggregates. Place concrete when the concrete temperature is between 50F and 90F. Do not use materials containing frost, lumps, or crusts of hardened materials. Do not place concrete on frozen base, subbase, or subgrade.

2. Hot Weather. When the air temperature in the immediate vicinity of concrete operations rises to 85F, take thermometer readings of the plastic concrete, at 1/2-hour intervals and at the conclusion of the mixing cycles. Discontinue concrete operations if the plastic concrete temperature exceeds 90F after mixing. When the plastic concrete temperature rises to 90F, cool the mixing water or aggregates to maintain a plastic concrete temperature within 50F to 90F at the time of placing.

(c) Concrete Mixture. Do not use mixtures from volumetric mixing plants or mobile mixers, unless approved by the District Executive in writing. For slip-form paving, the Contractor may use plant mixed cement concrete, volumetric mixing plants or mobile mixers as specified in Section 704.1(a).

(d) Forms. Use steel forms for concrete pavement except as specified herein. Use forms not less than 10 feet in length, with form depth and base width equal to pavement depth. Forms may be built-up no greater than 1/2-inch to meet the required pavement design thickness. Built-up form sections must be continuous, equal to the width of the steel form and secured to the form in a manner that prevents movement during concrete placement. Do not exceed 1/8 inch in 10 feet from the true plane of the face or top. The Contractor may use forms with a base of not less than 6 inches in width and meeting all other requirements for narrow strips of widening if approved by the District Executive in writing.

Use forms of an approved section without horizontal joints, and with flange bracing extending outward on the base not less than two-thirds of the form height. Use forms that do not deflect or deform more than 0.01 inch when a center load of 1,700 pounds is applied within a 4-foot span. Use form sections equipped with three stake pockets, each of which have positive non-detachable wedges, and positive interlocking devices, which form a neat tight joint.

Use a sufficient quantity of steel pins to securely hold the forms in place and provide the necessary rigidity.
For curves with a radius of less than 150 feet, the Contractor may use wood forms. Use two 1-inch (nominal) seasoned, surfaced planks properly joined together. Brace all wood forms with steel pins. Do not exceed 24 inch spacing between pins.

Clean and oil forms before each concrete placement. Cut and firm the subbase under the forms true to grade, and set forms accurately to line and grade for their entire length and width. Forms may be shimmed provided that the material used to shim the forms creates continuous contact between the form and the base course surface. The forms and shimming material must result in a full vertical face of concrete when removed. If concrete extrudes outside the shims or forms, remove this extruded concrete, as directed, before placing the adjacent concrete.

For concrete pavement constructed on aggregate subbase, if the grade is low, add additional subbase in 1/2-inch compacted lifts. If the grade is high, cut the subbase to the required grade and recompact.

For concrete pavement constructed on cement treated base courses or asphalt treated base courses, cut and trim high areas to required grade.

If the base course along the form is low, place shims to maintain vertical form alignment during the concrete placement. Shim forms to a height no greater than 1 inch. Shimming material shall be equal to or greater than the width of the form base and spaced so the forms do not deflect or deform more than 0.01 inch when a center load of 1,700 pounds is applied within a 4-foot span. Shimming material shall be secured to the form in a manner that prevents movement during concrete placement and shall not protrude beyond the inside face of the form. If concrete extrudes outside the forms, remove the extruded concrete, before placing the adjacent concrete.

(e) Preparation and Protection of Base Course. When placing concrete on the completed base course, do not disturb the form line after final testing. Remove accumulation of material adjacent to forms, to full depth of forms, in conjunction with final testing. If the prepared area is disturbed by any operations, or by traffic, check and correct before placing concrete.

Thoroughly sprinkle water on the base course before paving, if necessary, to ensure a moist base course and to cool the surface temperature of treated permeable base courses below 115F. Discontinue paving operations if the surface temperature of treated permeable base courses cannot be maintained below 115F. Do not create water puddles or mud. Sprinkle the base course with as much water as it readily absorbs, well in advance of paving.

If non-destructive depth testing is being utilized as specified in Section 501.3(s)2, place targets at locations determined by the Representative as specified in Section 501.3(s)2 and according to PTM No. 605. The measuring device and targets must be verified daily according to PTM No. 605 in the presence of the Representative before the installation of the targets. The Representative will verify the targets have been placed at the proper locations before paving operations. Remove and replace improperly located targets and repair any damage to the base course before paving operations at no cost to the Department.

(f) Placement and Initial Strike-Off of Concrete. Before placing concrete, ensure adequate equipment and trained personnel are available, and sufficient hauling units scheduled, to maintain continuity in placement.

For pavement construction around manholes, inlets, valve boxes, and similar appurtenances, place premolded expansion joint filler not less than 1/2 inch in total thickness, for the full depth of the pavement, around the outer sides of structures within the paved areas. Where pavements adjoin other rigid structures, bridges, or culverts, place premolded expansion-joint filler, not less than 3/4-inch thick, adjacent to the structures. Before placing pavement

adjacent to railway tracks, fill the spaces along the web and below the head and top flange of the rail with mortar. If construction crosses railway tracks, place a minimum 3/4-inch thick expansion joint filler against the mortar-filled rails. If constructing along tracks, place a minimum 1/4-inch thick expansion joint filler along each mortar-filled rail.

Do not use concrete that has developed an initial set.

If implanting dowel bars by mechanical means, the Contractor may deposit the concrete directly on the subgrade or prepared surface in front of the paver. Spread concrete as close as possible to joint assemblies to ensure proper concrete consolidation without disturbing the joint. Do not damage the prepared surface while transporting or depositing concrete ahead of the paver. If the prepared surface is an asphaltic leveling course on rubblized concrete, treated base course of cement or asphalt, or an aggregate subbase, travel on the prepared surface only in the immediate area of the paving operation for the purpose of depositing concrete ahead of the paver. Do not use the prepared surface for hauling. Satisfactorily repair or replace any damaged areas at no additional cost to the Department.

Use vibrators capable of transmitting vibration to concrete with a frequency of not less than 100 impulses per second. Operate the vibrator around, but not in contact with transverse or longitudinal joint assemblies. Do not cause segregation when vibrating. Do not operate manual vibrators in one place more than 5 seconds. Use vibrators only to consolidate concrete after it has been properly placed. Do not use vibrators to move or spread concrete. Remove and discard segregated concrete, as directed. Maintain sufficient reserve vibratory equipment to prevent shutdown due to failure of equipment.

(g) Slip-Form Paving Method.

1. Equipment. Use a fully energized, self-propelled, slip-form paving machine, equipped with side forms to support concrete laterally to prevent edge slumping. Use a paver equipped with automatic controls to control alignment and grade. Use a paver that vibrates or tamps concrete for the full width and depth of the layer being placed.

2. Line and Grade. Unless otherwise specifically shown on the construction drawings, construct pavement so the longitudinal joints do not traverse a driving lane or conflict with the final pavement markings. Construct longitudinal joints parallel to and within 12 inches of final pavement markings unless otherwise detailed on the construction drawings.

3. Placing Concrete. Place the concrete and spread in one or more layers, provided the concrete is fully consolidated, the reinforcement is satisfactorily embedded, and a satisfactory finished surface is obtained.

Operate the slip-form paver in a continuous forward movement. Coordinate operations of mixing, delivering, placing, and spreading concrete to provide uniform progress with stopping and starting of the paver held to a minimum. If the paver's forward movement is stopped, immediately disengage vibrating and tamping elements.

4. Joints. When load transfer units are used, stake in place in advance of paving operations, at the designated locations. Implanting of dowel bars by mechanical means is permitted. Accurately mark the dowel-bar locations to ensure sawing the transverse joints over the center of dowels. Saw, cure, and protect transverse and longitudinal contraction joints, as specified in Sections 501.3(i) and (j).

5. Edge Slumping.

5.a During Paving Operations. Test the pavement surface for edge slumping with a 12-foot straightedge, before the concrete becomes non-plastic. Strive to avoid edge slump. Edge slump not exceeding the following will be acceptable:

- 1/8 inch between adjacent lanes, and lanes and ramps.
- 1/4 inch between lanes and shoulders, and ramps and shoulders.

Measure edge slump for the 6-inch width contiguous to the pavement edge.

Suspend paving operations after 200 feet if edge slumping cannot be prevented or controlled within the above stated acceptable limits. The pavement within this 200-foot section will be evaluated as specified in Section 501.3(g)5.b.

5.b After the Concrete Hardens. Test the pavement surface with a 12-foot straightedge to ensure the requirements of Section 501.3(g)5.a have been met.

If testing confirms edge slumping exists in the hardened concrete, submit methods for correction to the District Executive for review. Make corrections according to the reviewed methods to eliminate the edge slumping. Remove and replace pavement determined defective, as specified in Section 501.3(t), at no additional cost to the Department.

(h) Handling and Placing Reinforcement. Use reinforcement free of rust, dirt, oil, grease, or other foreign substances, which impair bond of steel with concrete. A light, powdery coating of rust, formed during project storage, does not require cleaning. Remove loose, scaly, or thick rust by suitable methods. The Representative will reject reinforcement with rust that has caused detectable reduction in cross-sectional area.

If placing reinforced concrete pavement in two layers within fixed forms, strike off the entire bottom layer and lay the reinforcement full length on the concrete, in its final position, without further manipulation. Place reinforcement directly upon the concrete and place, strike-off, and screed the top layer of concrete. Remove and replace bottom-layer portions of concrete placed more than 1/2 hour without being covered with the top layer of freshly mixed concrete.

If placing reinforced concrete pavement in one layer, position mesh reinforcement on acceptable supports as specified in Section 1002.3(d)2 in advance of concrete placement. If a mechanical installer is used, avoid segregation of concrete or displacement of reinforcement.

(i) Transverse Joints. In new multilane pavements, place transverse joints perpendicular to centerline to form a continuous joint across the entire pavement width and locate dowels as shown on the Standard Drawings, except where paving operations must cease temporarily due to unavoidable conditions.

Handle LTU assemblies with care to avoid damaging the corrosion protection barrier. Remove and replace dowels with damaged coating before placement of concrete.

Place and anchor LTU assemblies so that dowel misalignments before concrete placements do not exceed the following limits:

- Vertical tilt or horizontal skew (relative to the plane of the grade and the centerline of the constructed pavement): 0.25 inch maximum displacement of each end of the dowel relative to the midpoint of the dowel.
- Longitudinal translation (relative to the intended transverse joint location, along the direction of travel): 1 inch maximum.
- Horizontal translation (relative to the intended location, across the joint): 1 inch.
- Vertical translation (relative to the intended depth of the constructed pavement): as shown on the standard drawings.

When LTU are used, secure them in place at the designated locations as shown on Standard Drawings in advance of paving operations to prevent their movement during paving operations.

Before paving, demonstrate the fastening method to the Representative for approval.

Before paving, apply bond-breaker lubricant to at least one-half of the length of Type B coated dowel bars, unless a bond-breaker lubricant has been applied in the shop. Stir the lubricant well and apply to the free end of dowels by spraying, or with a gloved hand, to produce a thorough coating. Do not use brushes for lubricant application. Apply the bond-breaker lubricant, as specified, at least 1 hour before placing the concrete around the dowel assembly. Type A coated dowel bars do not need lubricant.

Where existing concrete pavements are widened, align transverse construction or contraction joints, if possible, with existing construction or contraction joints or cracks; otherwise, do not place within 10 feet of a joint.

When constructing adjacent concrete pavement, shoulders or structures after pavement construction, seal the ends of all transverse joints and cracks to prevent intrusion of cement mortar into the joints and cracks. In these cases, when saw cutting transverse joints in the newly constructed lane or shoulders, saw cut the existing transverse joint in the previously placed lane to ensure the removal of any mortar that might have intruded into the joint.

1. Construction Joints. If more than a 30-minute interruption occurs in concreting operations, construct a transverse joint using a bulkhead. Place dowels in bulkheads by drilling or inserting into fiberglass dowel sleeves. Do not construct a transverse joint within 10 feet of another transverse joint. If not enough concrete has been placed or mixed at the time of interruption to form a slab at least 10 feet long, remove concrete to the preceding joint and dispose of excess mix.

2. Contraction Joints. Accurately mark using tacks or other approved methods the location for the center of the sawed transverse contraction joints. The sawed transverse joint must be located directly ±1 inch over the centerline of the dowel basket assemblies or the centerline of the mechanically implanted dowels. Saw joints with equipment having guides, a blade guard, watercooling system, and cut-depth control. Provide adequate and extra equipment and parts at the site, before placing concrete and during sawing operations.

Saw joints as soon as concrete has sufficiently hardened to permit sawing without excessive raveling resulting from the sawing operation and to prevent random cracking. Saw joints to a depth of D/3 and a width of 1/8 inch. If initial saw cuts do not extend through the slab edge to avoid blowouts or edge damage of green concrete, extend these cuts through the edge as soon as it can be done without causing damage. If damage to the pavement occurs, repair in an approved method at no additional cost to the Department. If necessary, conduct sawing operations continuously, both day and night, regardless of weather conditions.

If the pavement is cured by means other than white membrane curing compound, remove curing materials from pavement, at the location where a joint is to be cut. Only remove sufficient covering to provide space necessary for sawing joints. Immediately after sawing the initial saw cut, thoroughly clean the joint as necessary to remove all deleterious material. Place oversized (width plus 50%) backer rod in the top of the sawed joint to maintain cure. Monitor the movement of the joint throughout the cure period and up to placement of permanent seal. If at any time the joint opens, remove and replace backer rod with appropriate oversized backer rod. The maximum time period permitted for curing covers to be removed for sawing is 1/2 hour. If white membrane curing compound is used, reapply curing compound as specified in Section 501.3(l)1.c.

The Representative will not allow displacing coarse aggregate from the joint location by use of a vibrating T-bar, or by use of a filler strip at the joint.

When constructing adjacent concrete pavement, shoulders or structures, mark the dominant joints (first joints that have cracked and opened) on the previous lane placed. Align the location of the first joints sawed in the adjacent lane with the marked dominant joints on the previous lane to encourage dominant joint development in the adjacent lane. In lanes adjacent to previously constructed lanes, saw remaining joints before uncontrolled cracking occurs. Make the full required depth cut from edge to edge of the pavement. In formed paving, do this by loosening or removing the side forms or by other acceptable methods. When paving from October 1 to April 1, the use of early entry saws or another approved method is recommended to encourage dominant joint development in the adjacent lane at the same location of dominant joints in the previous lane.

If a crack or spall occurs at any location and any time before final inspection and resolution of all issues regarding the condition of the pavement, repair the pavement according to Table A, Repair Procedures for Deficiency in New Concrete Pavement, at no additional cost to the Department. Field coat the dowels with the bond-breaker lubricant, as specified in Section 501.3(i), where necessary as determined by the Representative. Join original pavement to replacement pavement and test as specified in Section 507; if Ride Quality and Incentive are not applicable, test as specified in Section 501.3(o).

For second stage sawing of joints, saw the sealant reservoir 72 hours or more after placing the concrete.

Clean joints of all deleterious material immediately after sawing. Patch voids or spalls, in excess of the specified width, as specified in Section 525. Continue curing and protect joint until sealed.

Table A
Repair Procedures for Deficiency in New Concrete Pavement

Item	Deficiency	Location	Description	Contractor Repair Options
1	Partial Depth Crack	Anywhere	≤ 0.007 inches wide	Do nothing
			>0.007 inches wide AND ≤ D/3 deep	Epoxy inject crack as specified in Section 1091
			> 0.007 inches wide AND > D/3 deep	Repair as specified in Section 516 Partial Panel Full Depth Patch[a, b, c]
2	Spall	Mainline or shoulder panel	Minimal spalling[d] ≤ 2 inches wide AND ≤ D/3 deep	Do nothing
			Significant spalling[e] > 2 inches wide (measured perpendicular to joint)	Spall Repair as specified in Section 525 (Repair must perform

			AND ≤ D/3 deep or > 12 inches wide (not at a joint) AND ≤ D/3 deep	satisfactorily for 1 year or replace with Partial Panel Full Depth Patch as specified in Section 516)[a, b, c]
			Significant spalling[e] > 2 inches wide (measured perpendicular to joint) AND > D/3 deep or > 12 inches wide (not at a joint) AND ≤ D/3 deep	Repair as specified in Section 516, Partial Panel Full Depth Patch[a, b, c]
			Significant spalling[e] > 2 inches wide (measured perpendicular to joint) AND > D/3 deep or > 12 inches wide (at a joint)	Repair as specified in Section 516, Partial Panel Full Depth Patch[a, b, c] OR as specified in Section 516, Full Depth Corner Repair OR as specified in Section 519, Full Depth Longitudinal Joint Repair
3	Single Full Depth Crack (any orientation)	Shoulder	Non-working crack with minimal spalling[d]	Epoxy inject crack as specified in Section 1091
			Working crack with minimal spalling[d]	Seal crack as specified in Section 590
			Crack with significant spalling[e]	Repair as specified in Section 516 Partial Panel Full Depth Patch[a, b, c] OR Full Panel Replacement[c]
		Mainline or Shoulder panel is affected by irregular geometry (construction joints do not line up)	Crack with minimal spalling[d]	Seal crack as specified in Section 590
		Mainline	Entire length of crack ≤ 9 inches from longitudinal joint AND crack is parallel to longitudinal joint ± 1 inch	Seal crack as specified in -Section 590
		Mainline crack is in center one-third of dowelled panel.	Crack ≤ 1/8 inch wide AND spalling ≤ 1/4 inch from edge of crack.	Dowel Retrofit as specified in Section 527: three dowels per wheel path (panels ≤ 10 inches thick); four dowels per wheel path (panels > 10 inches thick) OR Partial Panel Full Depth Patch[a, b, c] repaired as specified in Section 516 OR Full Panel Replacement[c]

		Mainline	All other conditions	Partial Panel Full Depth Patch[a, b, c] OR Full Panel Replacement[c]
4	Multiple Cracks > D/3 deep (any orientation)	Mainline or Shoulder	Panel has more than 1 crack > D/3 deep	Partial Panel Full Depth Patch[a, b, c] OR Full Panel Replacement[c]

Notes:	
a	Minimum patch length is 6 foot for Plain Cement Concrete (PCC) or 10 foot for Reinforced Concrete Pavement (RCP).
b	Minimum amount of panel left in place is 6 foot.
c	All patches (partial panel and full panel replacements) must be full width and depth.
d	Minimal spalling is defined as ≤ 2 inches total width AND ≤ 12 inches (combined length) along crack.
e	Significant spalling is defined as > 2 inches total width OR > 12 inches (combined length) along crack.
D	Design pavement depth.

Payment for new pavement where the crack has been removed is at the Contract Unit Price (CUP) with NO additional cost to the Department for the repair.
Payment for new pavement where the crack has not been removed but sealed as specified in Section 590 is at five percent CUP for the slab with NO additional cost to the Department for the repair.
Payment for slabs with Partial depth Crack or Spall is at the CUP with NO additional cost to the Department for the repair

Crack depth is to be determined by coring at no cost to the Department

3. Expansion Joints. Place transverse expansion joints, where indicated. If existing concrete pavements are widened, align transverse expansion joints, if possible, with existing expansion joints. Place transverse expansion joints, without load transfer units, in the plain cement concrete pavement in paved divisor areas. Conform to the dimensions and locations in adjacent concrete curb. Place expansion joint filler, as indicated or as directed.

(j) Longitudinal Joints. Place tie bars as indicated or directed. Ensure no tie bars are installed within 24 inches of a dowelled contraction joint. When paving from October 1 to April 1, remove one tie bar in each slab adjacent to dominant joints, as specified in Section 501.3(i)2, to minimize shear cracking in the previous lane placed.

The Representative will select 15 tie bars from the first day's concrete placement according to PTM No. 1. Test each selected tie bar for pull-out resistance after the concrete has attained a compressive strength of 3,500 pounds per square inch, or epoxy anchoring material has met manufacturer's requirements. Use a center-pull hydraulic jack with a load measuring gage and bearing ring capable of testing each tie bar to 12,000 pounds or to a 1/32-inch slippage. Do not use jack and gage having a calibration date older than 6 months. Record the gage reading at point of slippage or 12,000 pounds, whichever occurs first. Determine the average of pull-out test results. Divide pull-out test average by the tie bar spacing to determine pull-out resistance of tie bars, in pounds per cubic foot, for compliance with Table B. If the pounds per cubic foot is not in compliance with Table B, replace failed tie bars or install additional tie bars until compliance with Table B is attained, at no additional cost to the Department. Install additional tie bars from the center of slab out in an approved pattern. Do not install additional tie bars within 30 inches of a transverse joint. Do not construct adjacent lanes until the tie bars comply with Table B. Perform additional testing as directed.

Saw tied, longitudinal contraction joints to prevent random cracking, as specified in Section 501.3(i)2. Clean joints of all deleterious material immediately after sawing. Continue curing and protect the joint until it is sealed, as specified in Section 501.3(n).

TABLE B
Pull-Out Resistance of Tie Bars

Tied Width of Pavement (Distance from Joint Being Constructed to Nearest Free Edge)	Minimum Average Pull-Out Resistance of Tie Bars
	lb/ft of Joint
12 feet or less	2,200
Over 12 feet to 17 feet	3,200
Over 17 feet	4,500

If a longitudinal crack occurs within a lane, remove and replace slabs containing the crack at no additional cost to the Department. If damage to the pavement surface occurs, repair in an approved method at no additional cost to the Department. Join original and replacement pavements. Field coat dowels with bond-breaker lubricant, as specified in Section 501.3(i), where necessary.

(k) Final Strike-Off, Consolidation, and Finishing. Complete these operations during hours of natural light, unless using an acceptable lighting system.

1. Strike-Off and Consolidation.

1.a Machine Method. Immediately after placing, strike off and screed the concrete, with a finishing machine, as necessary, to properly consolidate the concrete and to leave a uniform textured surface.

Keep the top of forms free from accumulation of concrete or of foreign material. Maintain true machine travel on the forms without lift, wobble, or other variations that affect accurate finishing. Use equipment that does not groove the concrete pavement edges for a width greater than can be eliminated by edging tools. Use a rubber-tired wheel to support the spreader and a transverse finishing machine on the adjoining concrete pavement surface, keeping the wheel approximately 12 inches from the pavement edge.

Maintain a uniform roll of concrete ahead of the finishing machine front screed for its entire length. Overlap the previously screeded concrete on the last pass.

Place and vibrate concrete adjacent to joints and other areas, as specified in Section 501.3(f), then bring the finishing machine forward. Operate the machine carefully to avoid damage, misalignment of joints, or concrete segregation.

Do not add water or monomolecular film to the concrete surface to assist in finishing.

1.b Manual Method. Unless otherwise directed, do not use manual strike-off methods, except to strike off concrete already deposited on the subbase if a breakdown of mechanical equipment occurs or on small turnout areas and patches up to 10 feet in length.

If finishing manually, use screeds contoured to the pavement cross section. Provide screeds sufficiently rigid to retain their shape and at least 2 feet longer than the maximum slab width to be struck off. Operate the equipment in a manner to obtain consolidation and a uniform textured surface free of porous areas. Consolidate as specified in Section 501.3(f).

2. Floating. After the concrete has been struck off and consolidated, smooth and fill in open-textured pavement areas with a float, as necessary. Do not add water or monomolecular film to the surface to assist in finishing and do not overfinish. Mechanical floats or long handled floats may be used. Do not use steel or Fresno floats.

3. Straightedge Testing and Surface Correction. While concrete is still plastic, test the surface using a 12-foot straightedge, swung from handles 3 feet longer than one-half the slab width, as required. Hold the straightedge in contact with the surface in successive positions. Advance in successive stages of not more than 5 feet a stage. Immediately correct low areas, then strike off, consolidate, and refinish. Cut down high areas and refinish. Make sure the surface across joints meets requirements for smoothness as specified in Section 501.3(o). Continue straightedge testing and surface corrections until the entire surface is free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section.

4. Final Finish. After floating, straightedge testing and surface corrections have been completed, all excess moisture has disappeared, and before concrete becomes non-plastic, provide initial texturing with a turf drag or broom device to produce striations parallel with centerline.

4.a Longitudinal Texture. Install turf drags, brooms and tine devices on self-propelled equipment having external alignment control. Maintain the area of texture device in contact with the pavement surface constant at all times during texturing. Provide positive elevation control for texture devices. Maintain down pressure on pavement surface at all times during texturing to achieve uniform texturing without measurable variations in pavement profile. Operate self-propelled texturing machines to maintain constant travel speed when texturing. For small or irregular areas, or during equipment breakdown, hand methods may be approved. If unsatisfactory results are obtained, stop the placement of concrete until the equipment deficiency or malfunction is corrected.

Perform final texturing with a spring steel tine device to produce grooves parallel with centerline. Operate the spring steel tine device within 5 inches, but not closer than 3 inches, of pavement edges. Produce a textured finish with grooves that have the following characteristics:

- 1/8 inch (± 1/32 inch) in width;
- 1/8 to 3/16 inch in depth; and
- 1/2 to 3/4 inch nominal center-to-center tine spacing.

4.b Transverse Texture. For shoulders, gore areas, traffic separators, sidewalks, or other applications smaller in width, texture the surface transversely for the full width. Produce a textured finish with grooves that have the following characteristics: rectangular in shape; from 3/32 inch to 3/16 inch in width; and from 1/8 inch to 3/16 inch in depth.

For a 10-foot rake use center-to-center tine spacing as follows:

TABLE C
Center-to-Center Tine Spacing

1 3/8	1 3/8	1 7/8	2 1/8	1 7/8	1 3/4	1 1/4	1 1/4	1 1/8	1 3/8	1 1/8	1 3/4	7/8	1 3/4	7/8
1 5/8	2	1	3/4	1 1/8	1 5/8	1 3/8	1 1/8	1	1	1 1/8	3/4	1 1/2	1 1/2	2
2	1 3/4	1 1/2	1 3/4	2 1/8	1/2	1 1/8	1 1/2	1 5/8	1 5/8	1 1/8	1 3/4	1/2	1 3/4	1 3/4
1 1/8	1 1/2	1 1/4	1 5/8	1 1/8	1 1/4	2	1 3/8	1 3/4	5/8	3/4	1 3/4	2	5/8	2 1/8
2	1 1/8	1	3/4	5/8	2 1/8	3/4	1 1/2	2	1 5/8	5/8	5/8	1 7/8	2	1 1/2
2	1 3/8	1 3/8	1 1/2	1 3/4	1 1/8	1 1/2	2	1	1 1/4	(in)				

When using this chart begin in the upper left corner and read across the entire row then start again on the left side in the next row.

Produce the texture in one pass, without overlapping the previous pass, to provide a uniform finish. Keep the texturing device free of hardened concrete particles. If unsatisfactory results are obtained, stop the placement of concrete until the equipment deficiency or malfunction is corrected.

4.c Macrotexture. For pavements exposed to traffic with a radii less than 50 feet, ensure the final surface finish meets a minimum Mean Texture Depth (MTD) of 0.040 inches, unless otherwise directed or indicated.

Conduct the test for macrotexture depth according to ASTM E965 in the presence of the Representative. Conduct a minimum of four test locations for each lane of pavement. The Representative will determine each test location and will document the 4 rotated diameter measurements, the calculated average diameter, and the MTD at each location.

If any determined MTD is less than 0.040 inches, conduct additional tests every 50 feet to determine the extent of deficient macrotexture. Mechanically groove the pavement, determined deficient in macrotexture, perpendicular to the roadway, at no additional cost to the Department, having the following characteristics:

- Rectangular in shape
- 1/8 inch (± 1/32 inch) in width
- 1/8 inch to 3/16 inch in depth
- 1 1/2 inch nominal center-to-center sawed groove spacing

Terminate grooves as follows:

- No closer than 2 inches of transverse joints
- No closer than 3 inches of longitudinal joints
- Not greater than 15 inches any joint

Use smaller machine to minimize non-grooved areas of the pavement. Do not overlap grooves.

When diamond grinding surface corrections are made in the hardened concrete for pavement smoothness, no additional texturing is required.

(l) Curing Concrete. Apply curing materials after finishing and texturing, and within 30 minutes of the dissipation of bleed water. Maintain the curing materials until the pavement has achieved sufficient strength for opening to traffic as specified in Section 501.3(q). Do not mar the concrete surface. After removing forms and correcting honeycombed areas, cure the sides with the same method as the surface. When using covers, secure over the entire surface and sides. The Representative will suspend concrete operations immediately if sufficient curing is not provided. Cure by the same method throughout the work unless directed to change by the Representative. Have material available for emergency curing.

If normal curing is delayed, apply an intermediate monomolecular film curing compound to all cement concrete patches before normal curing.

Apply the monomolecular film in a light-fog application, using a pressure spray tank with an adjustable nozzle. Use a water-to-curing-agent ratio and rate of application both according to the manufacturer's recommendations. Agitate the solution before each application.

Apply the curing compound in a continuous film, immediately after finishing and texturing operations are completed on any area. Do not provide any additional finishing after application of the monomolecular film. Apply additional applications as required, if surface drying is taking place and curing covers have not been placed.

After application of the monomolecular film, provide normal curing as specified.

1. Normal Curing. The Contractor may use methods other than those described below to protect and cure joints, if the procedure and materials are acceptable. The Representative may require a change in method if unsatisfactory results are obtained.

For all accelerated strength concrete pavements, provide insulation or heating of pavements during the curing operation. Control the curing temperature and monitor at least hourly to ensure that the concrete pavement does not experience a curing temperature change in excess of 40F within any 1-hour period during the curing operation. If a change in curing temperature in excess of 40F occurs in the concrete pavement within any 1-hour period, the work will be considered defective.

1.a White Polyethylene Curing. Use sheeting wide enough to cover the pavement surface and sides. Provide lengths consistent with pavement joint spacing. Overlap sheets a minimum of 12 inches and secure sides and seams to form a tight seal. After form removal, fold sheeting down over the sides for the full pavement depth, then secure with suitable material.

1.b White Polyethylene Burlap-Backed Curing. Use sheeting wide enough to cover the pavement surface and sides. Provide lengths consistent with pavement joint spacing. Overlap sheets a minimum of 12 inches, then secure sides and seams to form a tight seal. Saturate the burlap side with water, then place and secure with the burlap side down. After form removal, fold sheeting down over the sides for the full pavement depth, then secure with suitable material.

1.c White, Poly-alpha-methylstyrene (PAMS) Liquid Membrane Forming Curing Compound. The Representative will allow this method of curing if the air temperature is above 40F at the time of application and the air temperature is forecasted to remain above 40F a period of 4 hours after application.

Following the final finishing, immediately after free water has left the pavement surface and while the surface is still damp, seal exposed concrete areas with an application of curing compound. Apply curing compound homogenously to produce a uniform, solid white opaque coverage on all exposed concrete surfaces. Apply at a rate of 1 gallon per 150 square feet, or according to manufacturer's recommendations. Using a self-propelled mechanical spreader, apply in a fine mist, without marring the concrete surface. Use atomizing type spraying equipment, equipped with a tank agitator providing continual compound agitation during application. Provide proper calibration to allow

accurate control of the amount of material being placed. Use a hood to protect the spray device against the wind and control so the spray overlaps transversely 50%, to produce two coverages of a continuous, uniform membrane. Do not drip curing compound on the pavement. If rain falls on newly coated pavement before the film has dried sufficiently to resist damage or if film is damaged in any way before the pavement is cured, apply a new coat immediately, in an amount equal to the original specified application. Alternate methods for the application of curing compound may be approved in writing by the District Executive. Areas inaccessible to self-propelled mechanical spray equipment may be coated using manual or alternate methods.

After form removal, apply a uniform coat to the sides, at the rate specified for the surface. Manual spraying equipment may be used for spraying the sides and for any small or irregular areas not reached by surface spraying equipment.

Cure and protect joints during the curing period to prevent moisture loss from concrete in and adjacent to joints. Include the method of joint curing in the pavement QC plan as specified in Section 501.3(a)1.

Keep workers, materials, and equipment off the membrane film during curing, unless adequate precautions are taken to protect the film.

1.d Burlap Curing. Place burlap in double-thickness by overlapping each strip one-half its width on the pavement surface. Keep this covering saturated with water for the full curing period. After sides are exposed, fold burlap down over the sides and secure with suitable material.

1.e White Polypropylene Fiber-Backed Curing. Use sheeting wide enough to cover the pavement surface and sides. Provide lengths consistent with pavement joint spacing. Overlap sheets a minimum of 12 inches, then secure sides and seams to form a tight seal. Saturate the burlap side with water, then place and secure with the burlap side down. After form removal, fold sheeting down over the sides for the full pavement depth, then secure with suitable material.

1.f Black Membrane-Forming Curing Compound. Liquid Membrane-Forming Curing Compound, Black, may be used, provided the cement concrete pavement will be overlaid with an asphalt pavement and is not accessible to traffic before the surface course is placed. Apply at a rate not to exceed 0.015 gallon per square yard to produce a uniform continuous film. Discontinue use of the compound if it becomes unsatisfactory as a curing agent; and resume curing by other methods, as specified.

2. Cold Weather Curing. If the forecasted air temperature during concrete curing is expected to fall below 50F, place high-low thermometers on the concrete surface and monitor concrete curing temperatures. Protect the pavement surface and sides to effectively maintain a temperature of not less than 40F until the pavement has achieved sufficient strength for opening to traffic as specified in Section 501.3(q). If at any time during this period the high-low thermometer falls between 40F and 35F, extend the cure period by an additional day. If at any time during the curing period the high-low thermometer temperature falls below 35F, the concrete will be considered defective. Remove and replace defective pavement as specified in Section 501.3(t) at no additional cost to the Department.

For applications less than 6 inches in nominal depth, provide adequate insulating blankets to prevent rapid heat loss if the air temperature is 45F or less. Insulation may be removed when the air temperature exceeds 45F or when the pavement has achieved sufficient strength for opening to traffic as specified in Section 501.3(q).

When insulation is used to protect the pavement, remove insulation in a manner such that the rate of temperature change at the concrete surface does not exceed 40F within any 1-hour period. Concrete that experiences a higher rate of temperature change will be considered defective.

The application or removal of insulation covers may be controlled by the use of maturity method as specified in Section 501.3(q), with full removal of insulation allowed after the minimum required degree-hours of curing has been accumulated at the top of the slab.

(m) Removal of Forms. Do not remove forms from freshly placed concrete until it has set. Remove the forms carefully to avoid pavement damage.

(n) Sealing Joints and Cracks. Seal all joints widened with second stage sawcuts before opening any pavement section to traffic including construction equipment, and before discontinuing work for the winter season. When permitted, the Contractor may open pavement to construction equipment provided second stage sawing has not occurred, a backer rod is installed and maintained near the surface, initial concrete strength is attained, and curing requirements are met. Provide construction equipment within vehicle code limits. Seal cracks as indicated or directed.

Thoroughly clean the joint and the joint sidewalls of all scale, dirt, curing compound, temporary joint sealing material, and other foreign material using methods that will not damage the joint, but will be sufficient enough to remove all contaminates and debris. Immediately before placing bond breaker or joint sealing material, ensure the joint is free of moisture and other contaminants. Do not place joint sealing material until the faces are thoroughly clean and dry to the satisfaction of the Representative.

1. Poured In Place Seal. Do not place poured joint-sealing material if the air temperature is less than 40F, unless permitted.

For hot-poured seals, seal all joints with an approved hot-pour or silicone sealant material according to the manufacturer’s recommendations. Use heating equipment of an indirect heating type, constructed as a double boiler. Provide positive temperature control and mechanical agitation. Determine the safe heating temperature range and recommended pouring temperature from the manufacturer's shipping container. Heat and maintain the material temperature within these recommended safe temperatures. Place the material as close as possible to the recommended pouring temperature. Do not maintain any single batch of material at the pouring temperature for more than 6 hours. Reheat according to the manufacturer’s recommendations.

Fill the joint reservoir with sealing material to the level shown on the Standard Drawings. Do not allow sealing material to spread over the pavement surface.

When required, place the tape bond breaker and/or backer rods on the bottom surface of the joint reservoir before sealing. Do not extend tape up the reservoir face more than 1/8 inch. If necessary for support, install an acceptable joint backing material below the tape.

2. Neoprene Seals. Install preformed neoprene seals as specified, using installation equipment capable of placement without cutting, nicking, twisting, or damaging the seal. Install seals with lubricant adhesive applied, according to manufacturer's recommendations, to the contact surfaces of the joint faces or sides of the seal. Install seal in one piece to the depth indicated unless approved. Do not elongate the seal more than 3% or compress longitudinally more than 2%.

Prepare and submit a QC Plan to the Representative at the start of the project, as specified in Section 106.03(a)2. As a minimum include the following in the QC Plan: Contractor's and manufacturer's representatives; list of equipment and construction sequence; list of material, along with sampling and testing procedures; test section schedule; and procedure to replace unacceptable seals.

Before sealing joints, seal a minimum of three full-width pavement joints, according to the test section schedule specified in the QC Plan. Have the manufacturer's representative witness the test section(s) unless otherwise permitted in writing. The Representative will inspect the test section(s). Do not seal the remaining pavement joints until the Representative accepts an installation procedure. Conduct test(s) according to QC Plan when material is changed or seal installations are unacceptable.

Replace seals exceeding 3% elongation or 2% compression, or otherwise not conforming to the specifications at no additional cost to the Department. Patch pavement damaged by removing unacceptable seals and adhesive as specified in Section 525.

3. Silicone Seals. Prepare the joint and place silicone sealant material according to the manufacturers recommendations.

(o) Surface Tolerance. After the concrete has hardened, test the surface of pavement again as specified in Section 501.3(k)3. The pavement surface will be accepted when the surface does not vary more than:

- 3/16 inch when the straightedge is laid parallel with the centerline
- 3/16 inch when the straightedge is laid perpendicular to the centerline and within a traffic lane.

Remove high points by means of grinding or cutting tools, as directed.

1. Longitudinal Joints. Test the surface of pavement at all longitudinal joints, including the joint between the pavement and shoulder, again for the following tolerance requirements:

- Where there is no change in the design cross slope across a joint, the tolerance will not be greater than 1/4 inch as measured by holding a 12-foot straightedge centered across and perpendicular to the joint.

- Where there is a change in the design cross slope across a joint, the tolerance will not be greater than 1/4 inch as measured by holding a 4-foot straightedge perpendicular to and on each side of the joint.

- Remove high points in excess of 1/4 inch by means of grinding or with cutting tools, as directed. Pavement containing depressions of 3/16 inch or more between adjacent lanes will be considered defective.

Retest corrected areas of the pavement surface. Corrected areas must be within 3/16 inch as tested above.

(p) Protection of Pavement. Protect pavement, as specified in Section 901, and exclude traffic, including construction equipment. When required to complete adjacent pavement, do not operate heavy equipment on any pavement until the pavement has achieved sufficient strength for opening to traffic as specified in Section 501.3(q).

Perform operations on new pavement as approved and according to the following:

- When moving on and off the pavement, construct a ramp to prevent damage to the pavement slab.
- Take positive action to prevent damage to the pavement surface and joints.
- Before placing the protective mats, sweep the pavement surface free of debris.
- Operate equipment on a slab without causing damage. If damage results, suspend operations and take corrective action as approved.
- New pavement will not be opened to any traffic until all joints have been sealed unless an acceptable method to protect joints from damage and keep non-compressible materials from entering the joint is approved.

1. Late Season Pavements. Apply Boiled Linseed Oil Mixture as specified in Section 503.3 on all concrete pavements and shoulders constructed after September 1.

(q) Opening to Traffic. From the same sample of concrete selected for acceptance testing as specified in Section 704.1(d)5, mold a sufficient number of concrete QC cylinders to be tested for opening to traffic compressive strength testing. In addition, mold a sufficient number of concrete QC cylinders from the last mixer load of the day for opening to traffic compressive strength testing of accelerated strength pavements.

For normal strength pavements, cure the QC cylinders as specified in Section 704.1(d)4.b. The Representative will determine when pavement may be opened to traffic based on when the concrete attains the minimum required compressive strength according to Table D as measured by either compressive strength testing of cylinders according to PTM No. 604 or estimating concrete strength by the maturity method according to PTM No. 640.

Table D

Slab Thick, inches	Strength for Opening to Traffic, psi			
	Slab Length < 10 ft		Slab Length ≥ 10 ft	
	f'c	MR (3rd)	f'c	MR (3rd)
6.0	3000	490	3600	540
7.0	2400	370	2700	410
8.0	2150	340	2150	340
9.0	2000	275	2000	300
10.0 +	2000	250	2000	300

For accelerated strength pavements, cure the QC cylinders as specified in Section 501.3(l). The Representative will determine when the accelerated strength pavement may be opened to traffic based on when the concrete attains the minimum required compressive strength of 1,200 pounds per square inch as measured by either compressive strength testing of cylinders according to PTM No. 604 or estimating concrete strength by the maturity method according to PTM No. 640.

Pavement opened to traffic before meeting the required compressive strength will be considered defective work as specified in Section 501.3(t). If not removed and replaced, continue testing cylinders for compressive strength until the 28-day minimum mix design compressive strength specified in Section 501.2(a) Table A is attained or for a maximum of 56 days

(r) Protection Against Rain. Provide sufficient materials on site, at all times, to properly protect the pavement edges and surface against rain, before initial set of concrete. If rain appears imminent, stop paving operations, immediately protect the pavement sides, and cover the concrete surface with protective material.

(s) Tests for Depth. Complete any surface corrective work before testing for pavement depth. Before final acceptance of each phase of the project, the concrete pavement thickness will be determined in the presence of the Representative by drilling cores according to PTM No. 606 or by non-destructive thickness measurements according to PTM No. 605. Other methods of non-destructive thickness testing may be requested in writing for approval by the District Executive.

The Department will divide the pavement into Lots representing not more than 3,000 square yards of pavement (n=5) in each traffic lane. Include ramps in a separate Lot(s).

Select one of the following options for thickness determination:

1. Measurement of Drilled Cores.

The Representative will select one coring location at random within each Lot according to PTM No. 1. Provide a measuring apparatus conforming to PTM No. 614. The Representative will determine the core depth according to PTM No. 614.

If any core measurement is deficient by more than 1/4 inch in required depth, drill additional cores in the presence of and for measurement by the Representative. Drill the additional cores at 100-foot intervals in both directions longitudinally from each deficient core, in the same traffic lane, until the depth is no more than 1/4 inch deficient. Each core will represent the condition in the same traffic lane for a distance of 50 feet in both directions longitudinally.

The pavement is defective if any core measurement is deficient by more than 1/2 inch in required depth.

Submit every fifth core as an information sample to the LTS where an evaluation will be made of the entrained air content according to PTM No. 623, and for 28-day compressive strength testing according to PTM No. 606. For a partial Lot, the Representative will randomly select one core, according to PTM No. 1, for testing. If the core strength is less than 3,500 pounds per square inch immediately perform an investigation of the concrete operations to determine the cause of the low strength. Provide a written evaluation of the problem and the proposed solution to the Department.

2. Measurement by Non-Destructive Testing.

The Representative will select pavement thickness measurement locations within each Lot according to PTM No. 605. Determine the pavement thickness according to PTM No. 605 in the presence of the Representative. One retest will be permitted if any average sublot thickness measurement is determined to be deficient by more than 1/4 inch in required depth.

If any average sublot thickness measurement is deficient by more than 1/4 inch in required depth, drill a core over the target in the presence of the Representative for confirmation of the deficient depth at no additional cost to the Department. If the core measurement confirms the pavement thickness is deficient more than 1/4 inch in required depth, drill additional cores to determine the extent of pavement deficient in depth as specified in Section 501.3(s)1. If the core measurement does not confirm the pavement thickness is deficient more than 1/4 inch in required depth, stop paving operations to investigate the equipment and targets used in the non-destructive testing to determine if re-verification is needed.

For Independent Assurance of non-destructive thickness measurements, the Representative will select one location within the initial Lot and one location within the subsequent ten Lots thereafter. Drill one core over the selected target locations as specified in Section 501.3(s) in the presence of the Representative. Cores drilled based on deficient non-destructive thickness measurements or based on suspect deficiencies may be used for Independent Assurance purposes. If the core measurement confirms the pavement thickness is deficient more than 1/4 inch in required depth, drill additional cores to determine the extent of pavement deficient in depth as specified in Section 501.3(s)1. If the core measurement confirms the pavement thickness is not deficient by more than 1/4 inch in required depth, the drilling of the core will be paid as specified in Section 501.4(c).

Thoroughly clean the vertical surface of any core hole of laitance and loose and foreign material. Fill the holes with the mixture used to construct the course and consolidate. As an alternative, use a premixed, nonshrink grout.

(t) Defective Work. Unless otherwise directed in writing by the District Executive, at no additional cost to the Department, remove and replace pavement that is:

- Defective in construction or sawing of transverse joints as specified in Section 501.3(i);
- Defective in curing requirements as specified in Section 501.3(l)2;
- Defective in surface tolerance, as specified in Section 501.3(o);
- Defective in depth, as specified in Section 501.3(s);
- Defective in air content, as specified in Section 704.1(c)3;
- Defective in compressive strength as specified in Sections 501.3(q) or 704.1(d); or
- Showing surface defects resulting from the effects of freezing and thawing, rain, improper final finish, or honeycombing which, in the Representative's opinion, cannot be repaired.

Repair pavement that is cracked or spalled according to Table A, Repair Procedures for Deficiency in New Concrete Pavement.

The minimum pavement removal and replacement length between transverse joints is 10 feet if constructing reinforced cement concrete pavements or 6 feet if constructing plain cement concrete pavements. After removal of defective pavement, construct required transverse joints according to the methods for joining pavements, as shown on the Standard Drawings. Where replacement extends to an existing transverse joint, satisfactorily salvage the joint or replace in kind, as directed.

If removing and replacing pavement defective in depth, start at the determined point of deficiency as determined by the Representative. Remove and replace defective work transversely for the full-lane width and longitudinally, until the pavement is not more than 1/4 inch deficient in depth, as specified in Section 501.3(s).

501.4 MEASUREMENT AND PAYMENT—Square Yard

(a) Adjustment for Deficient Pavement. Where a deficiency exists, as determined by cores, the Department will pay as follows:

Deficiency in Depth Determined by Cores inches	Proportional Part of Contract Price Allowed
0.0 to 0.25	100%
0.26 to 0.30	95%
0.31 to 0.35	85%
0.36 to 0.40	75%
0.41 to 0.45	50%
0.46 to 0.50	25%
≥ 0.51	Defective Work

(b) Defective Pavement Left in Place. The Department will not pay for defective pavement left in place, unless otherwise directed in writing by the District Executive. When the District Executive directs that defective pavement be left in place, final payment for this pavement will be at 5% of the contract price.

(c) Tests for Depth. Each

The price includes the measuring apparatus, which remains the Contractor's property upon completion of the project and targets provided for non-destructive testing. The Department will not pay for additional cores drilled if the depth is deficient by more than 1/4 inch.

SECTION 502—ROLLER COMPACTED CONCRETE PAVEMENTS

502.1 DESCRIPTION—This work is the construction of roller compacted concrete (RCC) pavement as indicated, on a prepared subgrade and subbase, using a low slump concrete mix, conventional or high-density asphalt paving equipment, and various size rollers to obtain the required thickness, density, and surface texture.

502.2 MATERIAL—

(a) Cement. Section 701

(b) Supplementary Cementitious Materials. Section 724

(c) Aggregate. Section 703, except use well-graded aggregate according to the following Table A:

TABLE A
Aggregate Gradation Requirements for RCC Material

	Percent Passing by Weight Based on Maximum Nominal Aggregate Size		
	Wearing Surface		Base Course
Sieve Size	Gradation A	Gradation B	Gradation C
1" (25 mm)	100	100	82 – 100
3/4" (19 mm)	100	87 – 100	72 – 91
1/2" (12.5 mm)	81 – 100	71 – 91	61 – 81
3/8" (9.5 mm)	71 – 91	60 – 85	50 – 71
No. 4 (4.75 mm)	49 – 70	42 – 63	36 – 55
No. 8 (2.36 mm)	33 – 54	30 – 49.5	23 – 42
No. 16 (1.18 mm)	24 – 40	18 – 36	15 – 32
No. 30 (0.60 mm)	12 – 28	11.5 – 27.5	8 – 22
No. 50 (0.30 mm)	7.5 – 22	5 – 19	4.5 – 17
No. 100 (0.15 mm)	3 – 16	1 – 13	1 – 12
No. 200 (0.75mm)	0 – 10	0 – 9	0 – 8

(d) Water. Section 720.1

(e) Admixtures. Section 711.3

(f) Concrete Curing Material. Section 711.1 and Section 711.2.

(g) RCC Mixture.

1. Mix Design. As specified in Section 704.1(c), except 704.1(c)3 and add the following: Use the same mix design and materials for the entire project. Optimize moisture content of mix according to AASHTO T 180, Method D. Any material change requires submission of a new mix design.

2. Mix Duration. Assure complete and uniform mixing. Do not exceed the manufacturer's rated volume capacity for dry concrete in the mixing chamber. Keep the sides of the mixer and mixer blade surfaces free of hardened concrete and other materials. Check mixer blades frequently for wear and replace if wear is sufficient to cause inadequate mixing.

3. Mix Ingredient Tolerances. Produce RCC meeting the tolerances as specified in Section 704.1(e). Supply daily plant records of production and quantities of materials used that day to the Representative. These records will be used as a check on plant calibration.

(h) Rapid Set Concrete Patching Material. Section 525.2(c). Use within the shelf life and temperature limitations set by the manufacturer.

502.3 CONSTRUCTION—

(a) General Requirements.

1. Field Operation QC Plan. Prepare a paving operation QC Plan, as specified in Section 704.1(d)1.a, for field control and evaluation of concrete paving operations for the Representative's review. Do not start paving until after the Representative reviews the QC Plan.

2. Concrete Technician. Provide a concrete technician as specified in Section 704.1(d)2 and a concrete field testing technician as specified in Section 704.1(d)2.a.

(b) Test Section. Construct a minimum 50-foot long test section of the RCC placement. Size the test section using the plan thickness by plan width. Use the proposed equipment for the project. Use placement to verify: the plant can produce a consistent mix and resolve any mix design issues; determine if the equipment will achieve the proper placement; establish the best combination of rollers to achieve thickness and best surface conditions; review testing procedure of field density acceptance testing; establish curing procedures and determine compressive strength. Place the test section within the RCC plan location as a portion of the pay item.

(c) Weather Restrictions. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of RCC mixture that are en route to the project. Do not place RCC pavement during a hard rain that may damage the pavement surface. Placement may continue during a light rain or mist as determined by the Representative as long as the RCC pavement surface is not damaged and hauling equipment meets the requirements as specified in Section 502.3(d)2.

1. Cold Weather. Unless otherwise approved in writing, discontinue RCC placement when the descending air temperature, away from artificial heat, falls to 40F. Do not resume paving until the air temperature, away from artificial heat, rises above 40F.

2. Hot Weather. If the air temperature in the immediate vicinity of RCC placement rises to 85F, take temperature readings of the plastic RCC mixture, at 1/2-hour intervals and at the conclusion of the mixing cycles. When the RCC mixture temperature has risen to 90F, cool the mixing water or aggregates to maintain a plastic RCC mixture temperature within 50F to 90F during placement. Discontinue RCC placement if the RCC mixture temperature exceeds 90F after mixing.

3. Environmental Conditions. Do not place concrete when the evaporation rate exceeds 0.20 pounds per square foot per hour unless mitigation measures are employed. The use of windbreaks and fog misting are acceptable methods to mitigate an excessive evaporation rate. When fog misting is employed, use equipment that atomize droplets in the air surrounding the concrete without causing water deposits.

(d) Equipment. Have all equipment on hand and approved by the Representative before work can proceed. Comply with, but is not limited to, the following:

1. Mixing Plant. Produce an RCC pavement mixture in the proportions defined by the approved mix design and within the specified tolerances. The plant must be able to produce a uniform mixture at a rate compatible with the placement equipment.

1.a Batch Type Plant. Meet the requirements as specified in Section 704.2 and 704.3.

2.a Continuous Mix Plant. Meet the requirements of AASHTO M 241.

2. Haul Trucks. Provide a sufficient number of trucks to ensure a continuous supply of RCC mixture to the paver. Equip haul trucks with covers to protect the RCC mixture during transit from inclement weather and to reduce surface moisture loss. Use clean trucks with no buildup of hardened or foreign material.

3. Paver. Use a paver of suitable weight and stability to spread and finish the RCC mixture without segregation, to the required thickness, smoothness, surface texture, cross-section, and grade. Do not use pavers that tear, shove, or gouge the mixture or that cause tracks, indented areas, segregation, or other permanent surface blemishes.

For single lift placement less than 6 inches**,** use either a conventional or high-density paver equipped with compaction devices capable of producing RCC pavement with a minimum compaction of 85% of the maximum wet density prior to using rollers. For single lift placement greater than or equal to 6 inches but less than 9 inches, use a high-density paver equipped with compaction devices capable of producing a minimum compaction of 90% of the maximum wet density prior to using rollers.

For multiple-lift placement, use either a conventional or a high-density paver equipped with compaction devices capable of producing RCC pavement with a minimum compaction of 85% of the maximum wet density in each lift before using rollers.

For areas inaccessible to pavers, submit alternate paving equipment for approval.

4. Compactors. Use rollers conforming to Section 108.05(c)3.

If a minimum 95% field density is not achieved with the paver, use a self-propelled smooth dual steel drum roller operating in static or vibratory mode having a minimum weight of 8 tons to achieve primary compaction before final compaction. Increased weight may be needed for thicker lifts. Use either a steel drum roller, operating in static mode; or a rubber-tired roller, or a combination of rollers for final compaction, surface finishing, and removal of equipment marks.

If a minimum 95% field density is achieved with the paver, use either a steel drum roller, operating in static mode; or a rubber-tired roller, or a combination of rollers for final compaction, surface finishing, and removal of equipment marks.

Use walk-behind vibratory rollers or vibratory plate tampers, for compacting areas inaccessible to large rollers.

5. Water Trucks. Have at least one water truck on site and available throughout the paving and curing process. Equip the water truck with a water distribution system containing fog nozzles capable of evenly applying a fine mist of water to the RCC pavement surface without damaging the final surface.

(e) Preparation of Base Course. Before placing the RCC, prepare the subgrade/subbase as required by the Plans and Specifications. Provide a subgrade/subbase surface clean and free of foreign material, ponded water and frost or frozen material before RCC placement. Do not place RCC pavement on frozen base, subbase, or subgrade. At the time of RCC placement, uniformly moisten the subgrade/subbase. If the subbase becomes dry, uniformly water without forming mud or pools of freestanding water.

(f) Transporting RCC Mixture. Use haul trucks to transport the RCC mixture from the plant to paver. Deposit the RCC mixture directly into the hopper of the paver or into a secondary distribution system, which deposits the material into the paver hopper. Discharge the trucks clean with no buildup or hanging of RCC mixture in the corners.

(g) Placing RCC Material. Use an RCC mixture that is within the temperature range of 50F to 90F. Do not use RCC material containing frost, lumps, or crusts of hardened materials. If needed, adjust moisture content of mix for paving equipment selected for placement. Place RCC pavement in a pattern so that the curing water from the previous placements do not pose a potential surface erosion or runoff problem on the fresh RCC surface or on the subbase layer.

1. RCC Placement. Adjust the paver and regulate the speed to prevent segregation and provide a surface course that is smooth, continuous without tears, and pulling. Limit the spread of the RCC material to a length that can be compacted and finished within the available period under the prevailing air temperature, wind, and climatic conditions. Proceed in a steady, continuous operation with minimal starts and stops. Regulate speed to assure a constant supply of RCC material in the hopper. Maintain RCC material above the auger shaft at all times during paving.

2. Lift Thickness. Minimum lift thickness is 4 inches. Construct pavements between 4 inches and less than or equal to 9 inches in single lifts. Construct pavements greater than 9 inches in multiple lifts of equal thickness, to achieve density requirements.

3. Multiple-Lift Placement. Place the second lift within 60 minutes of the completion of the first lift. If more than 60 minutes has elapsed, the interface between the first and second lift shall be considered a cold joint. Prepare the cold joint as specified in Section 502.3(i)2. At the discretion of the Representative, this time limit may be increased

or decreased depending on the use of retarding admixtures or the ambient weather conditions of temperature, wind, and humidity. Multiple pavers in tandem formation may be used to reduce the opportunity for cold joints to develop.

4. Adjacent Lane Placement. Place adjacent paving lanes within 60 minutes. If more than 60 minutes has elapsed between placements of adjacent lanes, the vertical joint is considered a cold joint. Prepare the cold joint as specified in Section 502.3(i)2. At the discretion of the Representative, this time may be increased or decreased depending on the use of retarding admixtures or the ambient weather conditions of temperature, wind, and humidity.

(h) Compaction. Allow for in-field density readings and then begin compaction of the RCC material behind the paver. Perform field density readings with the Representative present. Plan operations and supply sufficient rollers to minimize cold joints. Determine the sequence and number of passes by vibratory and non-vibratory rolling to achieve the density acceptance requirements and to achieve a surface finish without uneven roller marks. Operation of rollers in the vibratory mode while stopped or reversing-direction is not allowed. Use a steel drum roller, operating in static mode; a rubber-tired roller or a combination of rollers for final compaction, surface finishing, and removal of equipment marks.

1. Rolling at Joints. Do not operate rollers within 12 to 18 inches of the freshly placed lane edge until the adjacent lane is placed. Within the allowable time, roll together both edges of the two adjacent lanes. If the lane edge will not have an adjacent lane or if the lane edge is the outside pavement edge, the lane may be placed wider to achieve compaction for the required width with the additional uncompacted RCC pavement material cutoff after density acceptance. As an alternative to saw cutting, use an edge shoe on the paver. The shoe should have an angle of 15 to 30 degrees and should compact the edge as required. When a cold joint is planned, roll the complete lane and follow cold joint procedures as specified in Section 502.3(i)2.

Provide additional rolling for longitudinal joints with a vibratory roller as necessary to produce the specified density for the full depth of the lift and provide a tight smooth transition across the joint. Remove any uneven marks left during the vibratory rolling utilizing a static or rubber-tired roller. Roll until a smooth, flat surface, free of tearing and cracking is obtained. Avoid deformation of the RCC pavement, by operating the rollers at slow enough speeds at all times. Correct any deformations of the RCC pavement resulting from reverse direction of the roller or from any other causes.

2. Density Requirements. Perform in-place field density tests according to ASTM C 1040, Test Method A-Direct Transmission, as soon as possible, and no later than 30 minutes after completion of rolling. Use only the wet density reading for this test requirement. If the testing equipment does not calculate the compaction percentage, calculate the compaction percentage using the following equation.

$$X = \frac{\rho_w}{\rho_t} \times 100$$

X = Compaction percentage %
ρ_w = Recorded density in pounds per cubic foot
ρ_t = Computed RCC unit weight in pounds per cubic foot as provided on the project CS-4220 Batcher-Mixer Slip

Determine field density test locations according to PTM No. 1. Perform at least five tests directly behind the paver and at least five tests after final compaction for each 500 cubic yards of RCC material placed. Determine the compaction percentage.

Directly behind the paver, achieve a minimum compaction of 85% of the maximum wet density for thicknesses less than 6 inches, and 90% of the maximum wet density for thicknesses greater than or equal to 6 inches.

After final rolling, achieve a minimum compaction greater than 96% of the maximum wet density for all thicknesses. Record compaction percentages after final rolling for determining density acceptance as specified in Section 502.3(m)2.

(i) Joints.

1. Fresh Joints. A fresh joint is a vertical joint between lanes or a horizontal joint between multiple-lifts where the adjacent RCC material is placed within 60 minutes of placing the previous lane or lift. The time limit may be adjusted by the Representative depending on the use of retarders in the RCC mixture or ambient weather conditions.

Construct fresh vertical joints to assure a continuous bond between new and previously placed lanes of RCC pavement.

For fresh horizontal joints, maintain a moist surface to prevent excess moisture loss. Before placement of the second lift, clean all loose material from the surface.

2. Cold Joints. A cold joint is any planned or unplanned longitudinal or transverse construction vertical joint or any horizontal joint between multiple lifts in the RCC pavement that does not qualify as a fresh joint.

Before placement of an adjacent RCC lane, prepare the cold vertical joint as follows: Cut the pavement vertically for the full depth in sound compacted material, at least 6 inches from the exposed edge. Use an approved saw, wheel cutter, or other method that does not tear or ravel the vertical edge. Remove the excess RCC material. Clean the joint of any loose or foreign material. Moisten the vertical face of the cold joint immediately prior to placement of the fresh adjacent lane to prevent excess loss of moisture.

Cold vertical joints that are constructed utilizing a drop extension or edging shoe are exempt from the above cutting requirement when placed up to 15 degrees from vertical.

For cold horizontal joints, maintain a moist surface to prevent excess moisture loss. Before placement of the second lift, clean all loose material from surface and, if required by the Plans, place cement slurry or mortar grout (made with the same materials as in the RCC mixture) on the cold horizontal joint.

3. Control Joints. Saw cut control joints, as indicated on the Plans, to 1/4 depth of the compacted RCC pavement. Saw cut pavement, behind the rolling operation as soon as possible to prevent random cracking, using early entry saws set to the manufacturer's recommendations. Saw cut without causing raveling or other damage to the pavement; begin sawing no later than 18 hours after placement. If random cracking occurs in the pavement before the saw cutting operation, repair cracks as directed by the Representative at no additional cost to the Department.

4. Sealing Joints. If indicated, seal joints as specified in Section 501.3(n).

(j) Curing. Immediately after final rolling and in-field density testing, keep the RCC pavement surface moist until one or more of the following curing methods are used. Maintain the selected curing method(s) for a minimum of 72 hours and the RCC pavement has developed a compressive strength of at least 3,000 pounds per square inch, determine compressive strength as specified in Section 502.3(m)3.

1. Water Cure. Apply water cure using a water truck equipped with misting spray nozzles, soaking hoses, sprinkler system or other means to maintain a uniform moist condition on the RCC pavement surface. Apply moisture in a manner that does not wash out or damage the surface of the finished RCC pavement.

2. White Polyethylene Sheeting. Apply sheet material as specified in Section 501.3(l)1.

3. Curing Compound. Apply curing compound as specified in Section 501.3(l)1.c. Apply curing compound immediately after final rolling is complete. Apply curing compound at a rate which produces a uniform solid opaque coverage.

4. Cold Weather Curing. Section 501.3(l)2.

(k) Surface Tolerance.

1. Testing. Test the finished RCC pavement surface with a 12-foot straightedge or crown surface template at areas the Representative determines may be deficient or irregular. Hold the straightedge in contact with the surface and in successive positions parallel to the road centerline to check the entire width of the pavement. Advance along the pavement in stages of not more than 5 feet a stage until the entire area is tested.

2. Correction. When the pavement surface varies by more than 1/4 inch, remove high points by grinding the surface to within the tolerance; use a self-propelled diamond grinder or cutting tools at no additional cost to the Department. The Representative will consider depressions in the pavement surface of more than 1/4 inch to be defective. Continue straightedge testing and surface corrections until the entire surface is free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section.

3. Finishing. For RCC pavement with an exposed pavement surface and a speed limit of 35 miles per hour or greater, texture the pavement surface by diamond grinding as specified in Section 514.3(c).

(l) Open to Traffic. Protect the RCC pavement from vehicular traffic for the duration of the curing period. Open to traffic when the cure period is complete as specified in Section 502.3(j).

(m) Acceptance.

1. Lots and Sublots. Material will be accepted on a lot by lot basis. Lots will be established cumulatively and will be specific for each mix design. Each lot consists of five equal sublots (n=5). Test completed lots and sublots for density, compressive strength, and pavement thickness.

A normal lot size is 500 cubic yards. If breakdowns or stoppages of short periods due to such causes as weather or equipment failure occur, the lot's size is the quantity placed for that day.

2. Density. Determine density acceptance using the recorded compaction percentages after rolling in Section 502.3(h)2. The final average for each lot cannot be less than 98% of the maximum wet density and no test less than 96% of the maximum wet density. Properly placed and compacted RCC material not meeting these requirements should be cored and tested for compressive strength at 28 days according to AASHTO T 24 at no expense to the Department. Fill core holes with RCC material and consolidate or with a rapid set concrete patching material. If the tested area has achieved the minimum compressive strength of 3,500 pounds per square inch, the RCC material will be paid for at full price and left in place. If the lot does not meet the maximum wet density and the compressive strength requirements, the pavement is considered defective.

3. Compressive Strength. Mold and test cylinders according to ASTM C 1435 and PTM No. 604 to determine the 3-day, 7-day, and 28-day compressive strengths for each lot of RCC material.

Test the 3-day test cylinders to determine the compressive strength for the lot. If the 3-day compressive strength test result is greater than or equal to 3,000 pounds per square inch, the field cure on the lot of RCC pavement represented by the test cylinders may be discontinued unless otherwise directed. If the 3-day test cylinders do not meet the minimum value, continue curing the lot until the 7-day test cylinders are tested for verification. Test the 7-day test cylinders for compressive strength. If the 7-day compressive strength test result is greater than or equal to 3,000 pounds per square inch, the field cure on the lot of RCC pavement represented by the test cylinders may be discontinued unless otherwise directed. If the 7-day test cylinders do not meet the minimum value, continue curing the lot until the 28-day test cylinders are tested for verification.

Test the 28-day test cylinders to verify the RCC pavement has achieved a minimum compressive strength of 3,500 pounds per square inch. RCC pavement that fails to meet the 28-day compressive strength requirement is considered defective. Any cores taken for pavement depth measurements may be used for compressive strength testing if needed.

4. Pavement Depth. Using PTM No. 1, the Representative will designate one location within a lot to be tested for depth. For each lot, drill one core according to AASHTO T 24 in the presence of the Representative. Provide a measuring apparatus conforming to PTM No. 614 for the Representative to measure the core depth according to PTM No. 614. If the measured depth is within 1/4 inch of plan depth, the RCC pavement is acceptable. If the depth is deficient by more than 1/4 inch, core two additional cores in the presence of the Representative for measurement. If the average depth of the three cores is less than a 1/4 inch deficient, the pavement depth is acceptable. If the average depth is greater than 1/4 inch, the pavement depth is defective. Fill core holes with RCC material.

(n) Defective Work. Unless otherwise directed in writing by the District Executive, remove and replace pavement lots that are: defective during curing as specified in Section 502.3(j)4, defective in surface tolerance, as specified in Section 502.3(k)2, defective in density as specified in Section 502.3(m)2, defective in compressive strength as specified in Section 502.3(m)3, or defective in depth as specified in Section 502.3(m)4.

502.4 MEASUREMENT AND PAYMENT—

(a) Roller Compacted Concrete Pavement. Square Yard

(b) Defective Pavement Left in Place. If the District Executive directs in writing to leave defective pavement in place, the payment will be at 50% of the contract price.

SECTION 503—PROTECTIVE COATING FOR CEMENT CONCRETE PAVEMENT

503.1 DESCRIPTION—This work is the application of protective coating, to concrete pavements and shoulders.

503.2 MATERIAL—

- Boiled Linseed Oil, AASHTO M 233, from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

503.3 CONSTRUCTION—

(a) General. Thoroughly dry and clean concrete surfaces of all foreign matter, which would prevent protective coating penetration, adhesion, or drying. Allow a minimum of 28 days to elapse before applying protective coating on surfaces cured with white membrane curing compound. Allow 7 days to elapse after removing curing covers and before applying protective coating on all other types of curing methods. Apply the protective coating before subjecting the concrete surface to deicing chemicals.

(b) Application. Apply protective coating according to manufacturer recommendations. At a minimum, apply in two coats, at a rate of 0.02 gallon per square yard for each coat. Apply, as directed, by pressure-spray equipment, by portable hand spray equipment, by brushing, or by a combination of methods, to ensure complete coverage of treated concrete surfaces.

Apply in weather suitable for drying when the air temperature and concrete surface temperature are between 35F and 100F.

Unless otherwise recommended by the manufacturer, allow the first application to dry for a period of at least 24 hours before the second application. If the initial application is made on concrete surfaces carrying traffic, close these surfaces for a period of at least 4 hours, until penetration is complete and tackiness has disappeared.

After the second application, close surface to traffic for a period of at least 6 hours or until tackiness has disappeared and no pickup results from use.

(c) Safety Precautions. Protect traffic, workers, and concrete surface against the occurrence of fire, if in the presence of flammable and volatile mineral spirits blended into the protective coating. Before using the treated pavement surface, satisfactorily correct slippery pavement conditions, other hazards, or inconvenience to traffic, resulting from the protective coating application as directed.

503.4 MEASUREMENT AND PAYMENT—Square Yard

SECTION 504—PAVEMENT RELIEF JOINT

504.1 DESCRIPTION—This work is construction of a pavement relief joint, including sawing, sealing, subbase material, and necessary excavation.

504.2 MATERIAL—

- Class AA Cement Concrete—Section 704
- High Early Strength Cement Concrete—Section 704
- Reinforcement Bars— Section 709.1
- Asphalt Cement, PG 64S-22—Section 702
- Subbase—Section 350.2
- Asphalt Base Course—Section 313.2 and as follows: PG 64S-22, 3 to <10 million ESALs, or as indicated.
- Asphalt Wearing Course—Section 413.2 and as follows: PG 64S-22, 0.3 to <3 million ESALs, or as indicated.
- Polyethylene Sheeting – Section 505.2
- Sealing Material —Section 705.4(b), 705.4(c), or 705.4(g)
- Tape Bond Breaker— Section 513.2(c)

504.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in Section 501.3, and as follows:

(a) Excavation. Excavate for the sleeper slab after constructing the subbase.

(b) Sleeper Slab. Construct the sleeper slab as specified in Section 501.3.

(c) Polyethylene Sheeting. Construct as shown on the Standard Drawings.

(d) Base Course. Paint the entire joint faces of adjacent pavement with a thin coating of PG 64S-22 before placing fresh asphalt mixtures. Construct the asphalt base course as specified in Section 313.3.

(e) Wearing Course. Construct the asphalt wearing course as specified in Section 413.3.

(f) Transverse Joints at Interface of Pavement Relief Joint and Concrete Pavement.

1. Sawing. Make a saw-cut directly above the interface between the asphalt courses of the pavement relief joint and the concrete pavement within ± 1/4 inch. Saw cuts which do not meet this tolerance will be declared defective as specified in Section 105.12. Do not saw cut until the asphalt wearing course has cooled below 140F. Perform saw cutting within 7 days after placing the pavement relief joint. Perform this work on all finished pavement relief joints before discontinuing work due to seasonal paving limitations.

Extend the saw-cuts through all existing widening.

Saw cut to form a reservoir with dimensions 1 inch deep by ½ inch wide.

If wet sawing, immediately flush the reservoir with water.

2. Sealing. Do not place sealing material unless the reservoir faces are thoroughly clean and dry. Clean the reservoir immediately before placing sealing material. If using compressed air, use air free of oil, moisture, or any other substance that would prevent bonding of sealing material to the reservoir faces.

Do not place sealing material if the air temperature is less than 40F or above 90F, unless otherwise allowed by the Representative.

Determine the safe heating temperature and recommended pouring temperature from the manufacturer's shipping container. Heat and maintain the material temperature within these recommended safe temperatures. Place the material as close as possible to the recommended pouring temperature. Do not maintain any single batch of material at the pouring temperature for more than 6 hours. Reheat according to the manufacturer's recommendations. Place tape bond breaker on bottom of joint reservoir immediately before sealing. Do not allow tape to extend up the reservoir face more than 1/8 inch.

Fill the reservoir with sealing material to a level 1/8 inch to 1/4 inch below the pavement surface. Do not allow sealing material to spread over the pavement surface.

504.4 MEASUREMENT AND PAYMENT—Linear Foot

Measured transversely.

SECTION 505—BRIDGE APPROACH SLABS

505.1 DESCRIPTION—This work is construction of reinforced cement concrete approach slabs and associated sleeper slabs, including the subbase material and necessary excavation.

505.2 MATERIAL—

(a) Subbase – Section 350.2

(b) Reinforced Cement Concrete Pavement – Section 501.2

(c) Asphalt Impregnated Paper – Section 727

(d) Polyethylene Sheeting– Section 711.1(a)

(e) Concrete Curing Materials – Section 711.1

505.3 CONSTRUCTION—As shown on the Standard Drawings, approved Contract Drawings, as specified in Section 501.3, except Section 501.3(l), and as follows:

(a) Excavation. Excavate for the sleeper slab after constructing the subbase.

(b) Polyethylene Sheeting. Two layers of 4.0 mil minimum polyethylene sheeting to be used as a bond breaker under bridge approach slabs. Provide surface that is smooth without excessive depth of sheeting.

Install any seams in the longitudinal direction of the bridge and overlap seams a minimum of 12 inches.

Provide certification from the manufacturer concerning the above material requirements.

(c) Concrete Curing. Cure the approach slab in accordance with Section 1001.3(p), except Section 1001.3(p)3.a, and as follows:

Water cure bridge approach slabs for a minimum of 7 days. Use covers of a double thickness of burlap.

505.4 MEASUREMENT AND PAYMENT—

(a) Bridge Approach Slab. Square Yard

The price includes excavation, subbase material, polyethylene sheeting, asphalt impregnated paper, cement concrete, and reinforcement bars.

SECTION 506—REINFORCED OR PLAIN CEMENT CONCRETE PAVEMENTS, RPS

506.1 DESCRIPTION—This work is construction of normal strength or high early-strength (HES) cement concrete pavement, plain or reinforced, on a prepared surface under restricted performance specifications (RPS).

506.2 MATERIAL—Section 501.2

506.3 CONSTRUCTION—Section 501.3, with the following modifications:

(o) Surface Tolerance. Test the surface of pavement as follows:

1. Mainline Paving. Test as specified in Section 507 and Section 501.3(o)1. These pavements include, but are not limited to any full width lane used for travel, passing, climbing, center turn, acceleration, deceleration, and ramps.

2. Other than Mainline Pavement. Test as specified in Section 501.3(o). These pavements include, but are not limited to approach slabs, bridge decks, tapers, shoulders, medians, or other pavement surfaces as directed.

(s) Tests for Depth. Replace with the following:

The Inspector will determine lots and sublots as specified in Section 506.3(u).

Complete all surface corrections or diamond grinding / grooving if specified by the contract, before testing for pavement depth. Test pavement depth by obtaining one core from each sublot. The Inspector will determine the location of each core using PTM No. 1.

Drill cores at each sublot location, according to PTM No. 606, in presence of the Inspector. Thoroughly clean the vertical surface of the core hole of laitance and loose and foreign material. Fill the holes with the mixture used to construct the course and consolidate. As an alternative, use a premixed, non-shrink grout.

Provide a measuring apparatus conforming to the requirements of PTM No. 614.

The Inspector will:

- determine the core length according to PTM No. 614,
- determine the average lot pavement thickness by averaging the individual sublot core thicknesses,
- accept concrete as specified in Section 506.3(u)1, and
- determine price adjustments as specified in Section 506.4(a).

Submit every tenth core, as an information sample, to the LTS where an evaluation will be made of the entrained air content according to PTM No. 623, and for 28-day compressive strength testing according to PTM No. 606. For a partial lot, the Inspector will randomly select one core, according to PTM No. 1, for testing. If the core strength is less than 3,500 pounds per square inch immediately perform an investigation of the concrete operations to determine the cause of the low strength. Provide a written evaluation of the problem and the proposed solution to the Department.

(t) Defective Work. Replace with the following:

Unless otherwise directed in writing, as specified in Section 110.10(d)1., by the District Executive, remove and replace defective pavement determined as follows:

1. Depth. The lot will be defective if the average core depth of the lot is less than the design thickness (D) minus 1/2 inch or more than one individual sublot core depth is less than the design thickness minus 1/2 inch.

2. Compressive Strength or Air Content. The lot is defective if the Percent Within Limits (PWL) for compressive strength or plastic air content is less than 55%, as specified in Section 506.3(u)2.

3. Other Conditions. The lot is defective if the pavement contains surface defects from rain, improper joint construction, improper curing procedures, improper final finish, cracking, or honeycombing that cannot be satisfactorily repaired as determined by the Representative.

4. Other Than Mainline Pavement Surface Tolerance. The lot is defective if the pavement contains depressions or high points as specified in Section 506.3(o) that cannot be satisfactorily corrected as determined by the Representative.

5. Edge Slumping. The pavement is defective if the requirements as specified in Section 501.3(g)5 are not met.

Remove and replace a minimum of 10 feet of pavement between transverse joints of reinforced cement concrete pavements or an entire panel of plain cement concrete pavement. Longitudinal edge spall repairs are not considered satisfactory repairs for edge slumping or spalling between adjacent lanes or outside pavement edges.

Where replacement extends to an existing transverse joint, replace the joint in kind. Construct transverse joints at other locations resulting from removal of defective pavement using the methods for joining pavements as shown on the Standard Drawings.

(u) Acceptance. Add this section as follows:

Lots and sublots for the combined pavement characteristics of depth, strength, and air content will be determined based on the full width of pavement placement. Lots and sublots will begin at the starting point of paving and continue until 5,600 square yards are placed. Lots and sublots will be calculated as the work progresses and will include any pavement designated as RPS pavement. Do not combine various depth pavement into any lot or sublot.

A full lot is defined as 5,600 square yards of pavement, of the same constant depth, and consists of four equal sublots of 1,400 square yards each.

Combine partial lots with the last full lot or make a separate lot according to the following procedure:

- If less than 4,200 square yards remain, combine the remaining pavement with the last full lot.
- If the remaining pavement is equal to or greater than 4,200 square yards, consider the remaining pavement as a separate lot.
- Determine sublots for the last pavement lot by establishing a number of equal size sublots.
- Determine the number of sublots by dividing the area of the combined lot or partial lot by 1,400 square yards and then rounding to the nearest whole number.
- Determine the equal size of each sublot by dividing the combined lot or partial lot quantity by the number of whole sublots calculated.
- Determine lots and sublots based on the full width of pavement placement.

1. Depth. The Representative will accept each lot for compliance with the specifications, for depth if the average core depth of the lot is more than the design thickness (D) minus 0.5 inch and not more than one individual sublot core depth is less than the design thickness minus 0.5 inch.

2. Compressive Strength and Air Content. The Representative will accept concrete for compliance with the specification requirements, for compressive strength and air content, on a lot-by-lot basis, as specified in Section 105 and Section 106. The Representative will determine locations where samples of plastic concrete will be lifted according to PTM No. 1. Make one compressive strength test and one test for percentage of plastic air content on samples from each sublot. Sublot plastic air content acceptance test results outside specification limits will be included in the determination of the PWL.

Mold acceptance cylinders at the determined sublot location. The average of the test results from two cylinders, made from the same sample, tested according to PTM No. 604, will constitute the 28-day compressive strength. Cure test specimens according to Subsection 11.1 of PTM No. 611. The result of one sample of concrete obtained and tested according to AASHTO T 152 for stone and gravel, or AASHTO T 196 for slag coarse aggregate, will constitute the percentage of air content. The Representative will accept concrete based on the adequacy and uniformity of compressive strength at the age of 28 days, and, with respect to the air content, when the PWL is 55% or greater.

Calculate the value of Q by one of the following equations, where $\overline{X}_4$ is the average of the sublot test results. Q_L is the lower quality index and Q_U is the upper quality index. "s" is the Standard Deviation as specified in Section 106.03(a)3.a.4.

2.a For Class AA 28-day concrete compressive strength,

$$Q_L = \frac{\overline{X}_4 - 3{,}300\text{psi}}{s}$$

2.b For percentage of air content of Class AA concrete,

$$Q_L = \frac{\overline{X}_4 - 5.0\%}{s} \quad \text{and} \quad Q_U = \frac{8.5\% - \overline{X}_4}{s}$$

Determine the percentage of material within specification limits as specified in Section 106.03(a)3.

506.4 MEASUREMENT AND PAYMENT—Square Yard

The Department will pay on a lot-by-lot basis at the contract price, adjusted for pavement characteristics relative to depth, compressive strength, and air content. The lot payment will be determined according to the multiple characteristic formula as specified in Section 506.4(a)3.

(a) Adjustment for Pavement Characteristics.

1. Depth. The lot average core depth will be determined as specified in Section 506.3(s). The characteristic percentage for depth will be determined using Table A. The characteristic percentage for depth (Pd) will be placed in the multiple characteristic formula as specified in Section 506.4(a)3 to determine the lot payment.

2. Compressive Strength and Air Content. The PWL will be determined for the lot as specified in Section 506.3(u)2. The characteristic percentages for compressive strength and air content will be determined by using Table B. The characteristic percentage for compressive strength (Ps) and the characteristic percentage for air content (Pa) will be used in the multiple characteristic formula as specified in Section 506.4(a)3 to determine the lot payment.

3. Multiple Characteristic Formula. The lot payment will be determined according to the following formula:

$$L_p = C_p\left[\frac{(2Ps + 2Pd + Pa)}{500}\right]$$

where:

L_p	=	Lot Payment
C_p	=	Contract price per lot (contract price times lot size)
Ps	=	Characteristic Percentage of Compressive Strength—(Table B)
Pd	=	Characteristic Percentage for Depth—(Table A)
Pa	=	Characteristic Percentage for Air Content—(Table B)

TABLE A
Characteristic Percentages for Concrete Pavement Cores (Pd)
Relative to Specification Limits

15-inch Design Thickness		14.5-inch Design Thickness	
Average Core Thickness, inches	**Characteristic Percentage Pd**	**Average Core Thickness, inches**	**Characteristic Percentage Pd**
15.00 or greater	100.0	14.50 or greater	100.0
14.90 - 14.99	97.1	14.40 - 14.49	96.9
14.80 - 14.89	94.4	14.30 - 14.39	94.0
14.70 - 14.79	91.4	14.20 - 14.29	90.9
14.60 - 14.69	88.0	14.10 - 14.19	87.3
14.50 - 14.59	86.4	14.00 - 14.09	85.5
Less than 14.50	*	Less than 14.00	*

14-inch Design Thickness		13.5-inch Design Thickness	
Average Core Thickness, inches	**Characteristic Percentage Pd**	**Average Core Thickness, inches**	**Characteristic Percentage Pd**
14.00 or greater	100.0	13.50 or greater	100.0
13.90 - 13.99	96.7	13.40 - 13.49	96.5
13.80 - 13.89	93.6	13.30 - 13.39	93.2
13.70 - 13.79	90.3	13.20 - 13.29	89.8
13.60 - 13.69	86.5	13.10 - 13.19	85.8
13.50 - 13.59	84.6	13.00 - 13.09	83.7
Less than 13.50	*	Less than 13.00	*

13-inch Design Thickness		12.5-inch Design Thickness	
Average Core Thickness, inches	**Characteristic Percentage Pd**	**Average Core Thickness, inches**	**Characteristic Percentage Pd**
13.00 or greater	100.0	12.50 or greater	
12.90 - 12.99	96.3	12.40 - 12.49	100.0
12.80 - 12.89	92.8	12.30 - 12.39	96.1
12.70 - 12.79	89.2	12.20 - 12.29	92.4
12.60 - 12.69	85.0	12.10 - 12.19	88.7
12.50 - 12.59	82.8	12.00 - 12.09	84.8
Less than 12.50	*	Less than 12.00	81.9

12-inch Design Thickness		11.5-inch Design Thickness	
Average Core Thickness, inches	**Characteristic Percentage Pd**	**Average Core Thickness, inches**	**Characteristic Percentage Pd**
12.00 or greater	100.0	11.50 or greater	100.0
11.90 - 11.99	95.9	11.40 - 11.49	95.7
11.80 - 11.89	92.0	11.30 - 11.39	91.6
11.70 - 11.79	88.1	11.20 - 11.29	87.6
11.60 - 11.69	84.5	11.10 - 11.19	83.8
11.50 - 11.59	81.0	11.00 - 11.09	80.1
Less than 11.50	*	Less than 11.00	*

11-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
11.00 or greater	100.0
10.90 - 10.99	95.5
10.80 - 10.89	91.2
10.70 - 10.79	87.0
10.60 - 10.69	83.0
10.50 - 10.59	79.2
Less than 10.50	*

10.5-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
10.50 or greater	100.0
10.40 - 10.49	95.3
10.30 - 10.39	90.8
10.20 - 10.29	86.5
10.10 - 10.19	82.3
10.00 - 10.09	78.3
Less than 10.00	*

10-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
10.00 or greater	100.0
9.90 - 9.99	95.1
9.80 - 9.89	90.4
9.70 - 9.79	85.9
9.60 - 9.69	81.5
9.50 - 9.59	77.4
Less than 9.50	*

9.5-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
9.50 or greater	100.0
9.40 - 9.49	94.6
9.30 - 9.39	89.9
9.20 - 9.29	85.2
9.10 - 9.19	80.6
9.00 - 9.09	76.3
Less than 9.00	*

9-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
9.00 or greater	100.0
8.90 - 8.99	94.0
8.80 - 8.89	89.3
8.70 - 8.79	84.4
8.60 - 8.69	79.6
8.50 - 8.59	75.1
Less than 8.50	*

8.5-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
8.50 or greater	100.0
8.40 - 8.49	94.0
8.30 - 8.39	88.7
8.20 - 8.29	83.5
8.10 - 8.19	78.5
8.00 - 8.09	73.8
Less than 8.00	*

8-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
8.00 or greater	100.0
7.90 - 7.99	93.9
7.80 - 7.89	88.1
7.70 - 7.79	82.6
7.60 - 7.69	77.3
7.50 - 7.59	72.4
Less than 7.50	*

7.5-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
7.50 or greater	100.0
7.40 - 7.49	93.8
7.30 - 7.39	87.8
7.20 - 7.29	81.7
7.10 - 7.19	76.2
7.00 - 7.09	71.1
Less than 7.00	*

7-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
7.00 or greater	100.0
6.90 - 6.99	93.7
6.80 - 6.89	87.4
6.70 - 6.79	80.8
6.60 - 6.69	75.1
6.50 - 6.59	69.7
Less than 6.50	*

6.5-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
6.50 or greater	100.0
6.40 – 6.49	93.6
6.30 – 6.39	87.1
6.20 – 6.29	79.8
6.10 – 6.19	73.9
6.00 – 6.09	68.3
Less than 6.00	*

6-inch Design Thickness

Average Core Thickness, inches	Characteristic Percentage Pd
6.00 or greater	100.0
5.90 - 5.99	93.4
5.80 - 5.89	86.8
5.70 - 5.79	78.7
5.60 - 5.69	72.6
5.50 - 5.59	66.8
Less than 5.50	*

* Defective work, as specified in Section 506.3(t).

TABLE B
Characteristic Percentages for Concrete Pavement
Compressive Strength (Ps) or Air Content (Pa)
Relative to Specification Limits

Percent Within Specification Limits	Characteristic Percentage
90 - 100	100
85 - 89	99
75 - 84	94
65 - 74	83
55 – 64	66
Below 55	*

* Defective work, as specified in Section 506.3(t).

(b) Defective Pavement Left in Place. The Department will not pay for defective pavement left in place, unless otherwise directed in writing by the District Executive. If the District Executive directs defective pavement be left in place, final payment for this pavement will be at 5% of the contract price.

(c) Concrete Pavement Cores. Each
The price includes measuring apparatus, which remains the Contractor's property upon completion of the project.

(d) Evaluation of Concrete Pavement Ride Quality and Payment of Incentive. Section 507.4.

SECTION 507—EVALUATION OF CONCRETE PAVEMENT RIDE QUALITY AND PAYMENT OF INCENTIVE

507.1 DESCRIPTION—This work is evaluating a concrete pavement surface profile and determining the ride-quality incentive associated with the pavement surface profile.

(a) General Requirements. Determine the ride quality of finished pavement surfaces, including approach slabs and pavement relief joints. In the presence of the Inspector, measure the pavement surface profile according to PTM No. 428. Provide the resultant International Roughness Index IRI data to the Representative. The Representative will determine payment for each ride-quality lot based on the IRI.

Measure the pavement surface of the following excluded areas separate from the pavement surface profile of ride-quality lots. The Representative will not include measurements from excluded areas to determine lot incentive payment.

- Bridge decks.
- Ramps less than 1,500 feet in length.
- Tapered pavements less than 12 feet wide.
- Shoulders, medians, and other pavement surfaces indicated.
- Partial lots less than 100 feet.

(b) Lot Size. A full lot is 528 feet of a single pavement lane with the same lot type. The lot types are Type 1 (posted speed limit greater than 45 miles per hour) and Type 2 (posted speed limit less than or equal to 45 miles per hour). The Representative will designate lots starting at the beginning limit of paving and continuing to the ending limit of paving for each pavement lane and ramp that is 12 feet or wider. Do not include the length of excluded areas in the 528 feet. If the lot type changes, end the lot and begin a new lot.

The Representative will designate a partial lot at the ending limit of paving, at a change in the lot type, and at an excluded area, when the lot length is less than 528 feet. The Representative will evaluate a partial lot as a percentage of a full lot.

507.3 CONSTRUCTION—

(a) Equipment and Operator. Provide pavement surface profile measuring equipment that has been verified by the Department according to PTM No. 428. In the presence of the Inspector, calibrate the distance sensor and check the profile system calibration before each day's testing.

Provide an operator that is Department certified according to PTM No. 428.

(b) Testing.

1. Lots. Provide the traffic control and station marking necessary to accommodate testing. Remove objects and equipment from the surface and sweep the surface as necessary to remove debris. In the presence of the Inspector, determine the pavement surface profile for each lot according to PTM No. 428. At the completion of testing, immediately submit the lot IRI data, as defined in PTM No. 428, to the Representative.

2. Excluded Areas. Provide traffic control necessary to accommodate testing. Test the entire surface of each excluded area in stages using a 10-foot straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the road centerline and, in successive positions, test the pavement surface profile from one side of the excluded area to the other. Advance the test location to the next stage by moving the straightedge along the roadway centerline not more than 5 feet.

(c) Acceptance.

1. Lots. The Representative will compare the lot IRI to Table A in Section 507.4 to determine if the lot requires corrective action. Additionally, perform corrective action on any individual bump (must grind) where the irregularity is more than 1/4 inch when tested with a 10-foot straightedge.

2. Excluded Areas. Perform corrective action where irregularities are more than 1/4 inch when tested with a 10-foot straightedge. Correct longitudinal joints not conforming to the requirements specified in Section 501.3(o)1. To improve the ride quality and at the Department's expense, the Representative may require grinding of excluded areas that conform to the acceptable straightedge surface tolerances specified in Section 507.3(c).

(d) Corrective Action.

1. Do not produce a deviation, such as a ridge or valley with the adjacent pavement, of more than 1/8 inch when measured on the transverse profile. Correct a sufficient length of pavement to correct the pavement surface profile without producing additional high or low points. Retest the lots and excluded areas after completing corrective action. Perform additional measurements of the pavement surface profile, as necessary, for the Representative to determine which lots do not require additional corrective action. Correct surfaces to a uniform texture and cross section.

2. Perform all corrective action before testing for pavement depth. If protective coating was applied before grinding, reapply to ground area. Use one or more of the following methods:

2.a. Carbide Grinding. Use carbide grinding for correcting areas 15 feet in length or less. Use grinders of the walk-behind type that have cutting heads of carbide tipped shackles, stars, or blades and have a locking depth control to produce a uniform pavement surface texture.

Provide a pavement surface texture consisting of parallel grooves between 3/32 inch and 1/4 inch wide width a "land area" between grooves 1/16 inch and 3/16 inch. Operate the grinder by making multiple passes if necessary, with a maximum depth of any single pass of 1/8 inch. Grind longitudinally or transversely across the pavement surface.

2.b. Diamond Grinding. As specified in Section 514.3 and modified as follows:

(d) Tolerance. Delete this section.

Unless otherwise approved, grind the entire lane width.

2.c. Removal and Replacement. Remove and replace a minimum of 10 feet of pavement between transverse joints of reinforced cement concrete pavements or an entire panel of plain cement concrete pavement. Where replacement extends to an existing transverse joint, replace the joint in kind as directed. Construct transverse joints at other locations resulting from removal of defective pavement using the methods for joining pavements shown on the Standard Drawings.

(e) Defective Work. A ride-quality pavement lot is defective if:

- The IRI of the lot exceeds the maximum acceptable IRI specified in Table A of Section 507.4.
- Any individual bump (must grind) exists in the lot where the irregularity is more than 1/4 inch when tested with a 10-foot straightedge.
- The surface adjacent to another ride-quality lot contains a ridge or valley of more than 1/8 inch.
- The specifications for pavement construction require removal and replacement of pavement within the ride-quality lot.

Unless the Department and Contractor agree to leave a defective lot in place as specified in Section 507.4, remove and replace defective areas and retest the ride-quality lot.

507.4 MEASUREMENT AND PAYMENT—Dollar

The proposal will include an item and a predetermined amount of money for Evaluation Of Concrete Pavement Ride Quality And Payment Of Incentive. The contract item will have a unit of measure of DOLLAR, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the incentive or bonus status of the payment being made, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Evaluation Of Concrete Pavement Ride Quality And Payment Of Incentive item as follows:

If the lot is not defective, Table A and the IRI for each lot will be used to determine the incentive payment for ride quality.

The incentive payment for a lot subjected to corrective action will be determined using Table A and the IRI for the lot after the Contractor completes corrective action.

The incentive payment for a partial lot will be determined as a percentage of a full lot.

After corrective action, the Contractor may leave a defective lot in place if the District Executive provides written approval and the Contractor accepts a $4,000 downward adjustment (rebate) of the amount paid for the lot.

Costs associated with evaluating pavement ride quality will not be paid for separately.

TABLE A
Payment Schedule for Ride Quality Incentive

Type 1 Lots	
IRI inches/mile/lot	**Amount**
≤ 35	$1,500
≤ 50	$1,000
≤ 60	$500
≤ 70*	$0
> 70	Corrective Action Required
* Maximum acceptable IRI	

Type 2 Lots	
IRI inches/mile/lot	**Amount**
≤ 45	$1,500
≤ 55	$1,000
≤ 70	$500
≤ 90*	$0
> 90	Corrective Action Required
* Maximum acceptable IRI	

SECTION 509—NEXT GENERATION CONCRETE SURFACE

509.1 DESCRIPTION—This work is the Next Generation Concrete Surface (NGCS) texture utilizing diamond grinding and grooving on new or existing cement concrete pavement as indicated or directed.

509.3 CONSTRUCTION—

(a) Equipment. Use a power driven, self-propelled machine utilizing diamond blades capable of grinding and grooving the concrete pavement. The grinding equipment must weigh a minimum of 40,000 pounds when equipped with a grinding head capable of making a single pass, a minimum of 4 feet in width. Do not use grinding equipment that causes spalls at joints or cracks, or fractures surface aggregates.

(b) Grinding /Grooving. NGCS can be attained in either a single pass or two-pass operation as determined by the capability of the contractor's equipment. Texture the entire pavement surface in the longitudinal direction parallel to the pavement centerline. Grinding shall be performed in a manner that eliminates faults at joints and cracks so there is a maximum 1/16-inch differential between adjacent sides of joints and cracks.

Perform a feather pass to ensure proper pavement drainage on the adjacent shoulders and ramps to maintain a consistent cross slope. Maintain the existing cross slope of the roadway. No depressions or misalignment of slope greater than 1/8 inch in 12-feet, when measured with a 12-foot straightedge placed perpendicular to the centerline will be allowed. Non-compliant areas will be reground. Straightedge requirements will not apply across longitudinal joints.

Provide proper drainage of the roadway, by making a feather pass a minimum of 2 feet into the adjacent shoulder, gore area, auxiliary lane, or ramp lane, using conventional diamond grinding. The minimum length of a feather pass will be 100 feet.

- **Single-pass operation.** – Provide a flush ground surface that contains longitudinal grooves constructed in one, single-pass. Stack the diamond blade with two types of diamond grinding blades arranged to provide a ground surface along with blades that produce longitudinal grooves. The diamond blade stack for texturing shall be mounted on a minimum 4-foot wide grinding head, stacked with 1/8 inch blades separated by 1/32 inch spacers. If mounted on the grinding head, all blades used to produce the ground surface will be flat across the contact surface and in the same plane with other flush grinding blades, excluding the grooving blades. Use a 4-foot straightedge to verify all blades on the grinding head are straight across the contact surface with no bowing if installed to grinding equipment.

  The blades used to create the longitudinal grooves should be 1/4 inch to 3/8 inch taller in diameter than the grinding blades. The longitudinal grooves should be spaced among the grinding blades approximately 1/2-inch center to center and shall produce grooves 1/8 inch to 3/16 inch in depth.

  The grinding equipment will be equipped with a guide to ensure NGCS is parallel to the roadway centerline. No unground surface area is allowed between passes. Do not overlap any pass of the grinding/grooving head by more than 1 inch.

- **Two-pass operation** – Provide a flush ground surface that contains longitudinal grooves constructed in two operations. The first operation will grind the pavement surface using a diamond blade stack mounted on a minimum 4-foot wide grinding head, stacked with 1/8 inch blades separated by 1/32 inch spacers. If mounted on the grinding head, all blades used to produce the ground surface will be flat across the contact surface and in the same plane with other flush grinding blades. Use a 4-foot straightedge to verify all blades on the grinding head are straight across with no bowing if installed to grinding equipment.

  The second operation will provide the longitudinal grooves. The longitudinal grooves shall be 1/8 inch wide and 1/8 inch to 3/16 inch deep. The longitudinal grooves will be spaced approximately 1/2 inch center to center.

  The grinding equipment will be equipped with a guide to ensure NGCS is parallel to the roadway centerline. No unground surface area is allowed between passes. Do not overlap any pass of the grinding/grooving head by more than 1 inch.

Remove slurry or residue resulting from the diamond grinding and grooving in a continuous operation. Do not allow slurry to flow across lanes occupied by traffic or to flow into gutters or other drainage facilities. Clean the pavement surface after diamond grinding and before opening to traffic.

(c) Test Section – Construct one 300-foot test section in a single lane to demonstrate the equipment and procedures will provide an acceptable surface. Do not proceed until the test section has been approved. The test section may be waived if approved in writing by the District Executive.

(d) Final Surface Finish – The NGCS shall produce a pavement surface true to grade with a longitudinal grooved texture. The ground surface shall be smooth and contain no ridges that exceed 1/8 inch. A minimum 98% of the pavement surface shall be textured utilizing NGCS. Depressed pavement areas due to subsidence, edge slump, or other localized causes will be excluded from this requirement if approved.

(e) Smoothness Requirements – After completion of the NGCS, determine the ride quality of the pavement as specified in Section 507.3(a) and Section 507.3(b). Provide a maximum IRI of 70 in/mile for facilities if posted speed limits are greater than 45 miles per hour, and a maximum IRI of 90 in/mile for facilities if posted speed limits are less than or equal to 45 miles per hour. To receive payment, all IRI lots must meet the requirements for the posted speed limits.

1. Lots. A full lot is 528 feet of a single lane. The Representative will designate lots starting at the beginning ride quality limit and continuing to the ending ride quality limit for each pavement lane and ramp that is 12 feet or wider. Do not include the length of excluded areas in the 528 feet. Excluded areas will consist of; bridge decks, ramps less than 1,500 feet in length, tapered pavements less than 12 feet wide, partial lots less than 100 feet in length, shoulders, medians, and other pavement surfaces as indicated.

509.4 MEASUREMENT AND PAYMENT—Square Yard

Payment will be for the entire textured surface completed as part of this work, whether the work is performed in a single-pass operation or a two-pass operation.

No ride quality incentive will be paid for NGCS texturing on concrete rehabilitation projects.

SECTION 510—LONGITUDINAL GROOVING OF EXISTING CONCRETE PAVEMENT

510.1 DESCRIPTION—This work is the cutting of longitudinal grooves in existing cement concrete pavement.

510.3 CONSTRUCTION—Groove the existing pavement surface longitudinally between the limiting stations indicated. Do not use flailing type equipment. Do not cut grooves on bridge decks. Cut 3/32-inch wide grooves, with a tolerance of plus 1/16 inch, a 3/4 inch center-to-center spacing, and a minimum depth of 3/16 inch. Do not cut grooves within 6 inches of the outside edge and centerline pavement joint. Do not overlap grooves. Remove slurry or residue resulting from the grooving in a continuous operation. Do not allow slurry to flow across lanes occupied by traffic or to flow into gutters or other drainage facilities. Clean the pavement surface after grooving and before opening to traffic.

510.4 MEASUREMENT AND PAYMENT—Square Yard

Measured on the finished grooved area.

SECTION 511—PRESSURE RELIEF JOINT

511.1 DESCRIPTION—This work is construction of a pavement pressure relief joint.

511.2 MATERIAL—

(a) Pressure Relief Material. Section 705.4(e) or (f)

(b) Approved Sealant or Lubricant. As recommended by the manufacturer of the pressure relief material.

511.3 CONSTRUCTION—Saw the joint opening 4 inches wide, full depth, and full width of the pavement. Remove the existing concrete material. Immediately before placing the sealing material, clean all vertical faces of the joint, and ensure the joint is free of oil, moisture, and other contaminants. Coat joint sides with either the sealant or lubricant adhesive according to the manufacturer's recommendations.

511.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 512—LONGITUDINAL JOINT CLEANING AND SEALING

512.1 DESCRIPTION—This work is cleaning and sealing longitudinal joints in existing cement concrete pavements.

512.2 MATERIAL—Section 705.4(b) or (c)

512.3 CONSTRUCTION—Thoroughly clean the longitudinal joints of all existing sealing material, asphalt material, and other foreign material. Clean original saw-cut joints to a minimum depth of 1 1/2 inches. Clean original formed construction joints to a minimum depth of 3/4 inch. If sawing is used, immediately flush the joint with water. If water blasting, use a waterblaster with a minimum operating capacity of 10 gallons per minute at 7,000 pounds per square inch.

Seal the joint, as specified in the applicable parts of Section 501.3(n), to a level 1/8 inch to 1/4 inch below the pavement surface.

512.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 513—JOINT REHABILITATION

513.1 DESCRIPTION—This work is construction of a sealant reservoir and sealing transverse contraction, construction, or expansion joints in existing Portland cement concrete pavements of the type indicated.

Joint Rehabilitation is classified into two types as follows:

(a) Type 1. Joint Rehabilitation of existing saw-cut joints.

(b) Type 2. Joint Rehabilitation of existing metal plate joints.

513.2 MATERIAL—

(a) Joint Sealing Material. Section 705.4(b) or (c)

(b) Joint Backing Material. Section 705.9

(c) Tape Bond Breaker. Duct tape, the width of the sealant reservoir.

513.3 CONSTRUCTION—As shown on the Standard Drawings, and as follows:

(a) Type 1.

1. General. Perform this work after spall repairs at the joint are completed. Clean and seal any unrepaired spalls 2 inches or less in dimension. Construct the joint sealant reservoir by sawing to the width and depth indicated for the appropriate existing joint spacing. In general, center the sealant reservoir around the existing joint opening. Immediately after sawing, flush the joint with water.

Place tape bondbreaker on bottom of joint reservoir immediately before sealing. Do not allow tape to extend up reservoir face more than 1/8 inch.

2. Existing Wide Joint. If the existing joint is as wide as or wider than the required width of sealant reservoir, thoroughly clean the joint to the depth required for the sealant reservoir. If water blasting, use a waterblaster with a minimum operating capacity of 10 gallons per minute at 7,000 pounds per square inch. Place joint backing material to the depth required for the sealant reservoir, if necessary.

3. Sealing. Immediately before placing the sealing material, sandblast all vertical faces of the joint and clean, with a compressed air stream measuring 100 pounds per square inch at the source, free of oil, moisture, and other contaminants. Seal as specified in the applicable parts of Section 501.3(n).

(b) Type 2. Construct as specified for Joint Rehabilitation Type 1, except remove the portion of the existing steel plate that lies within the new sealant reservoir before sealing the joint. A maximum of 1/4 inch of the plate may protrude into the reservoir.

513.4 MEASUREMENT AND PAYMENT—Linear Foot

The unit price includes cleaning and sealing of small unrepaired spalls.

Repair any damage to the existing shoulders because of this work at no additional expense to the Department.

SECTION 514—DIAMOND GRINDING OF CONCRETE PAVEMENT

514.1 DESCRIPTION—This work is the diamond grinding of existing cement concrete surfaces as indicated or directed.

514.3 CONSTRUCTION—

(a) Equipment. Use a power driven, self-propelled machine having diamond blades and capable of grinding the surface of the pavement to the specified smoothness tolerances and texture. Do not use equipment that causes spalls at joints or cracks, or fractures the aggregate at the surface.

(b) Grinding. Grind the entire pavement surface in the longitudinal direction beginning and ending at lines normal to the pavement centerline, unless otherwise specified. Grind in either direction unless it is otherwise determined by the Representative traffic safety considerations mandate grinding with traffic flow. Provide a uniform finished surface and eliminate joint or crack faults. Operate the grinding machine parallel to centerline. Texture the entire pavement surface; however, do not perform extra depth grinding to eliminate minor depressions. Do not exceed 2 inches of overlap. Do not grind within 2 feet of existing curb, bridge barrier, and roadway barrier. Newly sealed longitudinal or transverse joints damaged due to the diamond grinding operation will be resealed as specified in Sections 512 and 521 at no additional cost to the Department. A newly sealed joint will be defined as a joint sealed under the current contract.

Remove slurry or residue resulting from the diamond grinding in a continuous operation. Do not allow slurry to flow across lanes occupied by traffic or to flow into gutters or other drainage facilities. Clean the pavement surface after diamond grinding and before opening to traffic.

(c) Texture. Provide a surface texture consisting of parallel grooves between 0.09 inch and 0.13 inch wide with a "land area" between grooves of 0.060 inch to 0.110 inch and a difference between the peaks of the ridges and the bottom of the grooves of approximately 1/16 inch.

(d) Tolerance.

1. Transverse Tolerance. Restore original pavement cross slope. Maintain a uniform cross slope. Check the uniformity of cross slope at 100-foot intervals longitudinally.

Correct all areas with deviations greater than 1/4 inch in 12 feet. Provide a positive cross slope so the pavement drains.

Provide the Representative with documentation recording each cross slope test location and the maximum depth of depression or slope misalignment at that location.

2. Longitudinal Tolerance. Supply and operate equipment as specified in Section 507.3(a), for all longitudinal roughness tests. Test the pavement surface roughness in the longitudinal direction and submit the record of the information to the Representative before beginning any diamond grinding work. Following grinding of the pavement surface, test the longitudinal roughness as specified in Section 507.3(c)1.

Regrind pavement segments as specified in Section 507.3(d).

(e) Concrete Pavement Rehabilitation. Concrete pavement repairs including concrete pavement patching, concrete spall repair, dowel retrofit, slab stabilization, and slab jacking must be completed before the start of any diamond grinding operations.

After completing the concrete rehabilitation operation, determine the ride quality of the existing pavement as specified in Sections 507.3(a) and 507.3(b), before performing any diamond grinding. After completing the diamond grinding operations, reevaluate the ride quality of the pavement surface as specified in Sections 507.3(a) and 507.3(b). Use the same pavement surface profile measuring equipment to perform all ride quality evaluations on the project.

After diamond grinding the pavement surface, provide a maximum IRI of 70 in/mile for facilities if posted speed limits are greater than 45 miles per hour, and a maximum IRI of 90 in/mile for facilities if posted speed limits are less than or equal to 45 miles per hour. Meet these requirements in all IRI lots where diamond grinding of the pavement was performed to receive payment.

1. Lots. A full lot is 528 feet of a single lane. The Representative will designate lots starting at the beginning ride quality limit and continuing to the ending ride quality limit for each pavement lane and ramp 12 feet or wider. Do not include the length of excluded areas in the 528 feet. Excluded areas will consist of: bridge decks, ramps less than 1,500 feet in length, tapered pavements less than 12 feet wide, partial lots less than 100 feet in length, shoulders, medians, and other pavement surfaces as indicated.

514.4 MEASUREMENT AND PAYMENT—Square Yard

The determination of longitudinal roughness and the determination of ride quality are incidental to this item.

No ride quality incentive will be paid for diamond grinding on concrete pavement rehabilitation projects.

SECTION 515—SAWING AND SEALING OF ASPHALT OVERLAYS

515.1 DESCRIPTION—This work is the saw cutting of new asphalt concrete courses directly above existing or constructed transverse joints in the underlying concrete pavement as directed, and sealing the reservoir.

515.2 MATERIAL—

(a) Sealing Material. Section 705.4(b), (c), or (g)

(b) Tape Bond Breaker. Section 513.2(c)

515.3 CONSTRUCTION—

(a) General. Locate and reference the location of each end of each existing transverse joint before placing any asphalt courses. For transverse joints across multiple lanes where traffic is diverted to an adjacent lane, locate and reference an additional point along the transverse joint to facilitate marking the location of the joint in one lane while traffic is traveling in the adjacent lane.

Prepare a QC plan outlining the control of locating and referencing transverse joints. Have the QC plan describe the personnel, equipment and methods necessary to accurately locate, reference and later mark for sawing all joint locations. Submit the QC plan to the Representative at least 21 days before the start of referencing operations. Do not begin joint referencing until the Representative reviews the QC plan.

Before or on the first day of joint referencing and before the placement of any asphalt courses, demonstrate the ability to accurately relocate the existing transverse joints using the reference data to the satisfaction of the Representative at no additional cost to the Department. If the joint referencing and relocating process does not yield consistent results within a ± 1inch tolerance, stop all related operations and amend the QC plan to ensure accurate referencing.

(b) Sawing. Make all saw-cuts directly above the existing transverse joints within ± 1 inch. Saw-cuts which do not meet this tolerance will be declared defective as outlined in Section 105.12. Do not saw cut until the asphalt course has cooled below 140F. Perform saw cutting within 7 days after placing the wearing course. Perform this work on all finished overlay areas before discontinuing work due to seasonal paving limitations.

Make saw-cuts only in the lane in which the existing joint is located. Extend the saw-cuts through any existing widening. Provide separate saw-cuts in each lane if existing transverse joints are offset more than 1 inch.

Use the following table to determine saw-cut reservoir size:

Overlay Thickness inches	Reservoir inches
≤1 1/2	1/2 deep by 1/2 wide
>1 1/2	1 deep by 1/2 wide

Additionally, if the total depth of overlay is 3 1/2 inches or greater, make an initial saw-cut 1/8 inch wide to a depth of 1 1/2 inches or one-third of the total overlay thickness, whichever is greater. Indicated overlay depths do not include scratch or leveling courses less than 1 inch.

If not placing the wearing course within the same construction season, provide a 1/8-inch wide saw-cut in the last placed asphalt course to a minimum depth of 1 inch or one-third the thickness of the asphalt material placed, whichever is greater.

(c) Sealing. Do not place sealing material unless the reservoir faces are thoroughly clean and dry to the satisfaction of the Representative. Clean the reservoir immediately before placing sealing material. When using compressed air, use air free of oil, moisture, or any other substance that would prevent bonding of sealing material to the reservoir faces.

Do not place sealing material if the air temperature is less than 40F, or above 90F, unless otherwise allowed by the Representative.

Determine the safe heating temperature and recommended pouring temperature from the manufacturer's shipping container. Heat and maintain the material temperature within these recommended safe temperatures. Place the material as close as possible to the recommended pouring temperature. Do not maintain any single batch of material at the pouring temperature for more than 6 hours. Reheat according to the manufacturer's recommendations. Place tape bondbreaker on bottom of joint reservoir immediately before sealing. Do not allow tape to extend up the reservoir face more than 1/8 inch.

Fill the reservoir with sealing material to a level 1/8 inch to 1/4 inch below the pavement surface. Do not allow sealing material to spread over the pavement surface.

515.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 516—CONCRETE PAVEMENT PATCHING

516.1 DESCRIPTION—This work is the construction of single course, full depth, normal strength or accelerated strength, cement concrete pavement patches, and corner repairs. If diamond grinding is to be performed, test the pavement surface in the longitudinal direction as specified in Section 514.3(d)2.

(a) Patching Joint. Provide full depth saw-cuts at the existing pavement/patch interface, install load transfer dowels in the transverse faces of the existing pavement, construct a sealant reservoir, and seal the joint.

(b) New Pavement Joint. Provide load transfer unit, construct sealant reservoir, and seal the joint.

(c) Normal and Accelerated Concrete Pavement Patching, Type A. Construct patches between 6 feet and 20 feet long. Do not patch less than one lane width.

(d) Normal and Accelerated Concrete Pavement Patching, Type B. Construct patches between 20.1 feet and 65 feet long. Do not patch less than one lane width.

(e) Normal and Accelerated Concrete Pavement Patching, Type C. Construct patches between 65.1 feet and 500 feet long. Do not patch less than one lane width.

(f) Full Depth Corner Repair. Provide full depth corner repair as shown on the Standard Drawings.

516.2 MATERIAL— Section 501.2 with the following modifications:

(j) Concrete Curing Material. Revise to read as follows:

Sections 711.1 and 711.2

Section 501.2 Material. Add the following:

(u) Subbase. Section 350.2

(v) Rapid Set Concrete Patching Material. Section 525.2(c). Only allowed for Corner Repairs. Use within the shelf life and temperature limitations set by the manufacturer.

516.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in Section 501.3 and as follows:

(a) General. Prepare a QC Plan as specified in Section 106.03(a)2.a and submit it for review. The QC Plan must describe appropriate action points for all phases of construction, including concrete mixing and curing, joint sawing and sealing, and sampling and testing for opening to traffic. If patching adjacent lanes, construct concrete pavement patches one-lane at a time where two-lane width construction would interfere with traffic. The Representative will surface mark patch areas in advance of the sawing operations.

Protect traffic from drop off conditions as specified in Section 901.3(j). Do not allow excavated patch areas to remain un-patched for more than 48 hours or over weekends or holidays. If an excavated patch area is to remain open for longer than 48 hours and is adjacent to open traffic lanes, use temporary fill or other approved methods to protect traffic.

If it rains while the patch area is open, excavate an outlet through the shoulder at the lowest point of the patch as directed. Repair any damage to the existing shoulders as a result of this work, at no additional cost to the Department. After saw cutting the existing pavement, allow traffic on patch areas of existing pavement for a maximum of 72 hours. Do not allow saw cuts greater than 1/2 inch in width or less than full depth to be opened to traffic.

Before placing concrete, ensure adequate equipment and trained personnel are available, and sufficient hauling units scheduled, to maintain continuity in placement.

(b) Saw Cutting. Use a saw equipped with a diamond-tipped blade, a blade guard, alignment guides, water cooling system, and cut-depth controls for saw cutting the perimeter of the patch. Do not allow cooling water, slurry, and dust from the sawing operation to enter any lane opened to traffic. Make all required full depth longitudinal saw cuts along the perimeter of the patch before making any full depth transverse saw cuts.

Where only one lane is being patched, make a full depth saw-cut in the existing longitudinal joint for the full length of the patch. Where multiple lanes are being patched one lane at a time, perform one of the following:

- Make a full depth saw-cut within the adjacent lane to be patched. Make the saw-cut parallel and not more than 1 foot from the existing longitudinal joint. Form the patch joint in the same location as the existing longitudinal joint and backfill behind the forms with aggregate at no additional cost to the Department.

- Make a full depth saw-cut in the existing longitudinal joint for the length of the patch and insert a temporary rigid separator between the adjacent lane and the patch area. Do not use a temporary rigid separator greater than 1/8 inch thick.

Make full depth transverse saw-cuts at the locations marked on the pavement surface. Do not break back the underside of the existing pavement. If break back or spalling occurs, make a new full depth transverse saw-cut beyond the area of break back or spalling. Place the additional length of patch at no additional cost to the Department. If break back or spalling occurs in the adjacent lane, repair the damaged area at a minimum with a full depth Type A concrete patch at no additional cost to the Department. Full depth saw cuts at the patch limits will be allowed to extend transversely into the adjacent pavement up to full depth + 2 inches provided dowel bars in the adjacent lane are not damaged. Additional full depth transverse saw cuts will be allowed to facilitate slab removal but may not extend transversely into the adjacent pavement to remain in place.

For corner repairs, only saw 2 inches in depth and a minimum of 2 inches beyond the damaged area as shown on the Standard Drawings to establish the boundary of the repair. Full-depth cuts will be allowed along the existing joints to relieve restraints of a dowel or a tie bar. Cut and remove exposed sections of dowel and tie bars.

(c) Removal of Existing Pavement. Remove concrete between narrowly spaced saw-cuts at the end of a proposed patch area in a manner that does not damage any adjacent pavement that is to remain in place.

As an alternate, a wheel saw having carbide steel tips may be used before making the full depth transverse saw-cuts necessary for the patching joint. Limit penetration of the wheel to minimize disturbance to the subbase. Do not allow wheel saws with carbide steel tips to cut into pavement that is to remain in place. Discontinue using a wheel saw if unsatisfactory results are determined.

Remove the concrete in the patch area in one or more pieces minimizing disturbance to the subbase, subgrade, and the adjacent pavement to remain in place. Do not use drop hammers or hydro-hammers. If damage occurs to pavement to remain in place, repair as specified in Section 516.3(b) at no additional cost to the Department.

For full depth corner repairs, use a 35 pound maximum jackhammer to remove the unsound concrete. Operate the jackhammer at a 45-degree angle or less to taper the boundary and to minimize damage to the remaining sound concrete.

If the surface of the subbase is disturbed by the removal technique, recompact the surface using small vibratory compactors. If the disturbed material is deeper than 1 inch, remove the disturbed material with hand tools and replace with concrete during paving at no expense to the Department.

Correct all subbase surface irregularities exceeding 1 inch in depth by loosening the surface and removing or adding material as required. Compact the corrected area and surrounding surface by rolling to proper grade and slope.

(d) Removal of Existing Subbase. Remove unsuitable subbase material, as directed. Replace as specified in Section 350.3.

(e) Transverse Joints. Section 501.3(i) and as follows:

1. General. Delete Section 501.3(i)2, Table A. If a crack or spall occurs at any location and any time before final inspection and resolution of all issues regarding the condition of the pavement, remove and replace the pavement at no additional cost to the Department.

If any patch is replacing an existing expansion joint, and the existing expansion joint in the adjacent lane is remaining in place, install 3/4-inch expansion joint material in the joint nearest to the remaining expansion joint.

Apply bond breaker lubricant to at least one-half of the length of Type B coated dowel bars, unless a bond breaker lubricant has been applied in the shop. Stir the lubricant well and apply to the free end of dowels by spraying, or with a gloved hand, to produce a thorough coating. Do not use brushes for lubricant application. Apply the bond breaker lubricant, as specified, at least 1 hour before placing the concrete around the dowel. Provide a tube with a minimum 1-inch clearance packet, over the lubricated end of all coated dowel bars. Type A coated dowel bars do not need lubricant.

For corner repairs, install 1/2-inch expansion joint material to reestablish original transverse joint location. Drill 5/8-inch diameter holes and install tie bars as shown on the Standard Drawings.

2. Patching Joint. Drill holes into the face of the existing pavement that has been saw cut full depth. Provide holes a maximum of 1/8 inch larger in diameter than the coated dowel bars. Mount drilling machines in a frame that maintains the proper horizontal and vertical alignment during drilling.

Do not use hand held drills or drills that rest upon the subbase or subgrade. Drill holes to ensure the dowel alignment tolerances shown on the Standard Drawings and as specified in Section 501.3(i). Change location of drill holes ±1 inch to avoid existing reinforcing steel.

Securely embed the coated dowel bars into place with an approved anchoring material. Inject all the mixed anchoring material into the rear of the hole before inserting the dowel bar. Rotate the dowel three to five complete rotations while inserting the dowel to purge air voids as completely as possible. Immediately trowel all excess anchoring material flush with the vertical face of the patch until the anchoring material reaches its initial set. Do not leave voids in the anchoring material. Use a plastic retainer washer to hold anchoring material in place, if directed, and remove before placement of concrete in the patch. Provide anchoring material formulated to reach an initial set within 5 minutes of application. Provide a material specification data sheet for the anchoring material used.

Render exposed portion of each coated dowel bar bondless as specified in Section 501.3(i).

2.a Dowel Bar Anchor Verification. On the first day of dowel bar anchoring operations, the Representative will randomly select three locations to evaluate proper anchoring of dowel bars to provide load transfer across the joint without deflection and to prevent intrusion of moisture. At each location, drill one 4-inch diameter core directly through the anchored dowel no closer than 3 inches from the joint face.

The Representative will determine if the anchoring of the dowels is acceptable. Acceptance will be the summation of voids around the perimeter of the dowel less than 0.50 inch. If the anchoring of the dowels is acceptable, continue production using the same anchoring operations. If the anchoring of the dowels is not acceptable, additional evaluations of dowel bar anchoring operations will be conducted. Construct a new patching joint offset 2 feet from each joint determined not acceptable at no additional cost to the Department.

Clean the vertical surface of any core hole of laitance, loose and foreign material. Fill the holes with the concrete mixture used to construct the pavement and consolidate. As an alternative, use a premixed, non-shrink grout.

3. New Pavement Joint. As indicated and when directed, provide load transfer units adjacent to existing joints. When patching all adjacent lanes, space joints as shown on the Standard Drawings.

Install load transfer units as specified in Section 501.3(i).

(f) Forms. Section 501.3(d). Form all patch sides not in contact with pavement remaining in place.

(g) Concrete. Design, mix, and place as specified in Section 501.3(a) through (h). Concrete will be accepted by lot as specified in Section 704.1(d)4.

For corner repairs, prepare the existing sound concrete surface to ensure proper bond according to manufacturer's recommendations immediately before placing patching material. Mix and place rapid set patching materials according to manufacturer's recommendations. Provide a copy of the manufacturer's recommendations for the epoxy bonding compound and the patching material to the Representative before installation.

(h) Final Strike-Off and Consolidation. Section 501.3(k).

(i) Final Finish for Pavements Not Being Overlaid. For Type A and B patches, finish the surface of the patch to match the existing pavement cross section. Include any existing wheel ruts. For Type C patches, taper the wheel ruts at both ends of the patch to a straight pavement cross slope, within the patch, with a minimum transition length of 20 feet.

Texture Type A and B patches to correspond with the texture of the surrounding pavement. Texture Type C patches as specified in Section 501.3(k)4.

Following the final finishing and before application of curing materials, scribe the date of the patch placement in the surface of the fresh concrete along the shoulder edge of the patch.

If the contract includes grinding of the pavement surface, then the matching of wheel ruts and the texturing of the patch surface is not necessary. Make the scribing of the patch dates deep enough that the grinding will not eliminate them.

(j) Curing of Concrete. Section 501.3(l) except, Type 2 white pigmented liquid membrane forming curing compound is allowed in lieu of white, poly-alpha-methylstyrene (PAMS) liquid membrane forming curing compound. Cure rapid set concrete patching material repairs according to manufacturer's recommendations

(k) Stabilizing Around Patches. After curing and before opening to traffic, grout around the patches. Use the hole pattern shown on the Standard Drawings. If directed, stabilize as specified in Section 679.

(l) Longitudinal Joints. Section 501.3(j) and as follows:

In two-lane width patching being performed at the same time, construct a Type L joint as shown on the Standard Drawings.

In two-lane patching being performed one lane at-a-time, or one-lane patching, provide a 1/4-inch, full depth, polystyrene board bond breaker in the longitudinal joint of Type A and B patches and corner repairs. Do not provide a bond breaker in the longitudinal joint of Type C patches. Provide tiebars in all Type C patches. For all patch types, saw cut the longitudinal joint 1/4 inch wide and 1 inch deep. Center the saw-cut over the joint.

(m) Sealing. Seal all longitudinal and transverse joints constructed as part of this work except, if the pavement is to be overlaid with asphalt pavement during the same construction season, then only expansion joint sealing is necessary. Seal the joints as specified in Section 501.3(n).

Seal all saw-cuts extending beyond the patch limits.

When the pavement will not be overlaid during the same construction season, construct a sealant reservoir and seal joints as specified in Section 501.3(n).

Longitudinal and transverse joints of accelerated strength concrete patches may be opened to traffic provided second stage sawing has not occurred, a backer rod is installed and maintained near the surface, initial concrete strength is attained, and curing requirements are met. Perform second stage sawing and seal the joints of accelerated strength concrete patches as specified in Section 501.3(n) within 24 hours.

(n) Surface Tolerance. Test the surface of the patch area, in the longitudinal direction, and across patch joints using a 12-foot straightedge. Correct, by grinding, any high points or depressions of 3/16 inch or more at no additional cost to the Department unless caused by surface deficiency in existing adjacent pavement. After grinding, retest the area with the straightedge. If the surface still exceeds the above limits, then the area is defective. Remove and replace the defective area at no additional cost to the Department.

(o) Protection of Pavement. Section 501.3(p).

(p) Protection Against Rain. Section 501.3(r).

(q) Opening to Traffic. Section 501.3(q). For rapid set concrete patching material repairs, cure the QC cylinders according to manufacturer's recommendations. The Representative will determine when pavement may be opened to traffic based on when the concrete attains the minimum required compressive strength of 1,000 pounds per square inch as measured by compressive strength testing of cylinders according to PTM No. 604.

(r) Defective Work. Section 501.3(t), except remove and replace cracked or spalled concrete pavement patches or corner repairs at no additional cost to the Department.

516.4 MEASUREMENT AND PAYMENT—

(a) Patching Joint. Linear Foot

Includes all costs associated with Dowel Bar Anchor Verification.

(b) New Pavement Joint. Linear Foot

(c) Concrete Pavement Patching. Square Yard

The Department will not pay for additional work required due to insufficient dowel bar anchoring.

For the type indicated. When longitudinal joint cleaning and sealing is part of the contract, the sealing of longitudinal joints is incidental to that item, not to concrete pavement patching.

The unit price includes removal of the existing pavement and all repairs or corrections specified in Section 516.3 that are needed as a result of patching operations.

(d) Full Depth Corner Repair. Square Foot

(e) Subbase Material. Cubic Yard

The unit price includes excavation.

(f) Slab Stabilization. Section 679.4(a)2 and (a)3, 679.4(b)2 and (b)3, and 679.4(c)2 and (c)3

SECTION 517—TRANSVERSE GROOVING OF CONCRETE PAVEMENT FOR RETEXTURING

517.1 DESCRIPTION—This work is the cutting of transverse grooves in existing cement concrete pavement after the original texture has been lost.

517.3 CONSTRUCTION—Groove the existing pavement surface transversely between the limiting stations indicated. Do not use flailing type equipment. Cut grooves 3/32 inch in width, with a tolerance of plus 1/16 inch, a 3/4-inch center-to-center spacing, and a minimum depth of 3/16 inch. Do not cut grooves within 6 inches of the outside edge or centerline pavement joint. Do not overlap grooves. Remove slurry or residue resulting from the grooving in a continuous operation. Do not allow slurry to flow across lanes occupied by traffic or to flow into gutters or other drainage facilities. Clean the pavement surface after grooving and before opening to traffic.

517.4 MEASUREMENT AND PAYMENT—Square Yard

Measured on the finished grooved area.

SECTION 518—CONTINUOUSLY REINFORCED CONCRETE PAVEMENT PATCHING

518.1 DESCRIPTION—This work is the construction of one course, full-depth, continuously reinforced cement concrete pavement patches. Do not patch less than one lane width.

(a) Patching Joint. Provide partial depth saw-cuts at the existing pavement/patch interface, construct a sealant reservoir, and seal the joint.

(b) Continuously Reinforced Concrete Pavement Patching, Type A. Construct patches between 6 feet and 20 feet long if using tied splices and between 4 feet and 20 feet long if using welded splices.

(c) Continuously Reinforced Concrete Pavement Patching, Type B. Construct patches between 20.1 feet and 65 feet long.

(d) Continuously Reinforced Concrete Pavement Patching, Type C. Construct patches between 65.1 feet and 500 feet long.

518.2 MATERIAL—

(a) Cement Concrete. Class AA or Class HES, Section 704.

(b) Reinforcement Bars. Section 1002.2

(c) Concrete Curing Materials. Section 711.1(a), (b), (c), (d), and (e).

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(d) Concrete Admixtures. Section 711.3

(e) Bondbreaker. Use polyethylene sheeting, clear or opaque, minimum 6-mil thickness, or a double application of Type 2, white pigmented, wax-based curing compound as specified in Section 711.1(a) and Section 711.2(a) respectively.

(f) Subbase. Section 350.2

(g) Joint Sealing Material. Section 705.4(b) or (c)

(h) Tape Bond Breaker. An acceptable self-adhesive tape the width of the sealant reservoir.

(i) Preformed Cellular Polystyrene. Section 516.2(m)

(j) Welding Material. Section 1105.02(t)

(k) Anchoring Material. Section 516.2(k)

518.3 CONSTRUCTION—As specified in Section 516.3, modified as follows:

(b) Saw Cutting. Replace the second paragraph of Section 516.3(b) with the following:

Make initial, full-depth, transverse saw-cuts from the outside edge of the pavement toward the longitudinal saw-cut. Make a second, 1-inch minimum depth, transverse saw-cut at each end of the patch area, parallel to and outside the initial saw-cut the distance shown on the Standard Drawings for the type of rebar splices to be used. Do not saw cut across an existing crack. Do not locate saw-cuts within 24 inches of an existing crack. Do not cut reinforcement bars when making the partial depth saw-cuts. If any of the reinforcement bars are cut, take corrective action by making

the partial depth saw-cut a full-depth cut and making another partial depth (1-inch minimum) saw-cut located as specified above. Place the additional length of patch at no expense to the Department.

(c) Removal of Existing Pavement. Replace Section 516.3(c), with the following:

> **(c) Removal of Existing Pavement.** Remove concrete between the two full-depth, transverse saw-cuts, before making the 1-inch minimum depth saw-cuts. A wheel saw having carbide steel tips may be used, while making the full-depth transverse saw-cuts, to provide a trench across the slab to relieve compression in pavement before lifting out failed area. Limit penetration of wheel into the subbase to a maximum of 1/2 inch. Do not allow the wheel to cut into pavement that is remaining in place. Discontinue use of the wheel saw if unsatisfactory results are obtained as determined by the Representative.
> Install lifting devices and lift out the concrete in the area enclosed by the full-depth saw-cuts, in one or more pieces, without disturbing existing subbase.
> Remove the concrete strips at each end of the patch area with jackhammers and hand tools. Limit jackhammer size to 15 pounds maximum. Do not damage existing reinforcement bars within the concrete strips. Do not break back the underside of the existing pavement. If break back greater than 2 inches occurs, make a new full-depth, transverse saw-cut beyond the area of break back. Saw cut a new outside edge, maintaining the appropriate bar length at the edge of patch. Place the additional length of patch at no cost to the Department.
> If the existing pavement was constructed on top of a bond breaker, remove the bond breaker from the top of pavement base. Place new bond breaker, of the existing type and thickness, before placing concrete. If polyethylene sheeting is used, cut to the surface dimensions of the patch.
> If the surface of the subbase is disturbed by the removal procedure, recompact the surface using small vibratory compactors. If subbase material is disturbed to a depth greater than 1 inch, remove the disturbed material with hand tools and replace with concrete during paving at no cost to the Department.

(e) Transverse Joints. Replace Section 516.3(e), with the following:

> **(e) Reinforcement.** Place reinforcement in the patch area as specified in Section 1002.3 and as shown on the Standard Drawings. Firmly support and tie bars at every intersection to re-establish the continuous reinforcing. Use tied or welded splices. Lap the new reinforcement bars with the existing bars as shown on the Standard Drawings for the type of rebar splices to be used. Weld splice as specified in Section 1105.03(m) and as shown on the Standard Drawings. When weld splicing, lap tie bars at the center of the patch, as shown on the Standard Drawings, to allow for expansion.

518.4 MEASUREMENT AND PAYMENT—

(a) Patching Joint. Linear Foot

(b) Continuously Reinforced Concrete Pavement Patching. Square Yard

For type indicated. The unit price includes removal of the existing pavement and repairs or corrections specified in Section 516.3 that are needed as a result of patching operations.

(c) Subbase Material. Cubic Yard

The unit price includes excavation.

SECTION 519—FULL DEPTH LONGITUDINAL CONCRETE JOINT REPAIR

519.1 DESCRIPTION—This work is the full depth longitudinal repair of an existing concrete pavement. If diamond grinding is to be performed, test the pavement surface in the longitudinal direction as specified in Section 514.3(d)2.

519.2 MATERIAL—Section 501.2 with the following addition:

(a) Subbase. Section 350.2

519.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in Section 501.3 and as follows:

(a) General. At least 2 weeks before the start of repairs, submit a QC Plan as specified in Section 106.03(a)2.a and submit it for review. Describe the construction equipment, personnel, and methods necessary to construct and test concrete for all pavement repair operations. Include testing frequencies, and action points to initiate corrective measures. Do not establish action points at either the upper or lower specification limits.

If constructing full or partial depth patching adjacent to longitudinal joint repairs, construct all patches prior to performing longitudinal repairs. For any full depth repair adjacent to the longitudinal joint, the patch should be combined with the longitudinal repair along that portion of the joint repair. The Representative will surface mark repair areas in advance of the sawing operations.

After saw cutting the existing pavement, allow traffic on repair areas of existing pavement for a maximum of 72 hours. Do not allow saw cuts greater than 1/2 inch in width to be opened to traffic.

Do not allow excavated repair areas to remain un-patched for more than 48 hours or over weekends or holidays. Protect traffic from drop off conditions as specified in Section 901.3(j).

Before placing concrete, ensure adequate equipment and trained personnel are available, and sufficient hauling units scheduled, to maintain continuity in placement.

(b) Saw Cutting. Use a saw equipped with a diamond-tipped blade, a blade guard, alignment guides, water cooling system, and cut-depth controls for saw cutting the perimeter of the patch. Do not allow cooling water, slurry, and dust from the sawing operation to enter any lane opened to traffic. Make all required full depth longitudinal saw cuts along the perimeter of the repair prior to making any full depth transverse saw cuts.

Make the saw-cuts parallel to the existing longitudinal joint. Make full depth transverse saw-cuts at the locations marked on the pavement surface. Do not break back the underside of the existing pavement. If break back or spalling occurs, make a new full depth transverse saw-cut beyond the area of break back or spalling. Place the additional length of repair at no additional cost to the Department. Full depth saw cuts at the repair limits will be allowed to extend transversely into the adjacent pavement up to full depth + 2 inches provided dowel bars in the adjacent lane are not damaged. Additional full depth transverse saw cuts will be allowed to facilitate slab removal but may not extend transversely into the adjacent pavement to remain in place.

(c) Removal of Existing Pavement. Remove concrete between narrowly spaced saw-cuts at the end of a proposed repair area in a manner that does not damage any adjacent pavement that is to remain in place.

Remove the concrete in the repair area in one or more pieces minimizing disturbance to the subbase, subgrade, and the adjacent pavement to remain in place. Do not use drop hammers or hydro-hammers. If damage occurs to pavement to remain in place, repair as specified in Section 516.3(b) at no additional cost to the Department.

If the surface of the subbase is disturbed by the removal technique, recompact the surface using small vibratory compactors. If the disturbed material is deeper than 1 inch, remove the disturbed material with hand tools and replace with concrete during paving at no additional cost to the Department.

Correct all subbase surface irregularities exceeding 1 inch in depth by loosening the surface and removing or adding material as required. Compact the corrected area and surrounding surface by rolling to proper grade and slope.

(d) Removal of Existing Subbase. Remove unsuitable subbase material, as directed. Replace as specified in Section 350.3.

(e) Final Finish for Pavements Not Being Overlaid. Finish and texture the surface of the patch to match the existing pavement cross section.

(f) Sealing. Seal all longitudinal and transverse joints constructed as part of this work, as specified in Section 501.3(n).

Seal all saw-cuts extending beyond the patch limits.

519.4 MEASUREMENT AND PAYMENT—

(a) Patching Joint. Linear Foot

(b) Pavement Joint. Linear Foot

(c) Longitudinal Concrete Joint Repair. Square Yard

When longitudinal joint cleaning and sealing is part of the contract, the sealing of longitudinal joints is incidental to that item, not to longitudinal concrete joint repair.

The unit price includes removal of the existing pavement and all repairs or corrections as specified in Section 519.3 that are needed as a result of patching operations.

(d) Subbase Material. Cubic Yard or Ton

The unit price includes excavation.

SECTION 520—PERVIOUS CONCRETE PAVEMENT SYSTEM

520.1 DESCRIPTION—This work is the construction of plant-mixed pervious concrete pavement on a prepared surface designed to allow the infiltration of storm water into the subsoil. The pervious concrete surface layer is a horizontal plane that is permeable to water and air. The second layer of the storm water system is an open graded, angular stone layer used for temporary storm water detention.

520.2 MATERIAL—

(a) Cement. Section 701

(b) Pozzolans. Section 724

(c) Aggregate. Section 703

1. Coarse Aggregate.

1.a For use in Concrete. AASHTO No. 8, Type A.

1.b For use in Detention Basin. Either AASHTO No. 3 as the primary detention coarse aggregate topped with AASHTO No. 57 as a choker and leveling coarse; or AASHTO No. 57 only, as designed and specified.

2. Fine Aggregate.

2.a For use in Concrete. Fine Aggregate, Type A.

2.b For use in Detention Basin. Fine Aggregate, Type A or Type B.

(d) Water. Section 720.1

(e) Concrete Admixtures. Section 711.3 with the following addition:

(i) Hydration Stabilizing Admixture. ASTM C494, Type D.

(f) Geotextile, Class 4, Type A. Section 735

(g) Concrete Mix Design. Design the pervious concrete mixture proportions according to ASTM C 1688. Design the mixture to have a plastic unit weight between 115 pounds to 130 pounds and water cement ratio of 0.36 ±0.04. Adjust the mix water, if necessary, during production if the mixture has a dull or dry appearance to produce a wet metallic sheen without causing the paste to flow from the aggregate. Additional mix water may be added at the project, if necessary, to achieve this condition provided the plastic unit weight is within 5 pounds per cubic foot of the target design unit weight.

If reactive aggregates are used in the mixture, remediate for Alkali-Silica Reaction as specified in Section 704.1(g).

Furnish the proposed mix design identifying all mixture components and weights or dosage amounts to the DME/DMM at least 3 weeks before the scheduled start of producing the mixture for the project. Include the target in-situ void content and 28 day unit weight values on the mix design form.

(h) Concrete Curing Material. Section 711.1(a) or 711.1(b)

(i) QC Plan. Prepare and submit a QC Plan, as specified in Section 106. Provide the QC plan to the Representative at the start of the project. Do not begin production until receiving approval of the QC Plan.

1. Cold Weather. Include provisions to protect pervious concrete from freezing throughout the 7 day curing period according to ACI 306.1.

2. Hot Weather. Include detailed plans indicating the amount of hydration stabilizing admixture to be added in 5F increments to provide time for placing and finishing the pervious concrete before initial set.

520.3 CONSTRUCTION—

(a) Test Sections. Produce two test sections using the approved mix design and placement and finishing operations to be used in production and construct at the project site on a prepared subgrade and base using the material and construction requirements used in production. Each section must have an area of at least 225 square feet. Perform infiltration on both test sections according to ASTM C 1701. The average of both infiltration values must exceed 200 inches per hour.

Submit the following information for each test section to the Representative:

- Test Section Thickness - Section 501.3(s). Thickness cannot be more than 1/4-inch less than the design thickness.
- Void Content - ASTM C 1754. Void structure of 20% ± 5%.
- Hardened Density - ASTM C 1754 (The average hardened densities of the two test sections will be the hardened density used as the basis of acceptance for the remainder of the project with a tolerance of ± 5 pounds per cubic foot and not to exceed 130 pounds per cubic foot.

Test sections may, with approval, be incorporated into the project.

(b) Equipment. Provide equipment to strike off pervious concrete that provides an acceptable final finish using either a form-riding paving machine, roller screed, vibrating screed, or an asphalt paver. The final surface finish may be applied with steel finishing equipment or a motorized pan finisher provided the surface voids are not sealed.

1. Rollers. Use smooth steel-wheeled rollers in the static mode seating with one to four passes. Do not use pneumatic tire rollers.

(c) Subgrade Preparation. Excavate subgrade to undisturbed soil without compaction allowing the subgrade to be left as permeable as possible. If erosion of subgrade has caused accumulation of fine materials or surface ponding or both, remove the accumulated material using light equipment and scarify the underlying soil to a minimum depth of 6 inches using a spring tooth rake or equivalent and a light tractor. Avoid driving concrete mixers or other equipment through the installation area. Correct and repair damaged or compacted areas to the satisfaction of the Representative. Notify the Representative upon completion of subgrade work for final inspection and acceptance before proceeding with basin and choker course installation.

(d) Detention Basin. Prevent sediment from washing into beds during site development. Cover the bottom of the detention base with a minimum of 2 inches of fine aggregate to prevent soils from migrating into the storm water storage area. Wrap basin sides with a non-woven geotextile fabric. Install detention basin coarse aggregate in 8 inch maximum lifts. Compact the course as specified in Section 360.3. Install aggregates to grades as indicated. Place the specified depth(s) of coarse aggregate on top of the fine aggregate and roll as specified in Section 520.3(b)1. Remove temporary sediment control materials when the site is fully stabilized.

(e) Setting Formwork. Set, align, and brace forms so the cured concrete meets the tolerances and specified elevations. Apply form-release agent to all formed faces in contact with the concrete immediately before placement. Undamaged vertical faces of previously placed concrete may be used for subsequent placement.

(f) Mixing and Hauling. Operate truck mixers at the speed designated by the manufacturer for a minimum of 70 to 100 revolutions of the drum. Unless otherwise approved, place pervious concrete within 90 minutes after final introduction of any mix water.

(g) Placing and Finishing Fixed Form Pavement. Wet the subgrade or subbase with water before concrete placement so the material is saturated but without standing water. Deposit the concrete either directly from the transporting equipment or by conveyor onto the subgrade. Do not place pervious concrete on frozen material. Deposit concrete between forms to an approximate uniform height. Spread the concrete using mechanized equipment or hand tools without segregation.

Where trucks or buses may access the concrete, utilize a paver equipped with compaction tampers.

For other areas, a roller screed or vibrating screed may be used.

(h) Final Surface Finish. Final finish for paver placed concrete is to be achieved with a maximum 2-ton roller to eliminate seams. Do not allow rollers to bridge previously placed and cured concrete for 7 days or before the Representative is satisfied the concrete has achieved sufficient strength to prevent damage.

Steel troweling may be used provided the surface voids remain open and the average density requirement and permeability values are met.

(i) Edging. Edge exterior formed surfaces to a radius of not less than 1/4–inch.

(j) Curing. Begin curing within 20 minutes of concrete discharge. Completely cover the pavement surface with polyethylene sheeting. Thoroughly secure the curing sheet at all exterior edges and interior laps to prevent removal from wind. Maintain curing for a minimum of 7 days.

(k) Construction Joints. Construct joints in the locations specified by either tooling into the pervious concrete immediately upon final finishing to approximately 1/4 slab thickness using a pervious concrete cross rolling tool or saw cut after the concrete has achieved sufficient compressive strength to prevent aggregate from being dislodged. If joints are saw cut, remove fines produced from the operation by vacuum to avoid clogging. If curing is interrupted, control the operation so the polyethylene sheeting and curing is reinstituted within 60 minutes of the initial removal.

(l) Weather. Do not place pervious concrete if air temperatures are projected to fall below 40F or lower any time during the 24-hour period following concrete placement or if rain is forecasted to occur before final finishing and curing. In the event a rainfall event occurs, immediately stop production, form a construction joint, and apply the polyethylene sheeting. With approval, a construction joint may be saw cut before resuming placement. Pervious concrete subjected to rainfall will be evaluated after curing for loss of mortar at the surface and repaired or removed and replaced at the discretion of the Representative.

(m) Testing and Acceptance.

1. Plastic Concrete. Perform unit weight testing on every truck according to ASTM C 1688.

2. In Place Hardened Concrete. Identify and remove three 4-inch diameter cores for each 5,000 square feet according to PTM No. 1. Transport the cores to the LTS for testing, indicating the required concrete thickness, density, and void content from the test sections.

2.a Project core lengths tested by LTS will be considered acceptable if meeting the following:

- Average core length: -3/8-inch + 3/4-inch
- Length of any individual -1/2-inch

2.b Oven dry density. ASTM C 1754.

2.c Core void content. Acceptance will be ± 5% of the average voids in the cores of the accepted test section.

3. Infiltration Testing. Perform infiltration on three areas selected according to PTM No. 1 for every 10,000 square feet of pervious concrete placed according to ASTM C 1701. Remove and replace pervious concrete not meeting or exceeding a minimum average infiltration rate of 200 inches per hour. Document the average infiltration value from testing for use in future maintenance activities.

(n) Opening to Traffic. Do not open the pavement to vehicular traffic until the concrete has cured for at least 7 days during which the ambient temperature has exceeded 55F during any time of the day.

520.4 MEASUREMENT AND PAYMENT—Square Foot

SECTION 521—TRANSVERSE JOINT CLEANING AND SEALING

521.1 DESCRIPTION—This work is the cleaning and sealing existing transverse joints in cement concrete pavements and shoulders.

521.2 MATERIAL—

- Joint Sealing Material—Section 705.4(b) or (c)
- Joint Backing Material—Section 705.9

521.3 CONSTRUCTION—Completely remove all existing joint sealing material, neoprene compression seals, asphalt material, and other foreign material in a manner that provides a clean, newly exposed concrete surface. Clean to a minimum depth of 1 1/2 inches.

Immediately before placing backer rod, clean the joint faces. For airblasting, use a compressed air stream of at least 100 pounds per square inch measured at the source. Use air free of oil, moisture, and other contaminants.

Immediately before sealing the joint, place the backer rod to a depth where the top of the rod is one to two times the width of the joint opening plus 1/4 inch below the pavement surface to allow a recessed sealant depth to width ratio of 1:1 to 2:1. Use a backer rod 25 to 35 % larger in diameter than the joint opening.

Seal joint as specified in Section 501.3(n) and as follows:

- Do not place sealant unless joint is clean and dry.
- Do not place joint sealant unless the ambient air and the pavement temperatures are 40F or greater.
- Fill the joint reservoir to a level of 1/8 inch to 1/4 inch below the pavement surface.

521.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 523—ULTRA-THIN PORTLAND CEMENT CONCRETE OVERLAY

523.1 DESCRIPTION—This work is the construction of an accelerated strength ultra-thin Portland cement concrete overlay as indicated.

523.2 MATERIAL—

(a) Accelerated Strength Portland Cement Concrete. Section 704.1(b), modified as follows:

- Delete Table A.

- Use concrete reinforced with polypropylene fibers according to ASTM C 1116, Type III 4.13 and ASTM C 1116 (Ref: ASTM C 1018) Performance Level 1 outlined in Section 21, Note 17 and Residual Strength. Use 100% virgin polypropylene (PE) manufactured to an optimum gradation for use as concrete reinforcement.

(b) Design Basis. Section 704.1(c), modified as follows:

- Revise the first sentence of the first paragraph as follows:
  Make trial mixtures and computations for accelerated strength Portland cement concrete including the molding and curing of test specimens.

- Revise the first sentence of the second paragraph and add a second sentence as follows:
  Design a concrete mix for having a 28-day minimum compressive strength of 3,750 pounds per square inch for acceptance when tested according to PTM 604 and a 24-hour minimum compressive strength of 3,000 pounds per square inch. Measure concrete consistency in inches of slump as specified in Section 523.3(v).

- Add the following sentence to the third paragraph:
  If the overlay depth is less than 3 inches, use No. 8 coarse aggregate instead of No. 57 coarse aggregate.

- Revise the fifth paragraph as follows:
  Use a cement factor of 650 pounds minimum per cubic yard and a water-cement ratio of 0.42 maximum.

- Revise the sixth paragraph as follows:
  The Contractor may substitute flyash for Portland cement at a maximum rate of 10% by weight for cement. Include flyash with cement when determining the water-cement ratio. Add PE fiber at the rate of 3.0 pounds minimum per cubic yard.

1. Air Content. Section 704.1(c)3. Revise the first sentence as follows:
Design cement concrete with an air content of 7.0% in the plastic state.

2. Class of Cement Concrete. Section 704.1(c)2. Revise the heading and first sentence as follows:
Accelerated Strength Portland Cement Concrete. The concrete design submitted for review is required to comply with the specified requirements, supported by air content and compressive strength test data according to ACI 211. Delete the last paragraph.

(c) Concrete Admixtures. Section 711.3 and as follows:

- If accelerating admixtures are used, provide accelerating admixtures that do not contain chlorides.

(d) Concrete Curing Material. Section 711.1 and Section 711.2(a), Type 2

523.3 CONSTRUCTION—Section 501.3, modified as follows:

(a) General. Section 501.3(a), with the following additions:

Prepare a QC Plan, as specified in Section 106, detailing the timing and sequence of the work, including timing of mixing, hauling, placing, curing, monitoring of concrete temperature, joint sawing, and sampling and testing for compressive strength for opening to traffic. Indicate variations on timing in response to anticipated variations in the air temperature for the time of placement. Submit the QC Plan for review before the start of the project. Do not start work until the QC Plan has been approved.

(e) Preparation and Protection of Base Course. Replace Section 501.3(e) with the following:

(e) Asphalt Surface Preparation. Completely clean milled pavement surface. Limit cleaning to area that will be overlaid the same day. Protect the cleaned and prepared surface from oil or grease drippings from compressors, concrete trucks, spreaders, pavers, etc. by using protective covers. Remove all deleterious materials before overlaying. Sprinkle to thoroughly dampen the asphalt surface immediately before placement of cement concrete without causing pooled or puddle water.

(h) Handling and Placing Reinforcement. Delete Section 501.3(h).

(i) Transverse Joint. Replace Section 501.3(i) with the following:

(i) Joints. Saw joints as soon as concrete has hardened sufficiently to permit sawing without excessive raveling resulting from the sawing operation. Space joints equidistant longitudinally and transversely. Determine spacing using formula of 1 foot of joint spacing per 1-inch of depth of cement concrete overlay. Saw joints with a green cut saw to a depth of D/3 and a minimum width of 1/8 inch. Do not seal joints. Clean joints of all deleterious material after sawing.

Saw soon enough after placement to prevent random cracking. If necessary, conduct sawing operations continuously, both day and night, regardless of weather conditions. Omit sawing if a crack occurs at or within 1.5 feet of a joint location, before the time of the sawing or during sawing. If a crack occurs before acceptance of pavement, remove and replace one full panel width and length.

Other than white curing compound, remove curing materials from overlay, at the location where a joint is to be cut. Remove only sufficient covering to provide space necessary for sawing joints. As soon as the joint is made, replace the covering. The maximum time period allowed for pavement curing covers to be removed is 1/2 hour. If white membrane curing compound is used, cure the joint area, as specified in the first six paragraphs in Section 501.3(l)1.c.

Do not displace coarse aggregate from the joint location using a vibrating T-bar, or using a filler strip at the joint.

(j) Longitudinal Joints. Delete Section 501.3(j).

(l) Curing Concrete. Section 501.3(l), revised as follows:

1. Normal Curing. Revise the first sentence as follows:

Allow curing materials to remain in place and maintain as specified, for a period of 24 hours or until the concrete has reached 3,000 pounds per square inch compressive strength.

Add the following paragraphs:

Provide adequate insulating blankets to prevent rapid heat loss if the air temperature is 65F or less. Remove any insulation when a minimum compressive strength of 3,000 pounds per square inch has been attained. Remove insulation at such a rate that the temperature change in the concrete does not exceed 40F within any 1-hour period. If a temperature change in the concrete in excess of 40F occurs within any 1-hour period, whether insulation is used or not, consider the work defective.

The application or removal of insulation covers may be controlled by the use of maturity concepts, provided the minimum degree-hours of curing has been achieved at the top of the slab.

(n) Sealing Joints and Cracks. Delete Section 501.3(n).

(r) Opening to Traffic. Replace Section 501.3(q) with the following:

(r) Opening to Traffic. Sample plastic concrete, for compressive strength testing (PTM No. 604) before opening to traffic, according to the approved QC Plan. The Representative will select sample locations according to PTM No. 1. The Representative will determine when pavement will be opened to traffic, but no sooner than 24 hours or when the concrete attains the minimum required compressive strength. If concrete pavement has not attained a minimum 24-hour compressive strength of 3,000 pounds per square inch at the time of opening to traffic, consider the work defective.

(t) Tests for Depth. Section 501.3(s), with the following exception:

- For projects at intersections and less than 3,000 square yards, drill two cores.

(u) Defective Work. Section 501.3(t), except revise the first paragraph as follows:

Unless otherwise directed in writing by the District Executive, remove and replace, at no expense to the Department, pavement that is; defective in surface tolerance, as specified in Section 501.3(o); defective in compressive strength as specified in Section 523.2(b); defective in depth, as specified in Section 523.3(t); defective in air content, as specified in Section 523.2(b)1; where the temperature change in concrete in excess of 40F occurs within a 1-hour period; or showing surface defects resulting from the effects of rain, hail, improper final finish, excessive raveling of joints during sawing, or honeycombing which, in the Representative's opinion, cannot be repaired.

(v) Test Slab. Construct an off-site slab 2 weeks before placement of accelerated concrete pavement on the project as follows:

Construct the test slab one lane width wide and 12 feet long. Use the concrete mix design specified in Section 523.2(a) and (b) in the test slab. Establish a target value for the consistency during placement of the test slab. The slump for production shall be the consistency of the test slab ±1 inch. Submit any adjustments for review.

If maturity concept is being used, correlate degree-hours of cure to compressive strength breaks at 8, 12, 16, and 24 hours following placement of the test slab. Establish the minimum number of degree-hours of cure by correlation with compressive strength tests. Verify maturity curves with first 2 days production work, regardless of quantity placed, by recording compressive strength breaks at 8, 12, 16, and 24 hours following placement.

Appropriately time joint saw cut operations as they are proposed for the actual work. The results of this test slab will be used to adjust the timing of joint sawing during construction of the actual project.

Cure the test slab as proposed for the actual work and demonstrate by compressive cylinder breaks, and maturity data if maturity concepts are used, that the mix conforms to the opening to traffic requirement within 24 hours of placement.

523.4 MEASUREMENT AND PAYMENT—

(a) Surface Preparation. Square Yard

(b) Ultra-thin Portland Cement Concrete Overlay. Square Yard

This unit price includes saw cutting of transverse and longitudinal joints and construction of test slab.

(c) Concrete Pavement Cores. Each

The price includes the measuring apparatus, which remains the Contractor's property upon completion of the project. The Department will not pay for additional cores drilled if the depth is deficient by more than 1/4 inch.

SECTION 525—CONCRETE PAVEMENT PARTIAL-DEPTH REPAIR

525.1 DESCRIPTION—This work is the construction of a partial-depth repair of an existing concrete pavement. This type of repair is suitable for use on transverse or longitudinal joints, cracks, and interior slab spalls if the depth of the repair is no greater than half the slab thickness.

Areas requiring repair depths greater than half the slab thickness will be repaired with full-depth concrete pavement patches or corner repairs, as specified in Section 516.

Concrete pavement partial-depth repair is classified by two types as follows:

(a) Concrete Pavement Partial-Depth Repair, Type 1. Spot repairs of transverse or longitudinal joints, cracks, and interior slab surface spalling between 15 inches and 6 feet in length.

(b) Concrete Pavement Partial-Depth Repair, Type 2. Extended length repairs of transverse or longitudinal joints, cracks, and interior slab surface spalling in lengths greater than 6 feet.

525.2 MATERIAL—

(a) Class AA Cement Concrete, Modified. Class AA Cement Concrete as specified in Section 704, except as follows:

- Coarse Aggregate, Type A, No. 8—Section 703.2
- Maximum Water Cement Ratio (lbs/lbs) 0.42

(b) Class AA Cement Concrete, Accelerated. Class AA Cement Concrete as specified in Section 704, except as follows:

- Coarse Aggregate, Type A, No. 8—Section 703.2
- Maximum Water Cement Ratio (lbs/lbs) 0.42

Submit mix design having a minimum target value of 1,500 pounds per square inch compressive strength at 7 hours, when tested according to PTM No. 604.

(c) Rapid-Set Concrete Patching Material. From a manufacturer listed in Bulletin 15, meeting the requirements of ASTM C928.

The material must be tested and meet the minimum test results for the ASTM and AASHTO test methods outlined below:

- The material must have a minimum durability factor of 80% at 300 cycles when tested according to ASTM C666 (procedure B) with and without aggregate extenders.
- A minimum initial set time of 15 minutes at 75 F ± 2 F as tested according to AASHTO T 131.

When the depth of the repair is greater than 2 inches, use aggregate extenders according to the manufacturer's recommendations. Use only aggregate extenders included with the prepackaged rapid-set concrete patching material. If aggregate extenders are not included as part of the prepackaged rapid-set concrete patching material, use AASHTO No. 8 coarse aggregate from a Bulletin 14 approved supplier with an expansion index less than 0.10, and only if allowed in writing by the material manufacturer. Use within the shelf life and temperature limitations set by the manufacturer.

(d) Grout. Use the following initial weight proportions:

Cement	Water	Fine Aggregate
2	1	1

Must be placed within 60 minutes of mix completion.

(e) Epoxy Bonding Compound. ASTM C881, Type II or Type V, Grade 2, as specified in Section 706.1 and as follows:

Provide a copy of the manufacturer's written installation instructions to the Representative. Use epoxy bonding compound within the shelf life established by the manufacturer. Apply the epoxy bonding compound within the application setting times (working or pot life) and temperature limitations established by the manufacturer.

(f) Concrete Curing Materials. Sections 711.1 and 711.2

(g) Preformed Cellular Polystyrene. ASTM C578

(h) Expansion Joint Filler. Section 705.1

(i) Joint Sealing Material. Section 705.4(a), (b) or (d)

(j) Tape Bond Breaker. An acceptable self-adhesive tape the width of the sealant reservoir.

525.3 CONSTRUCTION—

(a) General. Prepare and submit for approval a QC Plan specifically for concrete pavement partial-depth repair as specified in Section 106.03(a)2. Detail appropriate action points for all phases of construction including: removing unsound concrete, concrete mixing and curing, joint sawing and sealing, and sampling and testing for opening to traffic.

(b) Repair Area Preparation. In the presence of the Representative, sound the concrete to determine the extent of the concrete delamination using a steel bar, drag chains, or a hammer. Lay out rectangular repair limits to extend approximately 3 inches beyond the edges of the delaminated area. All repair areas will be rectangular, with minimum dimensions of 15 inches in length by 10 inches in width by 2 inches in depth. If partial-depth repair areas are less than 24 inches apart, combine them into one partial-depth repair area.

For areas where delamination extends through a pavement joint, the area should be repaired by maintaining the joint with two separate minimum repair areas unless a detailed procedure for reestablishing the joint and protecting the adjacent joint and crack from mortar intrusion is included in the QC Plan.

(c) Concrete Removal. Remove all unsound concrete in the designated repair area to a minimum depth of 2 inches and a maximum depth of half of the slab thickness.

For Type 1 partial-depth repairs only, saw cut the perimeter of the repair area to a minimum depth of 2 inches. Remove the existing concrete within the repair area to a minimum depth of 2 inches. Use a chipping hammer weighing not more than 35 pounds. Operate the chipping hammer at a 30 – 60 degree angle to remove damaged concrete without causing additional damage and to create a rough surface for proper bonding.

For Type 1 and Type 2 partial-depth repairs when using the milling machine, mill along the joint or crack. The head of the milling machine must be a “V” head, flat head, or a rounded head.

When using a milling machine, square the corners of the repair area by making a saw cut to a minimum depth of two inches. Remove the existing concrete in the corner of the repair area using a chipping hammer weighing not more than 35 pounds. Operate the chipping hammer at a 30 – 60 degree angle to remove the concrete in the corner of the repair area.

Cut and remove any reinforcement in jointed reinforced concrete pavement exposed after the removal of delaminated concrete. Do not cut or remove the reinforcement in continuously reinforced concrete pavement.

Do not disturb concrete outside the limits of the repair area. If the partial-depth repair area becomes a full-depth concrete pavement patch due to excessive, unnecessary removal of concrete or damage to the dowel bars during the concrete removal process, construct a full-depth concrete pavement patch as specified in Section 516 at no additional cost to the Department.

If dowel bars in the transverse joint are exposed and show little sign of corrosion or other damage, apply a bond breaking material to all exposed surfaces of these bars. If the Representative determines the dowel bars are unacceptable due to misalignment or extensive deterioration, construct a full-depth concrete pavement patch or corner repair as specified in Section 516. Resound the repair area in the presence of the Representative to ensure all delaminated concrete has been removed. Remove additional delaminated concrete within the repair area, but do not

exceed half the slab thickness. Produce a rough surface for material bond on all edges created by sawing.

Deploy the final cleaning method within 30 minutes before placing the partial-depth repair material. If using a compressed air stream, ensure it is free of oil, moisture, and other contaminants and has a minimum pressure of 100 pounds per square inch measured at the source. Re-clean areas not repaired within 30 minutes of the final cleaning.

(d) Mixing Equipment. Furnish mixing equipment for volumetrically mixed concrete as specified in Section 704.3 or prepare hand-batched mixtures using a power-driven revolving and tilting drum mixer or suitable revolving paddle mixer capable of thoroughly mixing the repair material. If using drum and paddle mixers, repair material batch sizes must be selected to fall within the minimum and maximum recommended batch size for the mixer.

(e) Transverse and Longitudinal Joints. If the partial-depth repair abuts an existing transverse joint, install 1/2" expansion joint material in the joint. If the partial-depth repair abuts an existing longitudinal joint, install 1/4" preformed cellular polystyrene in the joint. The expansion joint material and preformed cellular polystyrene should extend at least 1/2 inch below the bottom of the repair whenever possible. If the repair material can be sawed without damage, re-establish the joint by sawing through the full depth of the repair. Seal longitudinal joints as specified in Section 512.3 and seal transverse joints as specified in Section 521.3.

(f) Partial-Depth Repair.

1. Class AA Cement Concrete, Modified. Immediately after final cleaning, apply grout or epoxy bonding compound to all exposed surfaces within the repair area. Mechanically mix the grout and apply by brushing or scrubbing in a thin layer onto the concrete surface. Prepare and apply the epoxy bonding compound according to the manufacturer's recommendations. Do not allow the grout or epoxy bonding compound to run or puddle in low spots.

Place concrete in the repair area before grout begins to dry or while epoxy bonding compound is still tacky. Remove dried grout or hardened epoxy bonding compound. Re-clean the repair area as specified in Section 525.3(c) and recoat the repair area with fresh grout or epoxy bonding compound.

Place concrete if the ambient air and surface temperatures are 40 F and rising. Discontinue placement of the mixture if the ambient air and surface temperatures fall below 40 F. Protect repairs from freezing for a minimum of 24 hours.

Consolidate the concrete using a spud vibrator or other acceptable method. Work concrete into saw cuts extending beyond the corners of the repair area. Strike-off and shape concrete to match the surrounding pavement, including wheel ruts. Use expansion joint material and preformed cellular polystyrene temporary forms that extend to the pavement surface to keep the concrete out of existing joints.

2. Class AA Cement Concrete, Accelerated. Section 525.3(f)1

3. Rapid-Set Concrete Patching Material. Place the mixed material only within the manufacturer's recommended installation temperature range and when the ambient air and surface temperatures are 40 F or greater. Discontinue placement of the mixture when the ambient air and surface temperatures are outside of the manufacturer's recommended installation range or lower than 40 F. Protect repairs from freezing for a minimum of 24 hours.

Use vibration or tamping to consolidate the rapid-set concrete patching material. Work concrete into saw cuts extending beyond the corners of the repair area. Strike-off and shape concrete to match the surrounding pavement, including wheel ruts. Use expansion joint material and preformed cellular polystyrene temporary forms that extend to the pavement surface to keep the concrete out of existing joints.

The return-to-service time must be considered when placing the last partial-depth repair before opening to traffic.

(g) Curing.

1. Class AA Cement Concrete, Modified. Use white membrane forming curing compound as specified in Section 516.3(j), except use an atomizing type spray tank with an adjustable nozzle and agitate the solution before each application.

2. Class AA Cement Concrete, Accelerated. Apply white membrane forming curing compound as specified in Section 516.3(j). Cure test cylinders under the same conditions as the partial-depth repair. Provide insulation or heating of repair areas if the ambient air temperature drops below 80 F during the curing operation. Control the curing temperature and monitor at least hourly to ensure the repair area does not experience a curing temperature change in excess of 40 F within any 1-hour period during the curing operation. If a change in curing temperature in excess of 40

F occurs in the concrete pavement patch within any 1-hour period, the work will be considered defective.

3. Rapid-Set Concrete Patching Material. Cure according to the manufacturer's recommendations.

(h) Joint Sealing. Section 525.3(e)

(i) Resounding Repairs. Resound all completed repair areas in the presence of the Representative. Replace any completed repair areas that are delaminated, at no cost to the Department.

(j) Opening to Traffic.

1. Class AA Cement Concrete, Modified. Section 501.3(q), except use repair thickness and length according to Table D.

2. Class AA Cement Concrete, Accelerated. Section 501.3(q).

3. Rapid-Set Concrete Patching Material. Section 516.3(q).

(k) Defective Work. Section 501.3(t), except remove and replace cracked, spalled or delaminated repairs.

525.4 MEASUREMENT AND PAYMENT—

(a) Concrete Pavement Partial-Depth Repair. Square Foot
For the type indicated.
The unit price includes removal of existing pavement and repairs or corrections as specified in Section 525.3 that are needed as a result of partial-depth repair operations.

(b) Joint Sealing. Linear Foot
If transverse or longitudinal joint cleaning and sealing are part of the contract, sealing of joints at partial-depth repair areas are incidental to that item and will not be payable under concrete pavement partial-depth repair.

SECTION 526—RUBBLIZING OF CONCRETE PAVEMENTS

526.1 DESCRIPTION—This work is rubblizing and seating of existing concrete pavements before the placement of a pavement overlay.

Rubblizing is classified into two types as follows:

(a) Type 1. Rubblizing pavement into pieces having a maximum horizontal dimension of 12 inches.

(b) Type 2. Rubblizing pavement into pieces having a maximum horizontal dimension of 8 inches and with at least 50% of the pieces per square yard having a maximum horizontal dimension of 4 inches.

526.2 MATERIAL—

(a) Coarse Aggregate, Type A or Type B, No. 1. Section 703.2

(b) Subbase, No. 2A. Section 350.2

526.3 CONSTRUCTION—

(a) Equipment. Submit a pavement rubblizing plan and list of proposed equipment for Department approval before the start of construction. If, during rubblizing operations results are not being obtained, cease all rubblizing operations and submit an alternate plan and list of equipment capable of obtaining the specified results to the Representative. Resume rubblizing operations upon acceptance of the alternate plan.

(b) Existing Asphalt Surfaces. Remove any existing asphalt paving materials that are overlaying the concrete pavement, as specified in Section 490.3, before beginning rubblizing operations. Do not remove any existing full depth asphalt patches.

(c) Rubblizing. Use mechanical or sonic vibratory equipment capable of providing concrete pieces of the specified dimensions, throughout the full depth of the pavement, on a regular and continuous basis. Provide equipment suitable to the Representative.

For Type 2 rubblizing, ensure that pieces are free of bond with reinforcement to allow adequate seating.

Excavate two, 3-foot by 12-foot, full-depth sections of rubblized pavement, within the first 1/2 mile of rubblizing operations, to ensure that the pavement is being rubblized to the specific dimensions. Excavate additional areas, as directed, to ensure that the specified dimensions are being maintained. Repeat the initial two-section, full-depth pavement removal testing procedure whenever the equipment, rubblizing pattern, or breaking force is changed.

Use coarse aggregate to backfill all excavated areas. Place backfill in maximum 6-inch lifts and compact by rolling until nonmovement is achieved. Do not allow any shoving or wave motion under the roller.

Cut off and remove any reinforcement steel exposed at the surface of the rubblized pavement. If the transverse joints of the original pavement contained steel plates, remove any steel plates that are exposed.

Exercise care during rubblizing operations to prevent shattering pavement edges adjacent to asphalt base repairs.

Exercise extreme care during rubblizing operations to protect and prevent damage to underground utilities, drainage facilities, bridge approach slabs, and bridge decks. Repair any damage that occurs to these areas, at no cost to the Department.

(d) Seating. Following the rubblizing operation, use a 50-ton, pneumatic-tired roller, as specified in Section 108.05(c)3.e, to seat the rubblized pavement. Establish a rolling pattern that ensures all areas of rubblized pavement surface are directly contacted by the roller in no more than four passes. Do not use vibratory rollers.

Final seating of the rubblized pavement is satisfactory when vertical deflection under the roller is less than 3/4 inch. Undercut areas where this condition is not achieved. Remove all unsuitable or unstable material. Backfill to existing subgrade with suitable material, to the top of existing subbase with subbase material, and to the top of the rubblized pavement with coarse aggregate. Compact backfill as previously specified in Section 526.3(c).

Fifty-ton rollers may only cross bridges as approved by the Bridge Engineer. Repair any damage that occurs to bridge approach slabs and bridge decks during the seating operation, at no cost to the Department.

(e) Final Surface. After final seating, sweep and clean the surface of the rubblized and seated pavement to remove all loose material.

Prohibit traffic on the roadway after the pavement has been rubblized and seated.

Repair all rubblized and seated pavement areas disturbed by construction traffic, at no cost to the Department.

Complete all operations before construction of the leveling course. If an asphalt leveling course is indicated, apply a prime coat to the rubblized and seated surface, as specified in Section 461, before placing the leveling course.

Complete placement of the overlay within 60 calendar days after rubblizing and seating. Do not leave the rubblized and seated pavement exposed to freezing conditions.

526.4 MEASUREMENT AND PAYMENT—

(a) Rubblize and Seat Concrete Pavement. Square Yard

(b) Class 1A Excavation. Cubic Yard
(c) Class 1B Excavation. Cubic Yard
Measured to existing subgrade level.

(d) Coarse Aggregate. Cubic Yard
For the size indicated.

(e) Removal of Existing Asphalt Surface Course. Section 490.4

SECTION 527 - DOWEL RETROFIT

527.1 DESCRIPTION - This work is the installation of epoxy-coated, smooth dowel bars into existing concrete pavement across cracks or transverse joints without dowels.

527.2 MATERIAL -

(a) Load-Transfer Units. Section 705.3(a), (b) and (g)

(b) Caulking Compound. Section 705.8(b)

(c) Preformed Cellular Polystyrene. ASTM C578

(d) Rapid-Set Concrete Patching Material. Section 525.2(c). Use within the shelf life and temperature limitations set by the manufacturer.

(e) Concrete Curing Materials. Section 711.1 and 711.2(b)

(f) Intermediate Curing Compound. Section 711.2(d)

(g) Concrete Admixtures. Section 711.3
If accelerating admixtures are used, provide only accelerating admixtures that contain no chlorides.

(h) Joint Sealing Material. Section 705.4(a), (b) and (c)

(i) Bond Breaker Lubricant. Provide a commercially available bond breaking lubricant with a flash point of not less than 149F, and recommended for contact with steel materials according to manufacturer's recommendations. Do not use graphite-based lubricants.

(j) Expansion Joint Filler. Section 705.1

527.3 CONSTRUCTION – As shown on Standard Drawings and as follows:

(a) Equipment. Provide a power driven, self propelled saw capable of making two parallel cuts per dowel bar slot. Do not use equipment that may cause pavement to spall or cause surface aggregates to fracture.

(b) Slot Preparation and Cleaning. Saw cut pavement to place center of dowel at mid-depth of pavement slab. If repair area spans different pavement thicknesses, e.g. mainline to ramp transitions, place at the mid-depth of the thinner thickness. Align saw cuts parallel to roadway centerline. Cut three dowel slots (six saw cuts) per wheel path and centered over the crack or transverse joint. Provide three dowel bar slots in each wheel path.

Use a jackhammer weighing not more than 30 pounds to remove concrete between saw cuts. If pavement damage occurs from a 30 pound jackhammer, remove the damaged pavement and use a 15 pound jackhammer. Clean and backfill the damaged pavement area as specified in Sections 525.3(c) and 525.3(d). Create a level surface at bottom of slot parallel to roadway surface.

(c) Clean Slots. Clean exposed surfaces of slots. Remove all loose and foreign material within 24 hours before concrete placement and remove all slurry to prevent debris from emerging once dried. Final cleaning must be completed within 30 minutes before concrete placement. Reclean areas not repaired within 30 minutes of final cleaning or if contamination occurs before concrete placement. When cleaning by air blasting, use a compressed air stream of at least 100 pounds per square inch measured at the source, free of oil, moisture, and other contaminates.

(d) Dowel Preparation and Placement.

1. **Prepare Dowels.** Cut 1/4 inch thick preformed cellular polystyrene material to the cross-section

dimensions of the slot at the joint. Cut an opening in the polystyrene joint material to allow the dowel to fit without stretching and without gaps. Place the material centered on the dowel to form a temporary joint. Apply bond-breaker lubricant to Type B coated dowel bars, unless a bond breaker lubricant has been applied in the shop. Stir the lubricant and apply by daubing, mopping, or with a gloved hand, to produce a thorough coating. Do not use brushes for lubricant application. Apply the lubricant, as specified, at least 1 hour before placing the concrete around the dowel assembly. Type A coated dowel bars do not require lubricant as specified in Section 501.3(i). Place 1 1/2 inch non-metallic expansion caps with 1/4 inch clearance from the end of the dowel to the bottom of the cap. For crack or joint widths greater than 1/4 inch, use expansion joint material in lieu of the preformed cellular polystyrene material with a thickness matching the crack or joint width.

2. Place Dowels. Provide plastic or non-metallic chairs with a minimum 1/2 inch clearance between dowel bar cap and all slot surfaces, including end, both sides and bottom. Place chairs on the bottom of the slot. Place coated dowel bars parallel to roadway centerline and pavement surface not to exceed the following limits

- Vertical tilt or horizontal skew (relative to the plane of the grade and the centerline of the constructed pavement): 0.25 inch maximum displacement of each end of the dowel relative to the midpoint of the dowel.
- Longitudinal translation (relative to the intended crack or transverse joint location, along the direction of travel): 1 inch maximum
- Horizontal translation (relative to the intended location, across the crack or joint): 1 inch

Place dowels to align the temporary joint material with the existing joint or crack. Seal the temporary joint material at the sides and bottom of transverse joint or crack with caulking compound to prevent concrete patching material from entering into existing joint or crack.

3. Epoxy Bonding Compound. Apply according to the manufacturer's recommendations.

4. Fill Slot. Fill slot with concrete patching material. Vibrate to thoroughly consolidate the material in the slot and around dowel bar. Do not allow the dowel bar to move from the specified position.

(e) Final Finish for Pavements not being Overlaid or Diamond Ground. Finish the surface of the slots to match the existing pavement surface profile, including any existing wheel ruts.

(f) Curing of Concrete. Section 516.3(j).

(g) Saw and Seal Joint. Saw and seal transverse contraction joint sealant reservoirs for entire lane width as required

(h) Opening to Traffic. Section 516.3(q).

(i) Defective Work. Remove and replace dowel retrofits that are considered defective, at no additional cost to the Department.

527.4 MEASUREMENT AND PAYMENT – Each

For the existing joint or crack preparation, patching, curing and sealing operations. Includes six dowel bars per joint or crack.

SECTION 528—CONCRETE PAVEMENT CROSS-STITCHING

528.1 DESCRIPTION —This work consists of cross-stitching longitudinal cracks and may include cross-stitching longitudinal joints in plain cement concrete pavement by placing epoxy coated deformed tie bars, at an angle, across the longitudinal joint or crack.

528.2 MATERIAL—

(a) Reinforcement. Section 705.2(a)

(b) Epoxy Bonding Compound. Type I, Grade 3 Class B or C, as specified in Section 706.1, from a supplier listed in Bulletin 15. Follow the manufacturer's recommended procedures. Provide the Representative with the material data sheets before the start of work.

(c) Joint Sealing Material. Section 705.4 (b) or (c)

528.3 CONSTRUCTION—

(a) General. Prepare a QC Plan as specified in Section 106.03 and submit it for review a minimum of 14 days before the start of work. Detail all of the construction procedures, equipment, and materials to be used. Demonstrate the cross-stitching operation to the Representative to receive final approval of operation procedures and an assessment of the capability of the equipment to be used. Perform the demonstration on a longitudinal crack or a longitudinal joint located within the project limits.

Do not perform work if either the ambient air temperature or the pavement surface temperature is below 40F. Do not move drifted slabs back into position against the adjacent slabs. Do not use cross-stitching on transverse joints or cracks.

Before cross-stitching longitudinal pavement joints make a full depth saw cut, in the existing longitudinal joint, along the entire length of the slab.

(b) Equipment. Use a hydraulic powered drill that minimizes damage to the concrete surface. Provide a drill rig to assure that the proper drill angle is maintained. The use of a gang mounted drill is allowed.

(c) Drill Holes. Drill holes no more than 3/8 inch larger in diameter than the tie bar on each side of the longitudinal joint or longitudinal crack at the required angle, offset distance, and spacing as shown on the Standard Drawing RC-26M. If spalling of the concrete pavement surface occurs, drill shallow vertical holes at each tie bar location. Drill angled holes to intersect the crack at approximately mid-depth of the pavement thickness. Do not allow the drilled hole to extend through the bottom of the slab. Thoroughly clean the drilled holes of all dust and debris. If using compressed air, use a stream measuring at least 100 pounds per square inch at the source, free of oil, moisture, and other contaminants.

When cross-stitching existing longitudinal joints, drill holes to the alignment shown on RC-26M. Change location of drill holes ±1 inch to avoid existing longitudinal tie bars.

(d) Installing Tie Bars. Assure the drilled holes are dry and clean. Inject the epoxy bonding compound into the hole using a caulking gun or other approved method, leaving adequate space for the tie bar. Rotate the tie bar three to five complete rotations while inserting the tie bar to purge air voids as completely as possible. Provide 1 inch coverage for the tie bar at the surface of the pavement. Trowel the epoxy bonding compound flush with the pavement surface.

(e) Sealing. Route the longitudinal crack or longitudinal joint to a width of 3/4 inch wide and a depth of 1 inch. Immediately after routing, flush the entire longitudinal crack or longitudinal joint with water. Immediately before placing the sealant, clean the longitudinal crack or longitudinal joint. Do not place joint sealing material until the faces are thoroughly clean and dry to the satisfaction of the Representative.

Do not place sealing material if either the ambient air temperature or the pavement surface temperature is below 40F. Fill the longitudinal crack or longitudinal joint to a level of 1/8 inch to 1/4 inch below the pavement surface. Do not let sealing material spread over the pavement surface.

(f) Opening to Traffic. Do not open to traffic until the anchoring material has fully cured in accordance with the manufacturer's recommendations.

(g) Defective Work. Remove and replace any pavement slab where drilled holes have extended through the bottom of the slab with a full depth pavement patch at no additional cost to the Department.

528.4 MEASUREMENT AND PAYMENT— Each

Measurement of cross-stitching will be made per tie bar, at each individual location. Drilling holes, epoxy bonding compound, tie bar installation, crack sealing and all other items of work will be incidental to the payment for cross stitching.

SECTION 530—LONG-LIFE CONCRETE PAVEMENT (LLCP)

530.1 DESCRIPTION—This work is the construction of Long-Life Concrete Pavements (LLCP). LLCP is concrete pavement that is made with high quality materials and processes and is intended to provide a longer service life than conventional concrete pavement.

530.2 MATERIAL—Section 501.2 with the following modifications:

Limit thin and elongated coarse aggregate retained on the 3/8-inch sieve to 20% or less with a ratio of 3:1 according to 2010 ASTM D4791, Method B.

All concrete mixtures are limited to a Maximum Cement Factor of 611 pounds per cubic yard and a Maximum Water/Cement Ratio of 0.42.

(a) High Early Strength Cement Concrete. Do not use High Early Strength Concrete in LLCP.

(b) Load-Transfer Units (LTU). Section 705.3(f) and as follows:

1. Dowel Bar Acceptance. For High Performance Dowel Bars not listed in Bulletin 15, provide completed passing test reports for testing done according to PTM No. 642 (not executive summaries), shop drawings, and LTU samples to the Representative for verification testing at least 45 days before beginning paving operations. Provide one LTU sample that accommodates a minimum of six dowel bars with bond breaker lubricant preapplied to the dowel bars. Do not begin concrete paving until the Representative approves the LTU documentation and verifies passing test results for the LTU.

For High Performance Dowel Bars listed in the Bulletin 15, provide one LTU sample that accommodates a minimum of three dowel bars with bond breaker lubricant preapplied to the dowel bars at least 45 days before beginning paving operations for verification testing. Only one type of dowel bar can be used for Long Life Concrete Paving on a project unless approved. Do not begin concrete paving until the Representative verifies passing test results.

2. Storage, Handling and Placement. Do not store dowel bars at the jobsite for more than 30 days unless approved by the Representative. Store as specified in Section 1002.3(b) to allow air circulation. If field storage is expected to exceed 30 days, cover bars with opaque polyethylene or other protective material. Store stainless steel dowel bars as specified in Section 1002.3(i)3.

Provide dowel bars having uniform appearance. Do not use dowel bars with visible corrosion deposits, uncoated spots, or acid, flux or black spots. Do not place or store dowel bars in contact with uncoated reinforcement bars or other uncoated steel or stainless steel.

After placement, inspect the dowel bars and replace dowel bars damaged during placement.

3. Certification. Section 106.03(b)3

(c) Concrete Curing Material. Sections 711.1 and 711.2(b)

530.3 CONSTRUCTION—Section 501.3 with the following modifications:

(a) General. Add the following to Section 501.3(a).

The “Slip-form” method of construction is the standard construction method. Fixed forms may be used for pavement gaps and nonuniform areas with the approval of the Representative.

Use plant mixed concrete except for areas approved by the Representative. Areas that truck mixed concrete would be appropriate for include shoulders, closure pours, and projects with less than 15,000 square yards of mainline concrete paving.

Monitor aggregate gradations during concrete production by performing sieve analysis using plant stockpiled aggregate before beginning daily production and when restocking bins, but no more than daily. From the results of

the sieve analysis generate the cumulative percent retained chart. Verify that the daily production plots within the limits defined by the cumulative percent retained chart in PTM No. 529.

If necessary, adjust aggregate proportions during production to maintain the combined percent retained gradation within limits in PTM No. 529. Adjustments to aggregate proportions that also require adjustments to cementitious material or water content will require the development of new mix designs, including trial concrete batches. The DME/DMM may allow combined gradations during production that are less than 5% outside of the required percent retained gradation in PTM No. 529. The DME/DMM will immediately report acceptance of production gradations outside of the limits in PTM No. 529 to CMD QA personnel in writing.

1. Field Operation QC Plan. Section 501.3(a)1. Add the following:

Include a concrete temperature control plan that outlines the actions that will be taken to control concrete temperatures if they exceed 80F at the point of placement.

Provide a written QC Plan for Department approval that specifies a method for keeping the LTU assemblies anchored to the foundation. The LTU Quality Control Plan includes the following minimum requirements:

- Proposed type, number, and installation locations of fasteners.
- LTU assembly anchoring plan.
- A method for measuring proper alignment of LTU as specified in Section 530.3(i).
- Action plan if the proposed method fails to adequately anchor the assemblies.

The QC Plan must require that the first truck in each lot be sampled for plastic air and state that trucks that do not meet the requirement of 7.0%, plus or minus 1.5%, will not be incorporated. Each truck after any failing plastic air test will be tested until three consecutive passing test results are obtained.

The QC plan must include the method proposed to be used to cure and protect joints during the curing period, to prevent moisture loss from concrete in and adjacent to joints during and following joint sawing.

Submit an organizational chart listing names and telephone numbers of individuals and alternates responsible for mix design, process control administration, and quality control. Post the organizational chart in the Contractor's on-site field office.

Assign a QC Supervisor to manage all testing and plant operations. The QC Supervisor must be on site at all times during LLCP placement or have a mobile device in their possession and must be able to arrive at the project or plant site within 1 hour.

(g) Slip-form Paving Method.

1. Equipment. Section 501.3(g)1 and the following.

Provide a slip-form paver with the following characteristics:

- Automatic controls to control line and grade.
- A positive interlock system to stop all vibration and tamping elements when forward motion of the machine stops.
- A mechanical device that accurately spaces and positions the required tie bar reinforcement that allows satisfactory mechanical or manual tie bar insertion, and a non-oscillating extrusion plate with an adjustable angle of entry.

Provide an electronic monitoring device meeting the following characteristics and requirements to display the operating frequency of each individual internal vibrator for concrete pavement placed by the slip-form method:

- Contains a readout display near the operator’s controls, visible to the operator and the Representative.
- Operates continuously as the paving machine operates.
- Displays all the vibrator frequencies with manual and automatic sequencing for each of the individual vibrators.
- Records the following at least every 25 feet of paving or at least every 5 minutes:

- Clock time
- Station location
- Paver track speed
- Operating frequency of individual vibrators

Do not operate equipment, other than sawing equipment or a lightweight profiler, on the new pavement slab as specified in Section 530.3(q). Do not operate equipment wheels or tracks within 4 inches of the slab edge.

(j) Longitudinal Joints. Section 501.3(j) and add the following:

When tie bars are mechanically inserted, verify location of tie bars every 500 feet in tangent sections and 100 feet through horizontal curves to confirm that ties bars are inserted no closer than 24 inches from the transverse joint.

(k) Final Strike-Off, Consolidation and Finishing. Section 501.3(k) revised as follows:

4. Final Finish. Add the following:
Finish the surface of all travel and passing lane pavements with a longitudinal texture as specified in Section 501.3(k)4.a. Finish all other pavement surfaces as specified in Section 501.3(k)4.a or Section 501.3(k)4.b.

(o) Surface Tolerance. Test the surface of pavement as follows:

1. Mainline Paving. Test as specified in Section 507 and Section 501.3(o)1. These pavements include, but are not limited to any full width lane used for travel, passing, climbing, center turn, acceleration, deceleration, and ramps.

2. Other than Mainline Pavement. Test as specified in Section 501.3(o). These pavements include, but are not limited to approach slabs, bridge decks, tapers, shoulders, medians, or other pavement surfaces as directed.

(q) Opening to Traffic. Replace Section 501.3(q) with the following:

The Representative will determine when pavement may be opened to traffic. Do not open pavement to traffic or operate heavy equipment on it for a minimum of 96 hours, and until the concrete has reached a minimum compressive strength of 3,000 pounds per square inch. Estimating concrete compressive strength by the maturity method according to PTM No. 640 may be used as an alternate method of determining the compressive strength of the finished pavement.
Perform operations on new pavement as approved by the Representative and according to the following:

- When moving on and off the pavement, construct a ramp to prevent damage to the pavement slab.
- Take positive action to prevent damage to the pavement surface and joints.
- Before placing the protective mats, sweep the pavement surface free of debris.
- Operate equipment on a slab without causing damage. If damage results, suspend operations and take corrective action as approved.
- New pavement will not be opened to any traffic until all joints have been sealed unless an acceptable method to protect joints from damage and keep non-compressible materials from entering the joint is approved.

(s) Tests for Depth. Revise Section 501.3(s) with the following:

The Representative will determine lots and sublots as specified in Section 530.3(u).
Complete any surface corrective work before testing for pavement depth. Test pavement depth by obtaining one core or one Non-Destructive test in each sublot. The Representative will determine the location of each depth test according to PTM No. 1.
If the drilled core measurement method is used for depth measurement submit the first sublot core and every tenth core thereafter, as an information core, immediately to the Representative. If the non-destructive depth measurement method is used, drill one information core in the first sublot placed and one information core for every tenth sublot thereafter. Verify the depth of all drilled cores as specified in Section 530.3(s)1. The Representative will determine sublot and core locations according to PTM No. 1. For a partial lot the Representative will randomly select one core

or core location according to PTM No. 1. The Representative will immediately submit the information cores to the LTS for an evaluation of entrained air content according to PTM No. 623. If the entrained air content is below 3.5% or above 8.5% provide a written evaluation of the problem and proposed solution to the Department within 5 days. If positive action is not taken to address hardened entrained air results below 3.5% or above 8.5% within 5 days, the District Executive may require that paving operations be stopped until an acceptable solution is agreed upon.

1. Measurement of Drilled Cores. Add the following:

Drill cores at each sublot location, according to PTM No. 606, in presence of the Representative. Thoroughly clean the vertical surface of the core hole of laitance and loose and foreign material. Fill the holes with the mixture used to construct the course and consolidate. As an alternative, use a premixed, nonshrink grout.

Provide a measuring apparatus according to PTM No. 614.

The Representative will:

- determine the core length according to PTM No. 614,
- determine the average lot pavement thickness by averaging the individual sublot core thicknesses,
- accept concrete as specified in Section 530.3(u), and
- determine price adjustments as specified in Section 530.4(a).

2. Measurement by Non-Destructive Testing. Add this section as follows:

When indicated or when requested in writing and approved by the District Executive test the depth of the finished pavement as specified in Section 501.3(s)2.

(t) Defective Work. Replace Section 501.3(t) with the following:

Unless otherwise directed in writing, as specified in Section 110.10(d)1., by the District Executive, remove and replace pavement determined defective as follows:

1. Depth. The lot will be defective if the average core depth of the lot is less than the design thickness (D) minus 0.5 inch or more than one individual sublot core depth is less than the design thickness minus 0.5 inch.

2. Compressive Strength. The lot is defective if PWL for compressive strength is less than 55%, as specified in Section 530.3(u)2.

3. Other Conditions. The lot is defective if the pavement contains surface defects from rain, improper joint construction, improper curing procedures, improper final finish, cracking, or honeycombing that cannot be satisfactorily repaired as determined by the Representative.

4. Other Than Mainline Pavement Surface Tolerance. The lot is defective if the pavement contains depressions or high points as specified in Section 506.3(o) that cannot be satisfactorily corrected as determined by the Representative.

5. Edge Slumping. The pavement is defective if the requirements specified in Section 501.3(g)5 are not met.

Remove and replace a minimum of an entire panel of LLCP pavement as shown on the Standard Drawings. Longitudinal edge spall repairs are not considered satisfactory repairs for edge slumping or spalling between adjacent lanes or outside pavement edges.

(u) Acceptance. Add this section as follows:

Lots and sublots for the combined pavement characteristics of depth and compressive strength will be determined based on the full width of pavement placement. Lots and sublots will begin at the starting point of paving and continue until 5,600 square yards are placed. Lots and sublots will be calculated as the work progresses and will

include any pavement designated as LLCP pavement. Do not combine pavement with different depths into any lot or sublot.

A full lot is defined as 5,600 square yards of pavement, of the same constant depth, and consists of four equal sublots of 1,400 square yards each.

Combine partial lots with the last full lot or make a separate lot according to the following procedure:

- If less than 4,200 square yards remain, combine the remaining pavement with the last full lot.
- If the remaining pavement is equal to or greater than 4,200 square yards, consider the remaining pavement as a separate lot.
- Determine sublots for the last pavement lot by establishing a number of equal size sublots.
- Determine the number of sublots by dividing the area of the combined lot or partial lot by 1,400 square yards and then rounding to the nearest whole number.
- Determine the equal size of each sublot by dividing the combined lot or partial lot quantity by the number of whole sublots calculated.
- Determine lots and sublots based on the full width of pavement placement.

1. Depth. The Representative will accept each lot for compliance with the specifications, for depth if the average core depth of the lot is more than the design thickness (D) minus 0.5 inch and not more than one individual sublot core depth is less than the design thickness minus 0.5 inch.

2. Compressive Strength and Plastic Air Content. The Representative will accept concrete for compliance with the specification requirements, for compressive strength, on a lot-by-lot basis, as specified in Section 105 and Section 106. The Representative will determine locations where acceptance samples of plastic concrete will be taken, according to PTM No. 1. Make one set of compressive strength specimens and one test for percentage of plastic air content on samples from each sublot. All sampling and testing must take place before trucks being place on grade.

Trucks selected for acceptance testing with plastic air results that are outside specification limits will not be placed. If a truck is discarded because of low plastic air content, test consecutive trucks as specified in Section 704.1(d)4.a. Discard all concrete with failing plastic air results. Provide a testing station within 1 mile of the final concrete placement location unless an alternate location is approved by the Representative.

Mold acceptance cylinders at the determined sublot location. The average of the test results from two cylinders, made from the same sample, tested according to PTM No. 604, will constitute the 28-day compressive strength. Cure test specimens according to Subsection 11.1 of PTM No. 611.

The Representative will accept concrete based on the adequacy and uniformity of compressive strength at the age of 28 days, when the PWL is 55% or greater.

For compressive strength, calculate the value of Q_L by the following equation, where $\overline{X}_4$ is the average of the sublot test results. Q_L is the lower quality index, and "s" is the Standard Deviation as specified in Section 106.03(a)3.a.4.

2.a For Class AA 28-day concrete compressive strength,

$$Q_L = \frac{\overline{X}_4 - 3{,}300\text{psi}}{s}$$

Determine the percentage of material within specification limits as specified in Section 106.03(a)3

(v) Water/Cementitious Ratio Incentive (W/C ratio). Add this section as follows:

Provide and place concrete with a W/C ratio between 0.37 and 0.42.

Do not add water or finishing aids to the surface of the concrete to aid in finishing.

The Department will determine the W/C ratio for concrete hauled in dump or agitator trucks according to the following (concrete hauled in truck mixers is not eligible for W/C ratio incentives):

1. W/C Ratio Incentive Lots and Sublots. The Representative will determine the sample location for each sublot as specified in Section 530.3(u)2. The Representative will compute the average W/C ratio for each lot of material established as specified in Section 530.3(u) as follows:

1.a Water Content Determination. For plant mixed cement concrete, use a Representative approved electronic meter that is capable of recording and printing on the batch ticket the total amount of water added to the mix including temper water. The amount of temper water may be hand written on the delivery ticket if the District provides inspection personnel to certify the hand written information. All temper water must be from a metered and calibrated source.

The Representative will determine the water content for calculating the water/cement ratio for each sublot and lot.

1.b Cementitious Content Determination. The Representative will use the sum of all cementitious material weights printed on the plant delivery slip for each sublot to determine the cementitious content of each sublot.

1.c Water Content Verification. Provide the microwave oven and the ancillary equipment required by the Representative to perform this test.

The Representative will use PTM No.1 to select a minimum of 1 sublot in each lot placed. Take verification samples from the same truck load of concrete as specified in Section 530.3(v)1. Plastic concrete samples will be taken at the same site as the compressive strength and plastic air content as approved by the Representative. The Representative will determine the water content of the plastic concrete mixture according to AASHTO T 318. The Representative will begin the test within 45 minutes after the water has contacted the cement.

The representative will compare the W/C ratio from the AASHTO T 318 verification testing results to the W/C ratio results computed from the plant delivery tickets. If more than one sublot within a lot is tested according to AASHTO T 318, the average of the tested sublots will be compared to the average of the corresponding W/C ratios computed from plant delivery tickets.

If the W/C ratio computed from the delivery tickets is not within ± 0.03 of the W/C ratio from the AASHTO T 318 verification testing results, the lot is not considered verified and no incentive will be paid for the lot.

530.4 MEASUREMENT AND PAYMENT—Square Yard

The Department will pay on a lot-by-lot basis at the contract price, adjusted for pavement characteristics relative to depth, and compressive strength.

The lot payment will be determined according to the multiple characteristic formula specified in Section 530.4(a)3.

(a) Adjustment for Pavement Characteristics.

1. Depth. The lot average pavement depth will be determined as specified in Section 530.3(s). The characteristic percentage for depth will be determined using Table A. The characteristic percentage for depth will be placed in the multiple characteristic formula as P_d specified in Section 530.4(a)3 to determine the lot payment.

2. Compressive Strength. The PWL will be determined for the lot as specified in Section 530.3(u)2. The characteristic percentages for compressive strength will be determined by using Table B. The characteristic percentage for compressive strength will be used as P_s in the multiple characteristic formula specified in Section 530.4(a)3 to determine the lot payment.

3. Multiple Characteristic Formula. The lot payment will be determined according to the following formula:

Multiple Characteristic Formula
No Incentive / Disincentive

$$L_p = C_p \left[\frac{2P_s + 2P_d}{400}\right]$$

Multiple Characteristic Formula
With Incentive

$$L_p = C_p \left[\frac{2P_s + 2P_d}{400}\right] WC$$

L_p	=	Lot Payment
C_p	=	Contract price per lot (contract price times lot size)
P_s	=	Characteristic Percentage of Compressive Strength—(Table B)
P_d	=	Characteristic Percentage for Depth—(Table A)
WC	=	Incentive Pay Factor (Table C)

TABLE A
Characteristic Percentages for Concrete Pavement Depth (Pd)
Relative to Specification Limits

15-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
15.00 or greater	100.0
14.90 - 14.99	97.1
14.80 - 14.89	94.4
14.70 - 14.79	91.4
14.60 - 14.69	88.0
14.50 - 14.59	86.4
Less than 14.50	*

14.5-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
14.50 or greater	100.0
14.40 - 14.49	96.9
14.30 - 14.39	94.0
14.20 - 14.29	90.9
14.10 - 14.19	87.3
14.00 - 14.09	85.5
Less than 14.00	*

14-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
14.00 or greater	100.0
13.90 - 13.99	96.7
13.80 - 13.89	93.6
13.70 - 13.79	90.3
13.60 - 13.69	86.5
13.50 - 13.59	84.6
Less than 13.50	*

13.5-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
13.50 or greater	100.0
13.40 - 13.49	96.5
13.30 - 13.39	93.2
13.20 - 13.29	89.8
13.10 - 13.19	85.8
13.00 - 13.09	83.7
Less than 13.00	*

13-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
13.00 or greater	100.0
12.90 - 12.99	96.3
12.80 - 12.89	92.8
12.70 - 12.79	89.2
12.60 - 12.69	85.0
12.50 - 12.59	82.8
Less than 12.50	*

12.5-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
12.50 or greater	100.0
12.40 - 12.49	96.1
12.30 - 12.39	92.4
12.20 - 12.29	88.7
12.10 - 12.19	84.8
12.00 - 12.09	81.9
Less than 12.00	*

12-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
12.00 or greater	100.0
11.90 - 11.99	95.9
11.80 - 11.89	92.0
11.70 - 11.79	88.1
11.60 - 11.69	84.5
11.50 - 11.59	81.0
Less than 11.50	*

11.5-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
11.50 or greater	100.0
11.40 - 11.49	95.7
11.30 - 11.39	91.6
11.20 - 11.29	87.6
11.10 - 11.19	83.8
11.00 - 11.09	80.1
Less than 11.00	*

11-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
11.00 or greater	100.0
10.90 - 10.99	95.5
10.80 - 10.89	91.2
10.70 - 10.79	87.0
10.60 - 10.69	83.0
10.50 - 10.59	79.2
Less than 10.50	*

10.5-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
10.50 or greater	100.0
10.40 - 10.49	95.3
10.30 - 10.39	90.8
10.20 - 10.29	86.5
10.10 - 10.19	82.3
10.00 - 10.09	78.3
Less than 10.00	*

10-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
10.00 or greater	100.0
9.90 - 9.99	95.1
9.80 - 9.89	90.4
9.70 - 9.79	85.9
9.60 - 9.69	81.5
9.50 - 9.59	77.4
Less than 9.50	*

9.5-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
9.50 or greater	100.0
9.40 - 9.49	94.6
9.30 - 9.39	89.9
9.20 - 9.29	85.2
9.10 - 9.19	80.6
9.00 - 9.09	76.3
Less than 9.00	*

9-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
9.00 or greater	100.0
8.90 - 8.99	94.0
8.80 - 8.89	89.3
8.70 - 8.79	84.4
8.60 - 8.69	79.6
8.50 - 8.59	75.1
Less than 8.50	*

8.5-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
8.50 or greater	100.0
8.40 - 8.49	94.0
8.30 - 8.39	88.7
8.20 - 8.29	83.5
8.10 - 8.19	78.5
8.00 - 8.09	73.8
Less than 8.00	*

8-inch Design Thickness

Average Thickness, inches	Characteristic Percentage Pd
8.00 or greater	100.0
7.90 - 7.99	93.9
7.80 - 7.89	88.1
7.70 - 7.79	82.6
7.60 - 7.69	77.3
7.50 - 7.59	72.4

Less than 7.50 *

* Defective work, as specified in Section 530.3(t).

TABLE B Characteristic Percentages for Concrete Pavement Compressive Strength (Ps) Relative to Specification Limits	
Percent Within Specification Limits	**Characteristic Percentage**
90 - 100	100
85 - 89	99
75 - 84	94
65 - 74	83
55 – 64	66
Below 55	*

* Defective work, as specified in Section 530.3(t).

4. Adjustment for W/C Ratio Incentive. The lot average W/C Ratio will be determined as specified in Section 530.3(v). The Incentive Pay Factor will be determined using Table C. The Incentive Pay Factor will be placed in the W/C Ratio formula as WC as specified in Section 530.4(a)3 to determine the lot payment.

TABLE C
Adjustment for W/C Ratio Incentive

W/C Test Result	Incentive Pay Factor
0.38 to ≥ 0.37	+0.04
0.39 to > 0.38	+0.03
0.40 to > 0.39	+0.02
0.41 to > 0.40	+0.01
≤ 0.42 to >0.41	0.00

If a water/cementitious ratio greater than 0.42 is approved no incentive pay will be paid.

(b) Defective Pavement Left in Place. The Department will not pay for defective pavement left in place, unless otherwise directed in writing by the District Executive. When the District Executive directs that defective pavement be left in place, final payment for this pavement will be at 5% of the contract unit price.

(c) Concrete Pavement Cores. Each

The contract unit price includes measuring apparatus, which remains the Contractor's property upon completion of the project.

(d) Evaluation of Concrete Pavement Ride Quality and Payment of Incentive. As specified in Section 507.4.

SECTION 540—BONDED CONCRETE OVERLAY OF ASPHALT-SURFACED PAVEMENT

540.1 DESCRIPTION—This work is the construction of a Portland cement concrete overlay with a thickness of 4 to 8 inches, and is bonded to an existing asphalt-surfaced pavement. It includes asphalt surface preparation, overlay construction, construction of transitions, joint sawing and sealing, and other construction details, as indicated.

540.2 MATERIAL—

- Class AA Cement Concrete—Section 704 except, revise the Table A Maximum Water Cement Ratio by weight to 0.42. If the maturity method is intended to be used, correlate the degree-hours of cure to compressive strengths in accordance with PTM No. 640 except, at time intervals of 8 hours, 1, 7, 28 and 56 days.
- Expansion Joint Filler—Section 705.1
- Tape Bond Breaker—An acceptable self-adhesive tape with width matching that of the sealant reservoir.
- Joint Backing Material—Section 705.9
- Longitudinal Joint Material—Section 705.2, for use in transition areas only
- Load Transfer Units—Sections 705.3(a) and (b), for use in transition areas only
- Joint Sealing Material—Section 705.4(a) – Self-leveling, Section 705.4(b), or (c)
- Concrete Curing Material—Section 711.1 and 711.2(a), ASTM C 309 Type 2
- Concrete Covering Material—Section 711.1
- Concrete Admixtures—Section 711.3
- Class 4 Geotextile, Non-woven—Section 735, for use in transition areas only
- Epoxy Bonding Compound—Section 706.1 Type V
- Pre-Mixed Nonshrink Grout—An approved type as listed in Bulletin 15.

540.3 CONSTRUCTION—Section 501.3, modified as follows:

(a) General. Section 501.3(a) with the following modifications:

1. Field Operation QC Plan. Replace with the following:

1. Comprehensive QC Plan. Prepare a comprehensive QC Plan detailing all operations related to this work, including, but not limited to, surface preparation, the timing and sequence of the work, including timing of mixing, hauling, placing, curing, monitoring of concrete temperature, joint sawing, and sampling and strength testing or evaluation for opening to traffic. Indicate variations in timing of activities in response to anticipated variations in air temperature at the time of placement. Submit the QC Plan for the Representative's review before the start of the project. Do not begin construction-related work until the QC Plan has been accepted.

(e) Preparation and Protection of Base Course. Replace with the following:

(e) Asphalt Surface Preparation. Profile mill the existing asphalt pavement surface to the depth indicated in the plans as specified in Section 492. In lieu of replacing unsound pavement as specified in Section 492.3(c) with asphalt

materials, replace with Class AA Cement Concrete in conjunction with the placement of the concrete overlay. Saw cutting and chipping with pneumatic hammers may be used to remove areas inaccessible by a milling machine. Clean and fill in cracks greater than 3/4 inches with non-shrink grout or other material approved by the Department which will enable bond to the concrete overlay prior to pavement surface cleaning. No standing water should remain on the surface after the milling operation. If standing water occurs, immediately provide measures, acceptable to the Department, to drain the water from the milled surface. Completely clean the milled pavement surface to completely remove all loose debris. Protect the cleaned and prepared surface from oil or grease drippings from compressors, concrete trucks, spreaders, pavers, etc. Remove all deleterious materials before overlaying.

Conduct final cleaning of the surface no more than 30 minutes before the placement of the concrete overlay to remove loose material and debris. If using a compressed air stream, ensure that it is free of oil, moisture, and other potential contaminants, and that has a minimum pressure of 100 pounds per square inch measured at the source.

Immediately before placing the concrete overlay, ensure the asphalt surface is less than 120F. Fog-misting, protective covers or blankets will be allowed to achieve the proper condition of the surface, however, do not allow any standing water or moisture to remain on the pavement surface.

(h) Handling and Placing Reinforcement. Delete Section 501.3(h).

(i) Transverse Joints. Replace with the following:

(i) Joints. Space joints as indicated on the project plans and special provisions. If no joint spacing is indicated, develop a joint layout plan to be accepted by the Department and lay out joints before placement of concrete. Avoid placing longitudinal joints in the wheel paths. In general, maximum panel dimensions should not exceed 18 times the concrete overlay thickness, and the length of the longer panel dimension divided by the shorter panel dimension should not exceed 1.5. The Representative may allow or require slight deviations from nominal panel dimensions in order to match joints in adjacent pavement or structures, or to avoid the construction of panels with dimensions or shapes that would otherwise be subject to premature cracking.

Sawing is the only acceptable technique for creating concrete overlay joints. Saw joints as soon as concrete has sufficiently hardened to permit sawing without excessive raveling resulting from the sawing operation and to prevent random cracking. The use of "early entry" saws is recommended. FHWA's HIPERPAV or similar software approved by the Department may be used in determining a project-specific sawing window. If necessary, conduct sawing operations continuously, both day and night, regardless of weather conditions. Saw joints with a green cut saw to a depth of D/3 and a minimum width of 1/8 inch. If initial saw cuts do not extend through the slab edge to avoid "blowouts" or edge damage of green concrete, extend these cuts through the edge as soon as it can be done without causing damage. Omit sawing if a crack occurs at or within 1.5 feet of a joint location, before or during sawing, and address as specified in Section 590. Do not seal joints at this time. Clean joints of all deleterious material after sawing.

If pavement is cured by means other than white-pigmented, liquid membrane-forming curing compound, remove curing materials from overlay, at the location where a joint is to be cut. Remove only sufficient covering to provide space necessary for sawing joints. As soon as the joint is made, replace the covering. The maximum time period allowed for pavement curing covers to be removed is 1/2 hour. If white-pigmented, liquid membrane-forming curing compound is used, cure the joint area, as specified in Section 501.3(l)1.c.

(j) Longitudinal Joints. Replace with the following:

(j) Concrete Overlay Transitions. Construct transitions at the limits of the concrete overlay as indicated. In areas where transitions contain existing treated base course or concrete pavement directly below the overlay, place geotextile as a debonding layer as specified in Section 212.

(l) Curing Concrete. Section 501.3(l) with the following modifications:

- Replace the first sentence of Section 501.3(l)1 with the following:

Apply curing materials after finishing and texturing, and within 30 minutes of the dissipation of bleed water. Maintain the curing materials until the pavement has achieved sufficient strength for opening to traffic as specified in Section 540.3(q).

- Add the following paragraphs at the end of Section 501.3(l)1:

Provide adequate insulating blankets to prevent rapid heat loss if the air temperature is 45F or less. Insulation may be removed when the air temperature exceeds 45F or when the average compressive strength of the concrete

exceeds 3,000 pounds per square inch. Remove insulation in a manner such that the rate of temperature change at the concrete surface does not exceed 40F within any 1-hour period. Concrete that experiences a higher rate of temperature change will be considered defective.

The application or removal of insulation covers may be controlled by the use of maturity method as specified in Section 540.3(q), with full removal of insulation allowed after the minimum required degree-hours of curing has been accumulated at the top of the slab.

- Replace the second sentence of the second paragraph of Section 501.3(l)1.c with the following:

Apply curing compound homogenously to provide a uniform, solid white opaque coverage on all exposed concrete surfaces. Apply at a minimum rate of 1 gallon (± 0.1 gallon) per 125 square feet or as specified by the manufacturer's recommendations, whichever is greater. If conditions warrant, the curing compound can be applied in two equal rates of application, with the first applied as stated previously and the second applied immediately after sawing operations have been completed. Joint faces must be protected from exposure to curing compound or cleaned thoroughly prior to sealant installation.

(n) Sealing Joints and Cracks. Replace with the following:

(n) Sealing Joints. Seal all transverse and longitudinal joints with an approved hot-pour or silicone sealant material in accordance with the manufacturer's recommendations and as specified in Section 501.3(n).

(o) Surface Tolerance. Replace with the following:

Section 506.3(o)

(q) Opening to Traffic. Replace with the following:

The Representative will determine when pavement will be opened to traffic based on when the concrete attains the minimum required compressive strength of 3,000 pounds per square inch as measured either by compressive strength testing of cylinders in accordance with PTM No. 604 or by the maturity method in accordance with PTM No. 640.

(s) Tests for Depth. Replace with the following:

Before final acceptance of each phase of the project, proceed as follows:

- The Department will divide the concrete overlay pavement into lots representing not more than 3,000 square yards of pavement in each traffic lane. Include ramps in a separate lot(s). The Inspector will select one coring location at random within each lot according to PTM No. 1. Drill cores according to PTM No. 606 and in the presence of the Inspector. For projects at intersections or less than 3,000 square yards, drill two cores. Thoroughly clean the vertical surface of the core hole of laitance and loose and foreign material. Fill the holes with the mixture used to construct the course and consolidate. As an alternative, use a premixed, nonshrink grout.

- Provide a measuring apparatus conforming to PTM No. 614. The Inspector will determine the core depth according to PTM No. 614.

- If any core measurement is deficient by more than 1/4 inch in required depth, drill additional cores in the presence of and for measurement by the Inspector. Drill the additional cores at 100-foot intervals in both directions longitudinally from each deficient core, in the same traffic lane, until the depth is no more than 1/4 inch deficient. Each core will represent the condition in the same traffic lane for a distance of 50 feet in both directions longitudinally.

- The Inspector will consider the pavement to be defective if any core measurement is deficient in required depth as indicated in Table B.

(t) Defective Work. Replace with the following:

Unless otherwise directed in writing by the District Executive, remove and replace, at no expense to the Department, pavement that is: defective in construction or sawing of joints as specified in Section 540.3(i); defective in curing requirements as specified in Section 540.3(l); defective in surface tolerance, as specified in Section 501.3(o); defective in depth, as specified in Section 540.3(s); defective in air content, as specified in Section 704.1(c)3; defective in

compressive strength as specified in Section 704.1(d), or showing surface defects resulting from the effects of freezing and thawing, rain, hail, improper final finish, or honeycombing.

The minimum pavement removal and replacement will be one panel in length and width. Where deficiencies are exhibited in successive panels of pavement, remove and replace entire panels. After removal of defective pavement, reestablish replaced joints.

If removing and replacing pavement defective in depth, start at the determined point of deficiency as determined by the Representative. Remove and replace defective work transversely for the full-lane width and longitudinally, until the pavement is not more than 1/4 inch deficient in depth, as specified in Section 540.3(s).

540.4 MEASUREMENT AND PAYMENT—

(a) Profile Milling of Asphalt Pavement Surfaces. Section 492.4

Ownership of the milled material will be indicated by the selected item of work. The transition areas will be excluded.

(b) Bonded Concrete Overlay of Asphalt Pavement. Square Yard

This unit price includes all work associated with the construction of the concrete overlay with the exception of the cement concrete material and the profile milling. The price also excludes the concrete overlay transitions and the concrete pavement cores.

(c) Cement Concrete, Class AA. Cubic Yard

For producing the cement concrete needed for the overlay and delivering it to the jobsite. Pay quantity for the overlay will be computed based on the indicated depth and the placement area. An additional quantity, not to exceed 2% of the computed overlay quantity, may be paid as compensation for the cost of cement concrete material needed to replace unsound pavement material removed as part of the profile milling operation. Excludes cement concrete material used in transition areas. Submit written request for additional compensation with justification. The justification should indicate the cubic yardage of concrete delivered to the job site from delivery tickets, and show a deduction for the volume of the overlay and the quantity of concrete wasted.

(d) Concrete Overlay Transition. Each

This unit price includes all associated items of work within the limits of the transitions.

(e) Concrete Pavement Cores. Each

The price includes the measuring apparatus, which remains the Contractor's property upon completion of the project. The Department will not pay for additional cores drilled when the depth is deficient by more than 1/4 inch.

(f) Adjustment for Deficient Pavement Thickness Depth. Where a deficiency exists, as determined by cores, lot payment for both the bonded concrete overlay and the cement concrete material will be adjusted as specified in Table B.

TABLE B
Adjustment for Depth

Deficient in Depth Determined by Cores (inches)	Payment Percent of Contract Unit Price, by Lot, Based on Nominal Overlay Depth (%)		
	≤ 4.00 inches	4.25 to ≤ 6.00 inches	> 6.00 inches
-0.25 to 0.00	100	100	100
-0.30 to -0.26	95	97	99
-0.35 to -0.31	85	90	95
-0.40 to -0.36	75	80	90
-0.45 to -0.41	65	70	85
-0.50 to -0.46	50	60	75
-0.60 to -0.51	Defective Work	50	65
-0.75 to -0.61	Defective Work	Defective Work	50
> -0.75	Defective Work	Defective Work	Defective Work

(g) Defective Pavement Left in Place. The Department will not pay for defective pavement left in place, unless otherwise directed in writing by the District Executive. When the District Executive directs that defective pavement be left in place, final payment for this pavement will be at 5% of the contract unit prices of the concrete overlay and the cement concrete.

(h) Evaluation of Concrete Pavement Ride Quality and Payment of Incentive. Section 507.4

SECTION 545—BONDED CONCRETE OVERLAY OF CONCRETE-SURFACED PAVEMENTS

545.1 DESCRIPTION—This work is the construction of a bonded concrete overlay, or inlay, of concrete pavements including surface preparation and joint sawing and sealing.

545.2 MATERIAL—

(a) Cement Concrete, Class AA. Section 704, modified as follows:

(b) Material. Section 704.1(b), modified as follows:

- Coarse Aggregate, Type A, No. 57, No. 67, or No. 8 (Stone, gravel, or Slag)--Section 703.2, modified as follows:

(a) General. Section 703.2, modified as follows:

1. Stone. Provide durable stone, free from slate texture or cleavage planes. For use in cement concrete, wash thoroughly during production.

2. Gravel. Provide durable gravel particles. For use in cement concrete, wash thoroughly during production.

3. Blast Furnace Slag Aggregate. Blast furnace slag aggregate is not allowed for use in cement concrete paving applications.

- Section 704.1(b) TABLE A modified as follows:

1. Minimum Cement Factor for AA Slip Form Paving, Paving, and Accelerated Patching: 530 lbs/cu. yd.

2. Maximum Cement Factor for AA Slip Form Paving, and Paving (but not Accelerated Patching): 600 lbs/cu. yd.

3. Maximum Water-Cement Ratio: 0.42 lbs/lbs for all Class AA concrete.

4. Delete note 7 and replace with "The target Water-Cement Ratio is 0.40 lbs/lbs and will not fall below 0.38 lbs/lbs for all Class AA concrete."

(c) Design Basis. Section 704.1(c), revised as follows:

- Add the following paragraph to the end of Section 704.1(c)2.

For Class AA Paving, Portland cement may be replaced with pozzolan (flyash or slag cement) weighing as much or more than Portland cement replaced provided that at least 400 pounds per cubic yard of Portland cement is used and the total cementitious (cement plus pozzolan) content does not exceed the limits in Table A. The maximum slag cement content, if used, is not to exceed 30% of the total cementitious material, by weight.

- Replace the first sentence of Section 704.1(c)3 with the following:

For Class AA Slip-Form Paving, and AA Accelerated Patching concrete, design cement concrete to have an air content of 7.0%, within a tolerance of ± 1.5%, at the time and point of placement.

(d) Testing and Acceptance. Section 704.1(d), add the following:

4.c Verify Water-Cement Ratio. Verify water-cement ratio in the field using batch tickets (for cementitious content determination) and AASHTO T 318-02 "Standard Method for Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying (for water content determination)."

(g) Mix Designs Using Potentially Reactive Aggregate. Section 704.1(g) revised as follows:

- Replace the first sentence of the second paragraph in Section 704.1(g)2 with the following:

Use aggregates that are deemed reactive or potentially reactive with 14-day expansion between 0.10% and 0.30% only with an approved cement-pozzolan combination that is sufficient to mitigate the 14-day expansion to a value less than 0.1% and as specified in Section 704.1(g)3. Reject aggregate with 14-day expansion greater than 0.30%. This requirement applies to all paving concrete on this project. For other applications, use any of the cements or cement-pozzolan combinations specified in Section 704.1(g)3.

- Revise Section 704.1(g)3.b with the following:

3.b Blended Hydraulic Cement. Type IS or IP, ASTM C 595, from a manufacturer listed in Bulletin 15. If any blended cement is used for any paving and patching concrete, the maximum allowable mortar expansion at 14 days and 8 weeks are 0.02% and 0.06%, respectively.

(b) Concrete Admixtures. Section 711.3

(c) Concrete Covering Material. Section 711.1(a)

(d) Concrete Curing Materials. Section 711.1 or 711.2(a), Type 2

(e) Joint Backing Material. Section 705.9

(f) Joint Sealing Material. Section 705.4(a), (b), or (c)

(g) Tape Bond Breaker. An acceptable self-adhesive tape the width of the sealant reservoir.

545.3 CONSTRUCTION—Section 501.3, and as follows:

(a) Weather Restrictions. Section 501.3(b) with the following modifications:

1. Cold Weather. Replace the fourth sentence with the following:
Place concrete when the concrete temperature is between 65F and 90F.

(b) Surface Preparation. Prepare the existing concrete surface as follows:

1. Equipment.

1.a Scarifying Equipment. Provide a self-propelled mechanical scarifier capable of uniformly removing the old surface across the entire cutting path, to the depth indicated, as specified in Section 591.3.

1.b Shot Blasting, Sand Blasting, or Water Blasting Equipment. Provide equipment capable of removing any loose concrete and rust from exposed reinforcement.

2. Scarification of the Existing Pavement Surface. When used to lower the pavement elevation, scarify the existing pavement surface to the depth indicated. Cut off and remove any reinforcement that is exposed and loose. After scarifying, remove any deteriorated concrete or asphalt materials that extend below the level of the scarification, as indicated or directed. Remove all full-depth asphalt patches and replace with concrete as specified in Section 516. Remove all loose material from the pavement surface before cleaning. Minimal minor repairs of surface defects can be replaced with overlay.

3. Steel Plates. If inlaying and the existing transverse pavement joints have steel plates, remove exposed steel plates.

4. Final Preparation. Shot blast or water blast to produce a roughened surface, following the milling. Provide measures, acceptable to the Department, to drain or remove standing water from the prepared surface as directed by the Department. Completely clean the prepared surface to remove all loose debris. Protect the cleaned and prepared surface from oil or grease drippings from compressors, concrete trucks, spreaders, pavers, etc. Remove all deleterious materials before overlaying.

Conduct final cleaning of the surface in front of the paver no more than 30 minutes prior to the placement of the concrete overlay/inlay. If using a compressed air stream, ensure that it is free of oil, moisture, and other potential contaminants, and that has a minimum pressure of 100 pounds per square inch measured at the source.

Install joint backing or other approved joint filling material to within ±1/4 inch of the pavement surface in all existing transverse joints (including those associated with full-depth repairs) prior to placement of the overlay. Ensure that the joint backing or filling material cannot be dislodged by the paving operation.

Immediately prior to placing the concrete overlay/inlay, ensure the surface is less than 120F. Fog-misting, protective covers or blankets will be allowed to achieve and maintain proper temperature and moisture conditions of the surface. Completely blow off standing water with compressed air from the pavement surface.

(c) Overlay Transition. Construct paving notches, as indicated.

(d) Transverse Joint Location. Accurately mark the location of all transverse joints with the use of guide nails, tacks or other Representative-approved devices to accurately mark the locations of the centers of all transverse joints prior to placing the concrete overlay so that they can be located after the overlay has been placed. Submit the proposed method of location marking for approval 20 days before the start of construction. Do not begin paving without approval.

(e) Bond Strength. After the surface preparation has been completed and before placement of the overlay, test the prepared surface in the presence of the Inspector. Bond strength testing will be performed at 7 days, according to ASTM C 1583. Provide the test equipment.

1. Lot Testing. For each area represented by each day's placement of not more than 3,000 square yards, the Inspector will select five test locations at random, according to PTM No. 1, and test according to ASTM C 1583.

If the average of the test results on the three tests is below 175 pounds per square inch and each individual test has a minimum strength of 160 pounds per square inch, the area represented will be considered defective. If defective, obtain additional tests at 100-foot intervals in both directions longitudinally from the defective locations to determine the limits of defective work. Each set of three defective tests will represent the condition in the same traffic lane for a distance of 50 feet in both directions longitudinally.

(f) Final Finish. Section 501.3(k)4

(g) Curing Concrete. Section 501.3(l) with the following modifications:

- Replace the first sentence of Section 501.3(l)1 with the following:

Apply curing materials after finishing and texturing operations, and within 30 minutes of the dissipation of bleed water and maintain them in place until the pavement has reached sufficient strength as specified in 545.3(l) for opening to traffic.

- Add the following paragraph to the end of Section 501.3(l)1:

Provide adequate insulating blankets to prevent rapid heat loss if the air temperature is forecasted to be 45F or less. Insulation may be removed when the air temperature exceeds 45F or when the average compressive strength of the concrete exceeds 3,600 pounds per square inch. Remove insulation in a manner such that the rate of temperature change at the concrete surface does not exceed 40F within any 1-hour period. Concrete that experiences a higher rate of temperature change will be considered defective.

- Replace the second sentence of the second paragraph of Section 501.3(l)1.c with the following:

Apply curing compound homogenously to provide a uniform, solid white opaque coverage on all exposed concrete surfaces. Apply at a minimum rate of 1 gallon (± 0.1 gallon) per 125 square feet or as specified by the manufacturer's recommendations, whichever is greater. If conditions warrant, the curing compound can be applied in two equal rates of application, with the first applied as stated previously and the second applied immediately after sawing operations have been completed. Joint faces must be protected from exposure to curing compound or cleaned thoroughly prior to sealant installation.

(h) Transverse Joints. As soon as the concrete is strong enough for cutting the joints without significant raveling or chipping, saw cut transverse joints directly over all existing transverse joints, including those produced by pre-overlay repairs. Saw cut depth must be equal to the full thickness of the overlay (including any additional thickness used for grade corrections) plus 1/2 inch, but must not result in damage to dowel load transfer devices in the original pavement. To prevent debonding, saw cut width should be at least the width of the underlying joint or crack in the existing pavement or greater. Measure joint widths immediately prior to placement of the overlay/inlay.

When inlaying, saw cut transverse joints to the full depth of the inlay, including any extra depth concrete placed at the joint, directly over the existing transverse joint and a minimum of 1/2 inch wide.

Construct a sealant reservoir as shown on the Standard Drawing for Cement Concrete Pavement Joints. The overlay may be sawed in a second operation, or make the initial saw cut equal to the required reservoir width. After sawing, immediately flush the joint with water to remove sawing slurry that might otherwise prevent proper sealant installation.

Place backing material to the proper depth and seal the joints, as specified in Section 501.3(n).

In the case of overlaying an existing Continuously Reinforced Concrete Pavement (CRCP), only match the terminal joints and joints created from full-depth repairs.

(i) Intermediate Transverse Joints. Cut intermediate transverse joints between existing transverse joints such that the overlay panel length does not exceed 15 feet. Saw cut depth must be equal to the full thickness of the overlay (including any additional thickness used for grade corrections) plus 1/2 inch.

(j) Longitudinal Joints. Accurately reference the location of existing longitudinal joints within the overlay area and between the adjacent lane and the overlay area, so that they can be accurately located after paving. After paving, saw cut a sealant reservoir, 1/4 inch wide, and the full depth of the overlay plus 1/2 inch, directly over the existing longitudinal joint.

Seal joints as specified in Section 501.3(n).

Provide a neat vertical edge face, free of honeycomb and segregation, longitudinally along both sides of the overlaid pavement.

(k) Edge Slump. Maximum edge slump allowed in the outside 6 inches next to the shoulder is 1/4 inch. Maximum edge slump allowed in the outside 6 inches next to an adjacent lane is 1/8 inch.

(l) Opening to Traffic. The Representative can determine when pavement will be open to traffic based on when the concrete attains the minimum required compressive strength of 3,600 pounds per square inch as measured by compressive strength testing of cylinders in accordance with PTM No. 604, and the minimum acceptable bond strength as specified in Section 545.3(e).

(m) Surface Tolerance. Section 506.3(o)

(n) Defective Work. Unless otherwise directed in writing from the District Executive, remove and replace pavement overlay that is defective in depth, as specified in Section 545.4(c) Table A; defective in air content, as specified in Section 704.1(c)3 (modified as specified in Section 545.2(a); defective in bond strength, as specified in Section 545.3(e); or showing surface defects resulting from the effects of rain, improper final finish, or honeycombing which, in the Representative's opinion, cannot be repaired.

Replace defective pavement overlay as specified in Section 501.3(t); except, provide a minimum pavement removal and replacement length between transverse joints of 6 feet.

545.4 MEASUREMENT AND PAYMENT—

(a) Surface Preparation. Square Yard

(b) Cement Concrete, Class AA. Cubic Yard

For producing the cement concrete needed for the overlay and delivering it to the jobsite. Pay quantity for the overlay will be computed based on the indicated depth and the placement area. An additional quantity, not to exceed 2% of the computed overlay quantity, will be paid as compensation for the cost of cement concrete material needed to replace unsound pavement material removed as part of the surface preparation operation. Excludes cement concrete material used in transition areas.

(c) Bonded Concrete Overlay of Concrete Pavements. Square Yard

The unit price includes all work associated with construction of the concrete overlay with the exception of the cement concrete material and the surface preparation. Also excludes concrete overlay transitions and concrete pavement cores.

1. Adjustment for Depth. The Inspector will determine lots and sublots as specified in Section 506.3(u). Where a deficiency exists, as determined by cores, lot payment for bonded concrete overlay will be adjusted as specified in Table A.

TABLE A
Adjustment in Contract Price for Depth

Deficient in Depth Determined by Cores (inches)	Payment Percent of Contract Unit Price, by Lot, Based on Nominal Overlay Depth
-0.25 to 0.00	100%
-0.30 to -0.26	95%
-0.35 to -0.31	85%
-0.40 to -0.36	75%
-0.45 to -0.41	65%
-0.50 to -0.46	50%
> -0.50	Defective Work

2. Defective Pavement Left in Place. The Department will not pay for defective pavement left in place, unless otherwise directed in writing by the District Executive. When the District Executive directs that defective pavement be left in place, final payment for this pavement will be at 5% of the contract unit prices of the concrete overlay/inlay and the cement concrete.

(d) Concrete Overlay Transition. Each

This unit price includes all associated items of work within the limits of the transitions.

(e) Evaluation of Concrete Pavement Ride Quality and Payment of Incentive. Section 507.4

(f) Concrete Pavement Cores. Each

The price includes the measuring apparatus, which remains the Contractor's property upon completion of the project. The Department will not pay for additional cores drilled when the depth is deficient by more than 1/4 inch.

SECTION 548—UNBONDED CONCRETE OVERLAY OF CONCRETE-SURFACED PAVEMENTS

548.1 DESCRIPTION—This work is the construction of an unbonded concrete overlay of concrete pavements including surface preparation and joint sawing and sealing.

548.2 MATERIAL—Section 501.2 with the following modification:

(a) Non-Woven Geotextile Interlayer. Section 735 Class 4 Separation, Type A modified as follows:

Mechanical Properties	Test Method	Average Roll Value
Color	Visual Inspection	Uniform (all same color fibers)
Geotextile Type	EN 13249, Annex F (Certification)	Nonwoven, needle-punched, no thermal treatment to include calendaring
Weight per unit area	ASTM D5261	14.0 oz/sq.yd minimum
Thickness under load (pressure) 0.29 psi 2.9 psi 29 psi	ASTM D5199	 ≥ 0.12 inches ≥ 0.10 inches ≥ 0.04 inches
Wide Width Tensile Strength	ASTM D4595	≥685 lb/ft s
Wide Width maximum Elongation	ASTM D4595	≤ 130%
Water permeability in normal direction under 2.9 psi load	ASTM D5493	0.02 ft/min
In-plane Water Permeability (transmissivity) under load (pressure) 2.9 psi 29 psi	ASTM D4716	 0.10 ft/min 0.04 ft/min
Alkali Resistance	EN 13249, Annex B (Certification)	≥96% Polypropylene/Polyethylene
UV Resistance at 500 hours	ASTM D4355	retained strength 70% average with no value less than 60%

(b) Geotextile-Securing Devices, Materials, or Techniques. Anchoring devices, materials, or techniques approved by the selected geotextile manufacturer for project-specific use.

(c) Superpave Mixture Design, Standard Construction of Plant-Mixed HMA Fine-Graded Courses. Section 410 and Bulletin 27.

(d) Class AA Cement Concrete. Section 704 except for overlays with depth less than 7 inches use concrete reinforced with polypropylene fibers according to ASTM C1116, Type III 4.13 and ASTM C1116 (Ref: ASTM C1018) Performance Level 1 outlined in Section 21, Note 17 and Residual Strength. Use 100% virgin polypropylene (PE) manufactured to an optimum gradation for use as concrete reinforcement. Use a synthetic fiber that is a monofilament or bundled monofilament with a minimum length of 1.0 inches and a maximum length of 2 1/2 inches and has a maximum aspect ratio (length divided by the equivalent diameter of the fiber) of 150. Add a sufficient quantity of synthetic fiber(s) to the concrete mixture to have a residual strength ratio (R150,3) of 20.0 percent according to Illinois Modified ASTM C1609. Do not exceed the maximum dosage rate of 5.0 pounds per cubic yard, unless the manufacturer can demonstrate, through a field demonstration, that the concrete mixture will be workable and fiber clumping is not a problem.

Add the synthetic fibers to the concrete and mix in accordance with the manufacturer's recommendation.

548.3 CONSTRUCTION—Section 501.3 modified as follows:

(e) Preparation and Protection of Base Course. Replace with the following:

(e) Surface Preparation.

1. Pre-overlay Repairs.

1.a General. Areas with unstable slabs and slab fragments (e.g. slabs or fragments that move or rock visibly under normal traffic loads) that would otherwise result in non-uniform support of the overlay must be stabilized or repaired before placement of the interlayer material.

1.b Concrete Pavement Patching. Section 516, except delete Section 516.3(p)

1.c Slab Stabilization. Section 679 except delete Sections 679.3(b), (d)4, and (e).

1.d Slabjacking. Section 681

1.e Flexible Base Replacement. Section 316.

1.f Shallow Repairs. Repair surface defects with a patching material that consists of an asphalt material, a cementitious material, or a similar pavement repair material meeting the approval of the Representative before placing the overlay. When using a geotextile interlayer, fill all surface defects measuring greater than 4 square inches and 1 inch deep in the surface of the traffic lanes, with a patching material and compact to a flat, tight surface. When using an asphalt interlayer, shallow defects can be filled with an asphalt interlayer material as the interlayer is placed provided that the material in the defect can be properly compacted along with the interlayer; otherwise the defects must be filled with repair material before placement of the interlayer.

2. Sweeping. Sweep pavement to remove any loose debris by either using a power broom, vacuum truck, or other approved means before applying pavement interlayer.

3. Separation Layer.

3.a Geotextile Interlayer Placement. Mill joints with greater than 1/4 inch faulting.

Place geotextile flat on the repaired and cleaned existing pavement surface. Overlap edges of geotextile by 8 inches ± 2 inches. Do not allow more than three layers of the geotextile to overlay in any location. Sequence rolling out geotextile to ensure good lapping practice and prevent folding or tearing by construction traffic.

Extend free edge of geotextile interlayer a minimum of 4 inches beyond edge of pavement. Terminate interlayer in a drainable layer or at a daylighted location (e.g. ditch foreslope). Do not impair free drainage of the geotextile.

Secure geotextile in accordance with the geotextile manufacturer's instructions.

Avoid allowing construction traffic on the geotextile whenever possible. Delay geotextile installation on areas subject to potentially damaging traffic, such as crossovers, until immediately before concrete placement. Minimize sharp turns and braking on geotextiles

Keep geotextile clean and free of loose debris before overlay placement. Dampen geotextile but do not saturate, before overlay placement. Do not allow the surface temperature of the fabric to exceed 120F before the overlay placement.

3.b Asphalt Interlayer. Place a nominal depth of 1 inch of Superpave Mix Design as specified in Section 410.3. If joint faulting exceeds 1/2 inch, place a scratch course at the joint or mill/grind joints to reduce faulting. Use a rubber tire roller. Do not allow the surface temperature of the pavement to exceed 120F before the overlay placement. Control the asphalt surface temperature by misting the surface, using white-pigmented curing compound, whitewashing with lime water, or other method approved by the Representative.

(g) Slip-Form Paving Method. Modified as follows:

3. Placing Concrete. Add the following:

If dowel baskets are moving during the paving operation, suspend paving operations until a plan for securely anchoring the baskets is approved by the Representative and implemented.

4. Joints. Add the following:

Leave shipping wires intact, unless a Magnetic Tomography-Based Device is to be used for dowel placement verification. Secure dowel bar assemblies with anchors to hold the dowel bars in the correct position and alignment while preventing movement during concrete placement in accordance with the following:

- Provide a QC Plan for anchoring dowel basket assemblies.
- Fasten the baskets to the substrate surface so that they do not move vertically or horizontally more than 1/4 inch.
- Type, location, number, and length of anchors are dependent upon field conditions.
- Before starting concrete pavement placement and before each day of concrete pavement placement, demonstrate the fastening method to the Representative for approval.

(i) Transverse. Modified as follows:

3. Expansion Joints. Add the following:
Identify and mark any transverse expansion joints in the existing pavement. To allow for slab movement before sawing, precut the expansion joints in the plastic concrete. As soon as sawing is possible, saw two full-depth cuts on each side of the precut joint following the edges of the underlying expansion joint and remove the concrete between the saw joints.

4. Location. New transverse and longitudinal joints are not required to match existing joint locations, nor are they required to be offset by any minimum distance.

5. Panel Size. Determine the dimensions of the unbonded concrete overlay panels using lane geometry, concrete placement width and the following guidance:

Unbonded Overlay Thickness	Maximum Nominal Panel Dimensions
≤ 6 inches to < 8 inches	6 ft × 6 ft
≥ 8 inches to ≤ 10 inches	12 ft × 12 ft
> 10 inches	12 ft × 15 ft

The aspect ratio (longer dimension/shorter dimension) of any panel should be as close to 1.0 as is feasible and should not exceed 1.5.

6. Saw Cut Depth. The saw cut depth must be no less than D/3 within 12 inches of the pavement edges and must be no less than D/4 anywhere. Clean joint of all deleterious material after sawing. Seal all transverse and longitudinal joints. Consider concrete panels with cracking outside of the sawed joints defective.

7. Joint Spacing. Space joints as indicated on the project plans and special provisions. If no joint spacing is indicated, develop a joint layout plan to be accepted by the Department and lay out joints before placement of concrete. Avoid placing longitudinal joints in the wheel paths. In general, maximum panel dimensions should not exceed 18 times the concrete overlay thickness, and the length of the longer panel dimension divided by the shorter panel dimension should not exceed 1.5. The Representative may allow slight deviations from nominal panel dimensions in order to match joints in adjacent pavement or structures, or to avoid the construction of panels with dimensions or shapes that would otherwise be subject to premature cracking.

8. Sawing for Creating Concrete Overly Joints. Sawing is the only acceptable technique for creating concrete overlay joints. Saw joints as soon as concrete has sufficiently hardened to allow sawing without excessive raveling resulting from the sawing operation and to prevent random cracking. The use of "early entry" saws is recommended. FHWA's HIPERPAV or similar software approved by the Department may be used in determining a project-specific sawing window. If necessary, conduct sawing operations continuously, both day and night, regardless of weather conditions. Saw joints with a green cut saw to a depth of D/3 and a minimum width of 1/4 inch. If initial saw cuts do not extend through the slab edge to avoid "blowouts" or edge damage of green concrete, extend these cuts through the edge as soon as it can be done without causing damage. Omit sawing if a crack occurs at or within 1.5 feet of a joint location, before or during sawing, and address as specified in Section 590. Clean joints of all deleterious material after sawing.

9. Curing. If pavement is cured by means other than white-pigmented, liquid membrane-forming curing compound, remove curing materials from overlay, at the location where a joint is to be cut. Remove only sufficient covering to provide space necessary for sawing joints. As soon as the joint is sawed, replace the covering. The maximum time period allowed for pavement curing covers to be removed is 1/2 hour. If white-pigmented, liquid membrane-forming curing compound is used, cure the joint area, as specified in Section 501.3(l)1.c.

(j) Longitudinal Joints. Add the following:
Additional longitudinal joint requirements are as specified in Sections 548.3(i)4, 3(i)5, 3(i)6, 3(i)7, 3(i)8, and 3(i)9.

(k) Final Strike-Off, Consolidation, and Finishing. Modified as follows:

2. Floating. Add the following:
Do not use steel or Fresno Floats.

(l) Curing Concrete. Modified as follows:

1. Normal Curing. Replace the first sentence with the following:
Apply curing materials after finishing and texturing, and within 30 minutes of the dissipation of bleed water. Maintain the curing materials until the pavement has achieved sufficient strength for opening to traffic as specified in Section 548.3(q).

Add the following paragraph:

Provide adequate insulating blankets to prevent rapid heat loss if the air temperature is 40F or less. Insulation may be removed when the air temperature exceeds 40F or when the average compressive strength of the concrete exceeds 3,600 pounds per square inch. Remove insulation in a manner such that the rate of temperature change at the concrete surface does not exceed 40F within any 1-hour period. Take temperature readings of the concrete surface during insulation removal. Concrete that experiences a higher rate of temperature change may be considered defective.

1.c White Membrane Forming Curing Compound. Replace the second sentence of the second paragraph with the following:
Apply curing compound evenly to provide a uniform, solid white opaque coverage on all exposed concrete surfaces. Apply at a minimum rate of 1 gallon (± 0.1 gallon) per 150 square feet for pavements > 6 inches and per 125 square feet for pavements ≤ 6 inches or according to the manufacturer's recommendations, whichever is greater. If conditions warrant, the curing compound can be applied in two equal rates of application, with the first applied as stated previously and the second applied immediately after sawing operations have been completed. Joint faces must be protected from exposure to curing compound or cleaned thoroughly prior to sealant installation.

(o) Surface Tolerance. Replace with the following:
Section 506.3(o)

(q) Opening to Traffic. Replace with the following:
The Representative will determine when pavement will be open to traffic based on when the concrete attains the minimum required compressive strength according to Table A as measured either by compressive strength testing of cylinders in accordance with PTM No. 604 or by concrete maturity specifications in accordance with PTM 640.

Table A

Slab Thick, inches	Strength for Opening to Traffic, psi			
	Length < 10 ft		Length ≥ 10 ft	
	f'c	MR (3rd)	f'c	MR (3rd)
6.0	3000	490	3600	540
7.0	2400	370	2700	410
8.0	2150	340	2150	340
9.0	2000	275	2000	300
10.0 +	2000	250	2000	300

(u) Concrete Overlay Transitions. Add this section as follows:
Construct transitions at the limits of the concrete overlay as indicated. In areas where transitions contain existing treated base course or concrete pavement directly below the overlay, place geotextile as a debonding layer as specified in Section 548.3(e)3.a.

548.4 MEASUREMENT AND PAYMENT—

(a) Concrete Pavement Patching. Section 516.4(c)

(b) Slab Stabilization. Section 679.4(b) and (c)

(c) Slabjacking. Section 679.4(b) and (c)

(d) Flexible Base Replacement. Section 316.4

(e) Shallow Repairs. Square Foot

(f) Cement Concrete, Class AA. Cubic Yard
For producing the cement concrete needed for the overlay and delivering it to the jobsite. Computed based on the indicated depth of the overlay and the placement area. Includes all work associated with the construction of the concrete overlay with the exception of pre-overlay repairs. Excludes cement concrete material used in transition areas.

(g) Separation Layer – Geotextile. Square Yard
The unit price includes all required materials and placement/installation including sweeping.

(h) Separation Layer – Asphalt. Tons
The unit price includes all required materials and placement/installation including sweeping. The cost of necessary joint fault reduction efforts will be considered incidental to this item of work.

(i) Adjustment for Deficiencies. Section 501.4(a)

(j) Defective Pavement Left in Place. Section 501.4(b)

(k) Concrete Overlay Transition. Cubic Yard.
The unit price includes all associated items of work within the limits of the transitions.

(l) Evaluation of Concrete Pavement Ride Quality and Payment of Incentive. Section 507.4.

(m) Test for Depth. Section 501.4(c)

SECTION 590—CRACK CLEANING AND SEALING

590.1 DESCRIPTION—This work is cleaning and sealing of cracks in existing cement concrete pavements having an opening of 1/16 inch and wider.

590.2 MATERIAL—

(a) Joint Sealing Material. Section 705.4(b) or (c)

590.3 CONSTRUCTION—Saw or grind cracks to a width of 3/4 inch wide by 1 inch depth. Immediately after sawing and grinding, flush with water. If original crack is between 3/4 inch and 1 inch wide, saw or grind to a width of 1 inch and a depth of 1 1/4 inches.

Immediately before placing the sealant, thoroughly clean the crack. If using a compressed air stream, it should be at least 100 pounds per square inch measured at the source. Do not place sealing material until the faces are thoroughly clean and dry to the satisfaction of the Representative.

Seal cracks as specified in the applicable requirements in Section 501.3(n) and as specified here.

Do not place joint sealant unless the ambient air temperature is 40F or greater, and the pavement temperature is 40F or greater.

Fill the sealant reservoir to a level of 1/8 inch to 1/4 inch below the pavement surface.

590.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 591—MILLING OF CEMENT CONCRETE PAVEMENT SURFACE

591.1 DESCRIPTION— This work is milling of an existing cement concrete pavement surface to the indicated depth.

591.3 CONSTRUCTION—

(a) Equipment. Provide a milling machine designed and built for milling existing cement concrete pavements.

(b) Milling Operation. Mill to provide a finished surface that is free from gouges, grooves and ridges and that conforms to the surface tolerance requirements of Section 501.3(o). Immediately after milling, remove milled material. Carefully remove the existing cement concrete material around utility facilities within work areas. Repair or replace utility facilities that are damaged by the milling operation to the satisfaction of the utility owner. Control the rate of milling to avoid tearing of the mat, or chunky and non-uniformly milled material. If directed, separate oversized and chunky milled material. Maintain the milled pavement surface free of all loose materials and dust before placing a proposed asphalt overlay.

(c) Disposition of Milled Material. Satisfactorily dispose of the milled material or dispose as indicated.

591.4 MEASUREMENT AND PAYMENT—Square Yard

SECTION 600
INCIDENTAL CONSTRUCTION

SECTION 601—PIPE CULVERTS

601.1 DESCRIPTION—This work is construction or reconstruction, inspection, and cleaning of pipe culverts; including subsurface utility facilities, sewers, and storm drains. This work also includes the direct design, manufacturing and testing of reinforced concrete pipes.

601.2 MATERIAL—

(a) Pipes. Comply with the following:

1. Certification. Section 106.03(b)3

2. Size and Type of Pipe. As indicated.

3. Reinforced Concrete (RC) Pipe.

3.a Round and Elliptical Reinforced Concrete Pipe. Publication 280. Provide RC pipe conforming to BD-636M, PennDOT Design Manual Part 4, Appendix H, and the Pennsylvania Installation Direct Design (PAIDD) computer program or other Department accepted software program. Manufacture and test according to Publication 280.

3.b Plant Acceptance.

3.b.1 General. Do not begin fabrication before the Structural Materials Engineer's inspection and acceptance of the plant. Provide a permanent building offered for the Department's acceptance.

Material, equipment, test procedures, methods of fabrication, handling, storage, and transportation are subject to inspection. Through wall lift holes are permitted only if formed during the manufacturing process or cored after the pipe is cured on pipe diameters 42 inches (or elliptical equivalent) and larger. Punch through methods are prohibited on all pipe diameters. Through wall lift holes are prohibited on pipe diameters 36 inches (or elliptical equivalent) and smaller.

Register and certify the plant under either the American Concrete Pipe Association (ACPA) or National Precast Concrete Association (NPCA) plant certification program. Submit an annual endorsed copy to the Structural Materials Engineer for continued qualification.

3.c QC.

3.c.1 General. Establish a level of QC based on uniform production practices. Submit the plant's QC Plan and mix design(s) to the Structural Materials Engineer, BDTD, for review and approval. Include with the QC Plan a company organizational chart indicating a separate chain of command from the QC Manager to the Owner/Plant Manager independent of the Production Manager. Resubmit the QC Plan, mix design, and/or organizational chart, when required, due to changes in processes, materials, or personnel.

3.c.2 QC Manager. Provide a QC Manager who has the overall responsibility for the adequacy of production facilities, QC, sampling, and testing, and fabrication of the product, and who will ensure that items are fabricated as designed and specified. QC Managers are required to maintain an active ACI Grade I Field Technician Certification.

3.d Testing and Inspection.

3.d.1 Testing. Publication 280.

3.d.2 Inspection. Publications 145 and 280. Provide the necessary pipe inspection equipment and leaf gauges. Before installation, pipes may have non-through wall cracks of less than 0.003 inch in width. Any pipe having both an unloaded surface crack width of 0.003 inch or greater and extending 12 inches or longer, will be rejected. To determine whether rejection or remediation is required, measure crack widths with leaf gauges as described in AASHTO T 280. Use gauges having a thickness of 0.003 inches to determine pipe acceptability before installation.

4. Metal Pipes.

4.a Ductile Iron Pipe. ASTM A716

4.b Corrugated Steel Pipe, Metallic Coated. AASHTO M 36, Types I and IR; AASHTO M 218; AASHTO M 274; and AASHTO M 289

4.c Corrugated Aluminum Alloy Pipe. AASHTO M 196, Types I and IR

4.d Coated Corrugated Galvanized Steel Pipe. AASHTO M 245, Type I; AASHTO M 246; and AASHTO M 218. Fabricate pipes with coatings as follows:

- Grade 10/10 — 10 mil coating on all surfaces.

5. Half-Circle Pipe. Conforming to the requirements of the type indicated, except modified to meet the half-circle configuration.

6. Thermoplastic Pipes. Provide cell class of material (actual and minimum), minimum pipe stiffness, and the dimension ratio, when applicable, if not included in pipe markings. Thermoplastic connection for T-Y-K sections that meet the requirements of this section are allowed on pipe runs.

6.a Group I. 15-foot maximum fill—1.5-foot minimum fill height.

6.a.1 Polyethylene.

- ASTM F714, Type S, SDR<21, cell class 335434C, 48-inch diameter maximum
- ASTM F714, Type S, SDR=26, cell class 335434C, 21-inch diameter—48-inch diameter only
- ASTM F894, Type S, RSC=100, cell class 335434C, 36-inch maximum diameter
- ASTM F894, Type S, RSC=160, cell class 335434C, 18-inch diameter—42-inch diameter only

6.a.2 Polyvinyl Chloride.

- ASTM F794, Type S, PS=46, cell class 12454C or 12364C, 48-inch diameter maximum
- AASHTO M 304, Type S, cell class 12454C, 48-inch maximum diameter
- AASHTO M 304, Type S, cell class 12364C, 18-inch to 48-inch diameter
- ASTM F679, Types S, T1, or T2, PS=46, cell class 12364C or 12454C, 36-inch maximum diameter
- AASHTO M 278, Type S, cell class 12454B, 12-inch diameter and 15-inch diameter only

6.b Group II. 12-foot maximum fill—1.5-foot minimum cover. Section 601.2(a)6.a and as follows:

6.b.1 Polyethylene. ASTM F894, Type S, RSC=100, cell class 335434C, 42-inch diameter

6.c Group III. 8-foot maximum fill—2-foot minimum cover. Section 601.2(a)6.a and as follows:

6.c.1 Polyethylene.

- AASHTO M 294, Types D and S, cell class 435400C, 30-inch maximum diameter; PennDOT Design Manual Parts 2 and 4, and 2014 AASHTO LRFD Bridge Design Specifications Chapter 12.

6.c.2 Polyvinyl Chloride.

- AASHTO M 304, cell class 12364C, 12-inch diameter and 15-inch diameter

6.d Group IV. 7-foot maximum fill—2.5-foot minimum cover.

6.d.1 Polyethylene.

- AASHTO M 294, Types D and S, cell class 435400C, 36-inch, 42-inch, 48-inch; PennDOT Design Manual Parts 2 and 4, and 2014 AASHTO LRFD Bridge Design Specifications Chapter 12.

- AASHTO M 294, Type S, cell class 435400C, 54-inch and 60-inch diameters; PennDOT Design Manual Parts 2 and 4, and 2014 AASHTO LRFD Bridge Design Specification Chapter 12.

6.e Group V. 7-foot maximum fill—2.5-foot minimum cover

6.e.1 Polyethylene.

- AASHTO M 294, Type C, cell class 435400C, 24-inch maximum diameter

6.f Group VI. 15-foot maximum fill—2.0-foot minimum cover

6.f.1 Polyethylene.

- AASHTO M 294, Types D and S, cell class 435400C; PennDOT Design Manual Parts 2 and 4, and 2014 AASHTO LRFD Bridge Design Specifications Chapter 12.

6.f.2 Polypropylene.

- AASHTO M 330, Types D and S, 12-inch to 60-inch diameter; PennDOT Design Manual Parts 2 and 4, and 2014 AASHTO LRFD Bridge Design Specifications Chapter 12.

6.g Group VII. 12-foot maximum fill—2.0-foot minimum cover

6.g.1 Polyethylene (High Density Polyethylene (HDPE) 100-year pipe).

- AASHTO M 294, Type S, cell class 435400C, 18-inch, 21-inch, 24-inch, 30-inch, 36-inch, 42-inch, 48-inch, and 60-inch diameters; PennDOT Design Manual Parts 2 and 4, and 2014 AASHTO LRFD Bridge Design Specifications Chapter 12 with:

  F_u min = 0.5 ksi
  E min = 20 ksi

- Comply with the requirements of Table 1 for initial product approval testing. Comply with the requirements of Table 2 for production quality control sampling and testing in addition to the requirements of AASHTO M 294. Provide watertight joints according to AASHTO M 294 using a bell and spigot design. Except: as noted below in Bulletin 15 Product Approval and Approved Product Changes, Resubmittal, and Approval.

TABLE 1			
6.g.1(a) Stress or Crack Resistance (SCR) of Pipes			
Pipe Location	**Test Method**	**Test Conditions**	**Test Requirements**
1. Pipe Liner	FM 5-572, Procedure A	10% Igepal solution at 122F and 600 psi applied stress; 5 replicates	average failure time of the pipe liner ≥ 18 hours, no single value < 13 hours
2. Pipe Corrugation[1], (molded plaque)	ASTM F2136	10% Igepal solution at 122F and 600 psi applied stress; 5 replicates	average failure time ≥ 24 hours, no single value < 17 hours
3.b Junction	FM 5-572, Procedure B and FM 5-573	Full Test[2]: Test temperature 176F and applied stress of 650 psi and 450 psi. Also, test temperature 158F and applied stress of 650 psi; 5 replicates at each of three test conditions.	Determine failure time at 500 psi at 73.4F ≥ 100 years (95% lower confidence) using 15 failure time values[3]. The tests for each condition can be terminated at duration equal to or greater than the following criteria: 110 hours at 176F: 650 psi 430 hours at 176F: 450 psi 500 hours at 158F: 650 psi
3.b Junction		Single Test[4]: Test temperature 176F and applied stress of 650 psi; 5 replicates.	average failure time ≥ 110 hours
4.a Longitudinal Profiles[5]	FM 5-572, Procedure C and FM 5-573	Full Test[2]: Test temperature 176F and applied stress of 650 psi and 450 psi. Also, test temperature 158F and applied stress of 650 psi; 5 replicates at each of three test conditions.	Determine failure time at 500 psi at 73.4F ≥ 100 years (95% lower confidence) using 15 failure time values[3]. The tests for each condition can be terminated at duration equal to or greater than the following criteria: 110 hours at 176F: 650 psi 430 hours at 176F: 450 psi 500 hours at 158F: 650 psi
4.b Longitudinal Profiles[5]		Single Test[4]:	average failure time ≥ 110 hours

		Test temperature 176F and applied stress of 650 psi; 5 replicates.	
6.g.1(b) Oxidation Resistance of Pipes			
Pipe Location	**Test Method**	**Test Conditions**	**Test Requirements**
1. Liner and/or Crown[6]	OIT test (ASTM D3895)	2 replicates (to determine initial OIT value) on the as manufactured (not incubated) pipe	25 minutes, minimum
2. Liner and/or Crown[6]	Incubation test FM 5-574 and OIT test (ASTM D3895)	Three samples for incubation of 265 days at 176F[7] and applied stress of 250 psi. One OIT test per each sample.	average of 3 minutes[8, 9] (no values < 2 minutes)
3. Liner and/or Crown[6]	MI test (ASTM D1238 at 374F/4.762 lb	2 replicates on the as manufactured (not incubated) pipe	< 0.4 g/10 minutes
4. Liner and/or Crown[6]	Incubation test FM 5-574 and MI test (ASTM D1238 at 374F/4.762 lb	2 replicates (total) on the three aged samples after incubation of 265 days at 176F[7] and applied stress of 250 psi	MI Retained Value[9, 10, 11] > 80% and < 120%
6.g.1(c) Long Term Tensile Properties			
Pipe Location	**Test Method**	**Test Conditions**	**Test Requirements**
1. Liner	FM 5-577	2 replicates at applied stress of 500 psi	Determine creep modulus at 100-year at 73.4F ≥ 20,000 psi (95% lower confidence).
2. Junction[11]	FM 5-577, Procedure B	Test at 3 temperature/stress combinations: 176F at 650 psi 176F at 450 psi 158F at 650 psi; 5 replicates at each test condition.	Determine tensile strength at 100-year at 73.4F ≥800 psi (95% lower confidence) using 15 failure time values[3,12]. The tests for each condition can be terminated at duration equal to or greater than the following criteria: 110 hours at 176F: 650 psi 430 hours at 176F: 450 psi 500 hours at 158F: 650 psi
6.g.1(d) Antioxidant Index			
Pipe Location	**Test Method**		**Test Requirements**
Liner, Crown, Junction Corrugation	ASTM D6953-03		QA Index All pipe sizes

Note:

FM = Florida Method of Test
MI = Melt Index
OIT = Oxidative Induction Time

1. Required only when the resin used in the corrugation is different than that of the liner.
2. Perform full test on alternative (redesign) pipe diameter of pipe based on wall profile design, raw

material cell classification, and manufacturing process. Full test must be performed on maximum and minimum pipe diameters within a manufacturing process.

3. Provide documentation to predict the 100-year stress crack resistance with a 95% lower confidence.
4. Single test for the junction and longitudinal profile may be used on alternate (redesign) pipe sizes within a manufacturing process. Single point tests may not be used on maximum and minimum pipe sizes within a manufacturing process except by approval of LTS, Engineer of Tests. Single point tests may be used for quality assurance testing purposes.
5. Longitudinal profiles include vent hole(s), molded lines and circumferential weld seam.
6. OIT and MI tests on the crown are required when resin used in the corrugation is different than that of the liner.
7. The incubation duration and temperature can also be 187 days at 185F.
8. Within each replicate set of tests, the discrepancy range is to be within 6%. If an out-of-range discrepancy occurs, repeat the three OIT tests.
9. Perform the tests for incubated and "as-manufactured" pipe samples by the same lab, same operator, the same testing device, and in the same day.
10. Within each replicate set of tests, the discrepancy range is to be within 9%. If an out-of-range discrepancy occurs, repeat the two MI tests on the same pipe sample. If insufficient material is available, a repeat of one test is acceptable.
11. The MI retained value is determined using the average MI value of incubated sample divided by the average MI value of as-manufactured pipe sample.
12. The junction test results from the SCR test may be used to establish the minimum 100-year tensile strength of 800 psi.

- Florida Department of Transportation (FDOT) Method of Test: FM 5-572, Determining Stress Crack Resistance of HDPE Corrugated Pipes; FM 5-573, Predicting the Crack Free Service Life of HDPE Corrugated Pipes; FM 5-574, Predicting the Oxidation Resistance of HDPE Corrugated Pipes; FM 5-577, Predicting Long-Term Modulus of HDPE Corrugated Pipes. The laboratory performing these tests must be certified by the Geosynthetic Accreditation Institute (GAI).

- Provisional approval can be granted for all current Bulletin 15 approved products as well as products currently pending approval. Final approval will only be granted to systems which meet all requirements as currently outlined.

- **Bulletin 15 Product Approval (initial Bulletin 15 listing)**
  Initial testing of all 100 year HDPE pipes will include:

  Third party independent testing of all sizes, profiles, and manufacturing locations for all:

  1. AASHTO M 294 requirements (*except: ASTM D3212–testing for joint integrity)
  2. All Table 1 testing requirements (Note: only footnotes 1,3, and 5-12 apply)
  3. Fingerprint of antioxidant package by ASTM D6953-03 “Determination of Antioxidants and Erucamide Slip Additives in Polyethylene Using Liquid Chromatography” to be used to index the antioxidant package for future confirmatory testing.

     *The capability to provide watertight joints as per ASTM D3212 can be demonstrated by testing representative samples in the presence of the Representative in lieu of providing third party data.
  4. Manufacturers must submit to BOPD, information pertaining to materials identity, antioxidant variation, carbon black variation, and QC/QA plans for review and approval before use. Any change in resin or antioxidant raw materials from the initial product approval must be resubmitted to the Department for reevaluation and approval.

- **<u>Bulletin 15 Approved</u> <u>Product Changes, Resubmittal and Approval</u>**
  The following instances/changes trigger resubmittal:

  - Design
  - Antioxidant package
  - Additional sizes
  - Manufacturing location

  Full retest includes:

  1. AASHTO M 294 requirements (*except: ASTM D3212–testing for joint integrity)
  2. All Table 1 testing requirements (Note: all footnotes apply)
  3. ASTM D6953 antioxidant fingerprint

     *The capability to provide watertight joints as per ASTM D3212 can be demonstrated by testing representative samples in the presence of the Representative in lieu of providing third party data.

  Exceptions include:

  1. If no change in antioxidant package can be confirmed to be the same by ASTM D6953 antioxidant fingerprint then the Table 1 Oxidation Resistance tests 6.g.1(b)2 and 6.g.1(b)4 can be omitted.
  2. If solely a Design (longitudinal profile) change; than the Table 1 single point testing of SCR 6.g.1(a)4.b; full testing can be omitted. Take sample on the circumferential weld seam.

TABLE 2			
Pipe Location	**Test Method**	**Test Requirements**	**Minimum Test Frequency**
Pipe Liner	FM 5-572, Procedure A	Greater than or equal to the value of the initial approval test (within the statistical precision and bias of the test method).	Monthly[2]
Liner and/or Crown[1]	OIT test (ASTM D3895)	25 minutes, minimum	Quarterly[2]
1. OIT test on the crown is required when resin used in the corrugation is different than that of the liner. 2. The test is applicable for each pipe diameter manufactured within the stated time period.			

6.g.2 Polypropylene.

- AASHTO M 330, Types D and S, 12-inch to 60-inch diameter; PennDOT Design Manual Parts 2 and 4, and 2014 AASHTO LRFD Bridge Design Specifications Chapter 12 with:

  F_u min = 0.5ksi
  E min = 20 ksi

- Comply with the requirements of Table 3 for initial product approval testing.

TABLE 3			
Stress Crack Resistance (SCR) of Pipes			
Pipe Location	**Test Method**	**Test Conditions**	**Test Requirements**

Pipe Liner	FM 5-572, Procedure A	10% Igepal solution at 122F and 600 psi applied stress; 5 replicates	average failure time of the pipe liner ≥ 100 hours, no single value < 71 hours[1]
Oxidation Resistance of Pipes			
Pipe Location	**Test Method**	**Test Conditions**	**Test Requirements**
Liner and/or Crown[2]	OIT Test (ASTM D3895)	2 replicates (to determine initial OIT value) on the as manufactured (not incubated) pipe	25 minutes, minimum
Liner and/or Crown[2]	Incubation test FM 5-574 and OIT test (ASTM D3895)	Three samples for incubation of 264 days at 185F[3]. One OIT test per each sample.	average of 3 minutes[4] (no values < 2 minutes)
Liner and/or Crown[2]	MI test (ASTM D1238 at 446F/4.762 lb	2 replicates on the as manufactured (not incubated) pipe	< 1.5 g/10 minutes
Liner and/or Crown[2]	Incubation test FM 5-574 and MI test (ASTM D1238 at 446F/4.762 lb	2 replicates (total) on the three aged samples after incubation of 264 days at 185F[3]	MI Retained Value[4, 5, 6] > 80% and < 120%
Antioxidant Index			
Pipe Location	**Test Method**		**Test Requirements**
Liner, Crown, Junction Corrugation	ASTM D6953-03		QA Index All pipe sizes

Note:

FM = Florida Method of Test
MI = Melt Index
OIT = Oxidative Induction Time

1. If, due to sample size, this test cannot be completed on the liner, then conduct testing on a molded plaque sample. Samples can be removed if test time exceeds 100 hours without failure.
2. OIT and MI tests on the crown are required when resin used in the corrugation is different than that of the liner.
3. The incubation duration and temperature can also be 192 days at 194F or 140 days at 203F.
4. Perform the tests for incubated and "as-manufactured" pipe samples by the same lab, same operator, the same testing device, and in the same day.
5. Within each replicate set of tests, the discrepancy range is to be within 9%. If an out-of-range discrepancy occurs, repeat the two MI tests on the same pipe sample. If insufficient material is available, a repeat of one test is acceptable.
6. The MI retained value is determined using the average MI value of incubated sample divided by the average MI value of as-manufactured pipe sample.

(b) Other Material.

- Premolded Expansion Joint Filler—Section 705.1
- Mortar—Section 705.7(a)
- Caulking Compound—Section 705.8(a)
- Preformed Pipe Joint Gaskets—Section 705.5(b)
- Cement Concrete for Miscellaneous Drainage—Section 704
- Reinforcement Steel—Section 709

- Coarse Aggregate—Type C or better, Section 703.2
- Curing Compound—Section 711.2
- Curing and Protecting Covers—Section 711.1
- Asphalt Paint—Federal Specification TT-V-51F. Certify as specified in Section 106.03(b)3.
- Zinc Chromate Primer—Federal Specification TT-P-645. Certify as specified in Section 106.03(b)3.
- Flowable Backfill—Section 220.1(a)
- Geotextile, Class 4, Type A—Section 735
- Geotextile, Class 1 – Section 735
- Watertight Joint Gasket. ASTM F477

(c) Grout. Mix one part cement and two parts fine aggregate with the minimum amount of water necessary to obtain grout of the required consistency containing 3% to 7% entrained air. Air entraining cement may be used in place of the plain cement and air entraining admixture. Use materials conforming to the following requirements:

- Cement—Section 701
- Fine Aggregate—Type A or C, Section 703.1
- Water—Section 720.1
- Admixtures—Section 711.3

601.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) General. Provide 12-inch minimum cover from the bottom of base course to the top of pipe barrel. Construct the embankment to 4 feet above the top of pipe elevation or to subgrade, whichever is less, before excavating for the pipe. Do not haul over pipe with less than 4 feet of cover over the top of pipe barrel. Maintain a minimum pipe slope of 0.35% on drainage pipes unless otherwise specified.

If running water is encountered and cannot be diverted, provide an acceptable temporary pipe or other structure before placing embankment, or as otherwise directed.

Before placing pipe, inspect pipe for any defects such as cracks, dents, spalls, and/or coating as specified in Publication 280.

In advance of installation, submit to the Representative a detailed list of lifting equipment and hardware, including their rated capacity from the manufacturers for each size of pipe being installed. In addition, perform a visual review of the lifting equipment and hardware each day before installation for signs of damage or wear. Replace damaged or worn lifting equipment and hardware before use.

(b) Trench and Bedding. Excavate trench and construct bedding as shown on the Standard Drawings. Compact and proof roll the bottom of the trench as specified in Section 601.3(f)1 before placement of bedding material. Place appropriate bedding material for the type of pipe being placed. Do not compact pipe bedding materials. If, following compaction, the trench bottom is unable to withstand the force of the compaction equipment and provide adequate bearing for the bedding and pipe, discontinue work and immediately notify the Representative. Provide a proposed means to remediate the condition to provide adequate bearing to the Representative for review and acceptance before starting construction. Document the insufficient bearing location and the remediation technique on Form CS-6 for future reference. If flowable backfill material is used, provide support for pipe as specified in Section 220.3(b)2.

(c) Laying Pipe. Lay pipe as shown on the Standard Drawings before constructing base course or pavement. Lay

pipe with bells or grooves up grade in shaped recesses when required, spigot ends fully entered into the hubs. Begin placement of the pipe at the outlet end with a full length of pipe and continue towards the inlet end, unless otherwise directed. Fill lift holes with a manufactured lift hole plug that is soil-tight.

Control the pipe alignment and grade with suitable string lines, with an electronic laser beam system, or by other acceptable methods.

Camber the grade line to offset anticipated settlement due to the height of embankment and bedding used, if directed.

On straight-line pipe placements, join pipe sections according to the joint requirements specified in Section 601.3(n). Verify joint gaps during progressive pipe installation. If joint gaps cannot be maintained within the tolerance listed in Section 601.3(n), stop work and investigate the cause. Commence construction after resolving any joint fitup problem. Join pipes placed on a radius to within these tolerances as measured at a point halfway up the pipe, springline, along the interior of the curve. For pipe runs placed on curves with a radius less than 765 yards (greater than 2 degrees, 30 minutes) use shorter lengths of precast pipe to minimize the joint gap.

If pipes are protected by endwalls or connected with drainage structures, place exposed pipe end within cast-in-place wall or cut off flush with precast structure face and finish with mortar, as directed. Provide satisfactory connections to existing drainage structures.

Coat all aluminum surfaces that will be embedded into concrete with one coat of zinc chromate primer, or a coat of asphalt paint. Allow coating to dry completely before placement of concrete.

If an existing utility facility or other obstruction is encountered which will prohibit the proper installation and backfill of the pipe, cease installation and notify the Representative immediately. Carefully excavate by hand if necessary to determine the nature and extent of conflict. Submit to the Representative a sketch or plan sheet showing the extent and nature of conflict. The Representative will provide direction to arrange for relocation of the utility facility, remove the obstruction(s), or complete the installation in a modified manner. Document the location of the obstruction and the remediation technique on Form CS-6 for future reference.

(d) Joints. Lay pipe, except interlocking style and pipe joined with bands, with pipe joint caulk or preformed pipe joint gaskets or elliptical concrete pipe as follows:

1. Pipe Joint Caulk. Before placing succeeding pipe sections, place the caulk on the inside of the bell end of the pipe, such that a sufficient layer of material is placed around the entire circumference of the pipe. After the joint is assembled, remove excess caulk on the inside of the pipe, such that the flow of water is not obstructed and seal the outside circumference of the joint.

2. Preformed Pipe Joint Gaskets. Before placing succeeding pipe sections, place preformed pipe joint gaskets according to manufacturer's recommendation.

3. Elliptical Concrete Pipe. Wrap the joint of the pipes with two layers of Geotextile, Class 1, as shown on Standard Drawings, RC-30M.

4. Metal Pipe. Minimum metal pipe connecting band width of 12 inches. Use two layers of Geotextile, Class 1, as shown on Standard Drawings, RC-30M, if the connecting partial and fully corrugated band dimples do not properly index into each corrugation valley at the pipe end. Verify the corrugation indexing as part of joint inspection.

(e) Elongation of Metal Pipes. When indicated, elongate metal pipe vertically 5%, using acceptable shop methods. Elongate coated pipe by acceptable shop methods only. Satisfactorily repair coating damaged by elongation procedures.

(f) Backfilling Trench. After the pipe is laid, backfill the trench as shown on the Standard Drawings with suitable material above the course aggregate layer as approved by the Representative. Place material in accordance with the Standard Drawings and as specified for the portion of the trench where the backfill is being placed and the placement condition. Compact backfill material for the full trench width, as specified in Section 206.3(b) for the specific material type placed. Use equipment with a consistent application force that will not damage the pipe. Test as specified in Section 206.3(a). If flowable backfill material is used, backfill the trench as shown in the Flowable Backfill Detail on the Standard Drawings, and as specified in Section 220.3.

1. Bottom of Trench. Compact and proof roll the bottom of the trench with the equipment, as specified in Sections 108.05(c)3.d, 3.g, 3.i, or 108.05(c)4, that will be used to compact the backfill before placing the pipe bedding

material. The use of an excavator-mounted hydraulic plate compactor (hoe pac) for proof rolling is not allowed. Compact trench bottom as specified in Section 206.3(b) for the specific material type present. Perform proof rolling only in the presence of the Representative who will assess and approve or disapprove the stability of the area being investigated. In wet areas or unstable areas, the Representative may waive this requirement if other stabilization or treatment measures are indicated and/or required. Any areas displaying permanent deformation greater than 1/2 inch are considered unstable. Treat unstable areas by excavating material in the area to a depth of 1 foot. Dry the material and recompact or replace with compacted suitable material of the same type or other material, including Soil, Type 1 granular material, and Type 2 granular material, as specified in Section 206.2(a)1, except having particles no greater than 2 inches in size, as approved by the Representative or as indicated.

2. Sides of Trench. Place No. 2A Coarse Aggregate backfill in compacted 4-inch layers to the height shown on the Standard Drawings. Compact with equipment, as specified in Section 108.05(c)4. Do not compact the backfill directly over the crown of the pipe as shown on the Standard Drawings.

3. Above Pipe or Conduit. Backfill from the top of the required No. 2A Coarse Aggregate, as shown on the Standard Drawings, to the finished grade elevation with suitable material or other material, including Soil, Type 1 granular material, and Type 2 granular material, as specified in Section 206.2(a)1, except having particles no greater than 2 inches in size, when the trench is located beyond the roadway footprint, including the shoulders. For pipes constructed in new embankments, backfill to the pavement subgrade elevation (bottom of the pavement subbase layer) with No. 2A Coarse Aggregate when the trench is located within the roadway footprint, including the shoulders, and the distance from the top of pipe elevation to the pavement subgrade elevation is less than or equal to 4 feet. When the distance is greater than 4 feet, suitable material or other material, including Soil, Type 1 granular material, and Type 2 granular material, as specified in Section 206.2(a)1, except having particles no greater than 2 inches in size, may be placed from the top of the required No. 2A Coarse Aggregate to the pavement subgrade elevation. For reconstruction or replacement of pipes/utilities under existing pavements, backfill the entire trench with No. 2A Coarse Aggregate regardless of the distance from the top of pipe to the pavement subgrade elevation.

Place in 5-inch loose layers when using equipment, as specified in Sections 108.05(c)3.d and 108.05(c)4. Up to 10-inch loose layers are acceptable if using a vibratory roller, as specified in Section 108.05(c)3.i. If using a backhoe-mounted hydraulic plate compactor, up to 12-inch loose layers are acceptable.

(g) Shored or Trench Box Installation. Construct shored or trench box installation where indicated and as specified in Section 107.08. Construct shored or trench box installation as required for reinforced concrete pipe.

Construct shored or trench box installations for thermoplastic or metal pipe as follows:

- Leave trench sheeting in place to prevent loss of foundation support and backfill materials unless otherwise directed by the Chief Bridge Engineer. When the top of trench sheeting is to be cut off, make the cut 18 inches or more above the crown of the pipe. Leave rangers, walers, and braces in place as required to support the cut off sheeting and trench wall in the vicinity of the pipe zone. Leave timber sheeting in place. Treat timber sheeting against biological degradation and decay if placed above the ground water table.

- Do not disturb the installed pipe and its embedment when using movable trench boxes and shields. Do not use movable supports below the top of the pipe backfill pay limit zone unless methods for maintaining the integrity and level of compaction of the backfill material are submitted to and approved by the Chief Bridge Engineer. Before moving supports, place and compact embedment to sufficient depths to ensure protection of the pipe. Finish placing and compacting the backfill material as supports are moved.

- If the use of sheeting or other trench wall supports is permitted below the pipe backfill pay limit zone, ensure that pipe, bedding, and backfill materials are not disturbed by support removal. Fill voids left upon removal of supports and compact all material to required densities.

(h) Jacked Pipe. Jack pipe by means of conventional tunneling or boring methods, when indicated. Before commencement of this work, submit a complete plan and schedule for pipe installation. Include complete details of sheeting, shoring, and bracing for the protection of facilities above the pipe, as well as materials and equipment pertinent to the jacking operation. Do not proceed with pipe installation until the plan and schedule are accepted.

Do not disturb facilities or cause settlement of the ground above the pipe. Provide free and unobstructed use of

facilities above the pipe, without delay or danger to life, equipment, or property.

Install pipe immediately following the heading or tunneling excavation. After completion of the jacking operation, fill voids around the pipe with grout placed under pressure. Properly protect the grout for at least 3 days.

Place joint sealant material on concrete pipe in front of the jacking frame. Replace or repair pipe damaged during the jacking operations as directed. If steel casing pipe is used, butt-weld the joints as installation progresses. Make joints watertight.

Where 100-year service life pipe is installed using a steel pipe casing, the joint gap tolerances do not apply provided the annular space between the liner pipe and the jacked pipe is filled with grout and where no visible grout leakage is observed during the post installation inspection.

If it is determined that the pipe installation is being conducted in an unsatisfactory manner, stop this work and place a bulkhead at the heading until an alternate procedure is proposed and accepted.

(i) Extension of Existing Pipe. If extensions of pipe culverts or drains are indicated or required, remove the existing endwalls as directed. Cut the existing pipe to a true edge, as required, to make a satisfactory joint. Join the new pipe to the existing pipe or endwalls, using acceptable collars constructed of Class A Concrete or acceptable metal connecting bands. Clean the existing pipe, as specified in Section 601.3(j). Repair or replace existing pipe damaged during construction.

As an alternate to removing the endwall, if permitted, extend the pipe using a concrete collar for pipe extension, as specified in Section 618.

(j) Cleaning Existing Pipes. Clean existing pipe culverts, as indicated and as directed, before the start of roadway paving operations. Clean inlets, bridge scuppers and piping, manholes, endwalls, and other drainage appurtenances connected to the pipes, as directed. Clean in an acceptable manner and repair damage resulting from the cleaning operation. Remove any material deposited in inlets during paving operations. Prevent material cleaned from the drainage system from entering streams or other bodies of water, and dispose of this material in a satisfactory manner.

(k) Relaid Pipe. Remove and clean existing pipes as indicated, and have them inspected by the Representative. Transport and relay accepted existing pipes at the indicated locations, in the same manner specified for new pipes.

(m) Removal and Replacement. Remove and replace pipe that is not true to alignment, shows settlement after installation, or is broken or damaged.

(n) Final Inspection of Pipes Except 100 Year Design Life Pipes. Before final acceptance, inspect all of the following types of installed pipe with total backfill/embankment load applied. Perform inspection on pipes at least 30 days after backfill/embankment is completed. If the final wearing course is placed more than 30 days after the pipe backfill/embankment is completed, the inspection must be performed before placing final wearing course. Provide pipe inspection equipment and inspect all pipes over 30 inches in diameter from inside the pipe. Inspect 18-inch to 30-inch diameter pipes from access points. Provide written documentation on Form CS-601 of all inspections to the Representative following each inspection. Locations of pipe installation documented as having been modified due to obstructions or insufficient bearing will be excluded from the acceptance criteria of this section.

1. Concrete Pipes. Provide pipe gauges, as specified in Section 601.2(a)3.d.2. and inspect concrete pipes for signs of damage. Inspection criteria for the pipe are as follows:

1.a Joints.

- If joint separation is greater than the joint gap installation allowance but less than the maximum joint gap allowance noted in Tables A or B and soil tight, then the pipe joint will be accepted with reduced payment. Note all joint gaps that are greater than the installation allowance in the inspection report.
- If joint separation is greater than the maximum joint gap allowance noted in Tables A or B and soil tight, then submit a remediation plan for repair or replacement as specified in Section 601.3(p). Note all joint gaps that are greater than the installation allowance in the inspection report.
- If any soil infiltration is identified at the pipe joint during inspection a pipe analysis and a remediation plan for repair or replacement as specified in Section 601.3(p) is required. Note all joints with soil infiltration in the inspection report.

TABLE A ROUND PIPE**		
Diameter (inches)	**Joint Gap Installation Allowance (inches)**	**Maximum Joint Gap Allowance (inches)**
12-36	0.700	1.000
42-54	0.800	1.200
60-72	0.850	1.275
78-90	0.900	1.350
96	1.000	1.500

TABLE B ELLIPTICAL PIPE**		
Equivalent Diameter (inches)	**Joint Gap Installation Allowance (inches)**	**Maximum Joint Gap Allowance (inches)**
18-36	0.750	1.125
42-48	0.850	1.275
54-60	0.900	1.350
66-72	1.200	1.500

**Special design joints will be subject to manufacturer submittal and individual review and approval. If the bell depth is greater than the tongue depth, include the difference between these depths to the joint gap table allowances.

1.b Cracks. Cracks with a width less than or equal to 0.007 inches are considered hairline and minor. Note these cracks in the inspection report; however, no remedial action is necessary.

Cracks identified during inspection having a width greater than 0.007 inches and a length greater than 12 inches require a pipe analysis and a remediation plan for repair or replacement as specified in Section 601.3(p). Note these cracks in the inspection report.

1.c Spalls/Chips. Check spalling area for exposed reinforcement.

- If spalling area has no exposed reinforcement, then repair according to Publication 145, Non-Structural Repair Section. Note these spalls in the inspection report.
- If spalling area has exposed reinforcement with a single spall area less than or equal to 150 square inches, then repair according to Publication 145, Structural Repair Section. Note these spalls in the inspection report.
- If spalling area has exposed reinforcement with a single spall area greater than 150 square inch, prepare and submit a pipe analysis and a remediation plan for repair or replacement as specified in Section 601.3(p). Note these spalls in the inspection report.

2. Metal Pipes. Inspect metal pipes for damage. Perform deflection testing using either electronic deflectometers, calibrated television or video cameras, properly sized, 9-leg (minimum) “go, no-go” mandrel, direct measurement by extension rulers or tape measures in pipes that allow safe entry, or other acceptable devices. At a minimum, perform deflection testing if pipe cannot be physically inspected. Inspection criteria for the pipe are as follows:

2.a Joints.

- If joint separation is greater than the joint gap installation allowance but less than the maximum joint allowance noted in Table C and soil tight, then the pipe joint will be accepted with reduced payment. Note all joint gaps that are greater than the installation allowance in the inspection report.
- If joint separation is greater than the maximum joint allowance noted in Table C and soil tight, then submit a remediation plan for repair or replacement as specified in Section 601.3(p). Note all joint gaps that are greater than the installation allowance in the inspection report.
- If any soil infiltration is identified at the pipe joint during inspection a pipe analysis and a

remediation plan for repair or replacement as specified in Section 601.3(p) is required. Note all joint with soil infiltration in the inspection report.

TABLE C METAL PIPE AND PLATE CULVERT		
Material	**Joint Gap Installation Allowance (inches)**	**Maximum Joint Gap Allowance (inches)**
Corrugated Metal Pipe, Type I (Round)	1.500	2.000
Corrugated Metal Pipe, Type II (Pipe-Arch)	2.000	2.500
Metal Plate Culvert	N/A[1]	N/A[1]
Iron Ductile Pipe (All Diameters)	1.000	1.500

Note:
1. Structural plates have lap joints.

2.b Coating. Repair damaged coatings according to AASHTO M 36 and AASHTO M 245 where the original coating has pinholes, blisters, cracks in the coating, lack of coating bond to surface, or loss of galvanizing. Note coating damage in the inspection report. Perform repairs at no expense to the Department.

2.c Deflection/Buckle. Note all deflections in the inspection report. Prepare and submit a pipe analysis and a remediation plan for repair or replacement as specified in Section 601.3(p) if deflection is greater than 7.5% of a round pipe nominal diameter plus a manufacturing tolerance of 1% or 1/2-inch undersize, whichever is greater.

For pipe arch, prepare and submit a pipe analysis and a remediation plan for repair or replacement as specified in Section 601.3(p) if the deflection limits of 7.5% decrease in rise and a 7.5% increase in span from the nominal dimension with no allowance for manufacturing tolerance are exceeded. Note all deflections in the inspection report.

2.d Dents. Note all dents in the inspection report. If any of the following criteria are identified in the report, then prepare and submit a pipe analysis and a remediation plan for repair or replacement as specified in Section 601.3(p).

- Dents greater than 5 % deflection of diameter
- Dents with an area greater than 1.0 square feet
- Dents with a length or width greater than 10 % of the circumference

2.e Holes. Note all holes in the inspection report.

- Holes with a diameter less than 1/2 inch without water leakage or soil infiltration will be accepted.
- Pipes with diameters greater than 30 inches having holes with a diameter less than 1/2 inch which exhibit either water leakage or soil infiltration require an internal repair patch as shown in Project Office Manual (POM) C.6.11.
- Pipes 30 inches and less in diameter having holes with a diameter less than 1/2 inch which exhibit either water leakage or soil infiltration require a remediation plan for repair as specified in Section 601.3(p).
- Pipes with diameters greater than 30 inches having holes with a diameter greater than or equal to 1/2 inch but less than the width of 1.5 of corrugation require an internal repair patch as shown in POM C.6.11.
- Pipes 30 inches and less in diameter having holes with a diameter greater than or equal to 1/2 inch but less than the width of 1.5 of corrugation require a remediation plan for repair or replacement as specified in Section 601.3(p).
- Holes with a diameter greater than or equal to 1/2 inch but greater than the width of 1.5 of corrugation require a pipe analysis and a remediation plan for repair or replacement as specified in Section 601.3(p).

3. Thermoplastic Pipes. Inspect thermoplastic pipes for damage. If the pipe run is 40 feet or less in length, not under the roadway, and the initial visual inspection does not indicate any deflection or other deficiencies, additional testing will be waived. In all other cases, perform the deflection testing using either electronic deflectometers, calibrated television or video cameras, properly sized "go, no-go" mandrel, direct measurement by extension rulers or tape measures in pipes that allow safe entry, or other acceptable devices. Perform deflection testing at a minimum if pipe cannot be physically inspected. Provide the unloaded inside diameter pipe size from the manufacturer for each pipe type and size delivered to the project. Inspection criteria for the pipe are as follows:

3.a Joints.

- If joint separation is greater than the joint gap installation allowance of 3/4 inch but less than the maximum joint gap allowance of 1 inch without water leakage or soil infiltration, then the pipe joint will be accepted with reduced payment. Note all joint gaps that are greater than the installation allowance in the inspection report.
- If joint separation is greater than the maximum joint gap allowance of 1 inch without water leakage or soil infiltration, then submit a remediation plan for repair or replacement as specified in Section 601.3(p). Note all joint gaps that are greater than the installation allowance in the inspection report.
- If any water leakage or soil infiltration is identified at the pipe joint during inspection a pipe analysis and a remediation plan for repair or replacement as specified in Section 601.3(p) is required. Note all joints with soil or water infiltration in the inspection report.

3.b Cracks. Note all cracks identified during inspection of the interior wall of the pipe in the inspection report:

- Cracks less than 1/8 inch in width and less than 6 inches in length without water leakage or soil infiltration will be accepted.
- Cracks less than 1/8 inch in width and less than 6 inches in length with water leakage or soil infiltration require a remediation plan for repair or replacement as specified in Section 601.3(p).
- Cracks greater than or equal to 1/8 inch in width and greater than or equal to 6 inches in length require a pipe analysis and a remediation plan for repair or replacement as specified in Section 601.3(p).

3.c Holes. Note all holes in the inspection report.

- Holes with a diameter less than 1/2 inch without water leakage or soil infiltration will be accepted.
- Pipes with diameters greater than 30 inches having holes with a diameter less than 1/2 inch which exhibit either water leakage or soil infiltration require an internal repair patch as shown in POM C.6.11.
- Pipes 30 inches and less in diameter having holes with a diameter less than 1/2 inch which exhibit either water leakage or soil infiltration require a remediation plan for repair as specified in Section 601.3(p).
- Pipes with diameters greater than 30 inches having holes with a diameter greater than or equal to 1/2 inch but less than the width of 1.5 of corrugation require an internal repair patch as shown in POM C.6.11.
- Pipes 30 inches and less in diameter having holes with a diameter greater than or equal to 1/2 inch but less than the width of 1.5 of corrugation require a remediation plan for repair or replacement as specified in Section 601.3(p).
- Holes with a diameter greater than or equal to 1/2 inch but greater than the width of 1.5 of corrugation require a pipe analysis and a remediation plan for repair or replacement as specified in Section 601.3(p).

3.d Deflection/Buckling. Note all deflections in the inspection report. Prepare and submit a pipe analysis and a plan for repair or replacement as specified in Section 601.3(p) if deflection is greater than 5 % of the unloaded inside diameter of the pipe. If the pipe analysis provides a remediation method that will provide a structurally adequate pipe, then the pipe may remain at the elevated deflection, otherwise remove and replace.

(o) Final Inspection of 100 Year Design Life Pipes. For 100 year design life pipe installations ≤20 feet in length at each location, perform final inspection as specified in Section 601.3(n). For all other 100 year design life pipe installations, perform final inspection as follows:

Before final acceptance, inspect the entire length of all installed pipe types listed in Table D with total backfill/embankment load applied. Perform inspection on pipes at least 30 days after backfill/embankment is completed. If the final wearing course is placed more than 30 days after the pipe backfill/embankment is completed, the inspection must be performed before placing the final wearing course. Provide the measurement equipment listed in Table D to document the required items. Provide the required documentation of all inspections directly from the inspection service provider and/or data processor to the Representative following each inspection.

Locations of pipe installation documented as having been modified due to obstructions or insufficient bearing will be excluded from the acceptance criteria of this section. Deficiencies of the pipe that remain in-place which do not meet specification will be noted on Form CS-601.

TABLE D
REQUIREMENTS FOR PIPE CULVERT INSPECTION BY TYPE OF PIPE

Pipe Type	Measurement Equipment	Items Required for Documentation
Ductile Iron Pipe	Crawler-Mounted Camera with Laser Profiler*	Joint Separation, Crack Widths and Lengths, Deflection, Evidence of Soil Intrusion**, Vertical Alignment (i.e. ponded water)
Reinforced Concrete Pipe	Crawler-Mounted Camera *	Joint Separation, Crack Widths and Lengths, Spalls, Offset Joints, Bell/Spigot Shear Failure, Evidence of Soil Intrusion**, Vertical Alignment (i.e. ponded water)
Corrugated Steel Pipe (Aluminized, Galvanized, or Polymer Coated)	Crawler-Mounted Camera with Laser Profiler*	Joint Separation, Crack/Gouge Widths and Lengths, Dents, Buckling, Seam Separations, Deflection and Ovality, Evidence of Soil Intrusion**, Loss of Aluminized Coating, Oxidation, Vertical Alignment (i.e. ponded water)
Corrugated Aluminum Alloy Pipe	Crawler-Mounted Camera with Laser Profiler*	Joint Separation, Crack/Gouge Widths and Lengths, Dents, Buckling, Seam Separations, Deflection and Ovality, Evidence of Soil Intrusion**, Oxidation, Vertical Alignment (i.e. ponded water)
Thermoplastic Pipe	Crawler-Mounted Camera with Laser Profiler*	Joint Separation, Crack Widths and Lengths, Buckling, Deflection and Ovality, Evidence of Leakage or Soil Intrusion**, Vertical Alignment (i.e. ponded water)

*Manual tools as measurement equipment for pipes with manual inspection procedures as specified in Section 601.3(o)2.
**Leakage or Soil Intrusion will be in conformance with AASHTO R 82.

1. Remote Inspection. Perform a remote inspection according to PTM No. 450, Section 2, in the presence of the Representative for all 100 year design life pipe installations 48 inch in diameter and smaller. When defects or irregularities are observed with closed circuit television but cannot be measured within acceptable tolerances on pipes greater than 30-inch, inspect and report in accordance with manual inspection procedures including man-entry, as indicated in PTM No. 450, Section 3. Develop a remediation plan as specified in Section 601.3(p) to address all joint separation, cracks, deflections, and other irregularities exceeding the specification limits established in Section 601.3(c) and Sections 601.3(n)1, 2, or 3.

2. Manual Inspection. Perform a manual inspection according to PTM No. 450, Section 3, in the presence of the Representative for all 100 year design life pipe installations larger than 48 inch in diameter. Develop a remediation

plan as specified in Section 601.3(p) to address all joint separation, cracks, deflections, and other irregularities exceeding the specification limited established in Section 601.3(c) and Sections 601.3(n)1, 2, or 3.

(p) Remediation. Remedial action may include but is not limited to removal and replacement or an accepted repair procedure with a reduced payment. Reference POM C.6.11 for pipe remediation and reduced payment (rebate) guidance. Submit all pipe remediation plans to the Representative for approval. All pipe remediation plans that require pipe analysis must be prepared and sealed by a Professional Engineer registered in the State. Include in the pipe analysis the structural integrity, hydraulic capacity, and service life.

(q) Inspection During Installation. For pipe installations under the roadway, sidewalk, or shoulder, perform trench backfill work only in the presence of an authorized Inspector. The Inspector will complete Form CS-6 for each run of the conduit or pipe. Certify the work by signing the completed form and submit the signed form to the Representative.

601.4 MEASUREMENT AND PAYMENT—

(a) Pipe Culverts and Relaid Pipe Culverts. Linear Foot

Measured to the point of centerline intersection of "T," "Y," "K", and other branches. The unit price includes the excavation, the removal and disposal of existing pipe, the bedding material, the pipe, connecting bands, and the backfill as shown on the Standard Drawings or as indicated. Furnishing personnel and equipment for dewatering operations, inspection of pipes, and all remedial measures are incidental to the pipe items.

If the pipe item for shore/trench box is indicated or required; the unit price includes placement and removal or keeping in place of shoring, supports, shield systems and trench boxes as specified in Section 601.3(g).

Payment for remediation of the trench bottom including changes to or the addition of trench support methods, when directed by the Representative, will be made as specified in Section 110.03(c).

Payment for obstructions encountered including changes to or the addition of trench support methods, when directed by the Representative, will be made as specified in Section 110.03(c).

(b) Half-Circle Pipe. Linear Foot

(c) Cement Concrete for Miscellaneous Drainage. Cubic Yard

As indicated, for the class specified, for the item indicated.

The unit price includes reinforcement when required.

(d) Class 2 Excavation. Cubic Yard

For Half-Circle Pipe including bedding and anchors.

(e) Cleaning Existing Pipe Culverts. Linear Foot

Measured from inlets, manholes, endwalls, and other drainage appurtenances along the pipe centerline.

Pay items will establish a break point based on the sizes of pipes to be cleaned. The Department will pay for cleaning of pipe culverts having diameters up to and including 36 inches under one pay item, and cleaning of pipe culverts having diameters over 36 inches under a separate pay item.

(f) Jacked Pipe. Linear Foot

The unit price includes excavation.

(g) Flowable Backfill Material. As indicated, for all pipe installations, flowable backfill and geotextile are incidental to linear foot of pipe payment.

SECTION 602—CORRUGATED METAL PIPE-ARCH CULVERTS

602.1 DESCRIPTION—This work is construction or reconstruction of pipe-arch culverts.

602.2 MATERIAL—Sections 601.2(a)1 and 2; 601.2(b) and (c); and as follows:

(a) Corrugated Steel Pipe-Arch, Metallic Coated. AASHTO M 36, Types II and IIR; AASHTO M 218; AASHTO M 274; and AASHTO M 289.

(b) Corrugated Aluminum Alloy Pipe-Arch. AASHTO M 196, Types II and IIR.

(c) Coated Corrugated Galvanized Steel Pipe-Arch. AASHTO M 245, Type II; AASHTO M 218; and AASHTO M 246. Fabricate pipe-arch with coating as follows:

- Grade 10/10—10 mil coating on all surfaces.

602.3 CONSTRUCTION—As specified in Section 601.3, according to the requirements applicable to metal pipes.

602.4 MEASUREMENT AND PAYMENT—As specified in Sections 601.4(a), (c), and (f).

SECTION 603—METAL PLATE CULVERTS

603.1 DESCRIPTION—This work is construction of metal plate pipes, metal plate pipe-arches, and metal plate arch culverts.

603.2 MATERIAL—

(a) Metal Plate Pipes, Metal Plate Pipe-Arches, and Metal Plate Arches. Certify as specified in Section 106.03(b)3. Comply with the requirements of AASHTO M 167/M 167M (Steel) and AASHTO M 219/M 219M (Aluminum Alloy), except modify as follows:

1. AASHTO M 167/M 167M. Modified as follows:

1.a Section 11, Fabrication. Except:

- Space bolt holes 9.4 inches apart along plate edges that are to form circumferential seams.
- For bolt hole diameters, do not exceed the bolt diameter by more than 1/8 inch for longitudinal bolt holes or 1/4 inch for circumferential bolt holes.
- Form corrugations at right angles to the structure's longitudinal axis, having a depth of not less than 1 7/8 inches but not greater than 2 1/8 inches, unless otherwise accepted.
- Where necessary, to secure additional seam strength for pipe assembled with lap joints, increase the number of bolts per foot of longitudinal seam to six or eight.

In addition:

- Furnish plates in sizes that will allow length increments of 2 feet for square-ended structures.
- Provide a lap joint capable of transmitting the design thrust through the joint.
- Fabricate plates so not more than three plates come together at a point.
- In the two bottom segments of an arch, plates may be punched with one row of holes adjacent to the longitudinal plate edge that is to rest on the pier or abutment.

1.b Section 14, Dimensions and Tolerances. Determine the thickness of plates by weight of flat plates before corrugating. Comply with the following theoretical weights and tolerances.

THEORETICAL WEIGHTS AND TOLERANCES

Gage	Theoretical Weight Before Galvanizing (lbs. per sq. ft.)	Theoretical Weight After Galvanizing (lbs. per sq. ft.)	Permissible Variation of Average Weight of Lots* (percent)	
			Over	Under
1	11.25	11.406	5.5	3
3	10.00	10.156	5.5	3
5	8.75	8.906	5.5	5
7	7.50	7.656	5.5	5
8	6.875	7.031	5	5
10	5.625	5.781	5	5
12	4.375	4.531	5	5

* The term “lot” means all the plates of one gage in the shipment, for thicknesses gage 7 and heavier and not less than 6,000 pounds, for thicknesses gage 8 and lighter, with all individual plates not below the theoretical weights by more than 10%.

1.c Section 17.1, Inspection. Inspect mill and factory base metal when required, according to AASHTO M 36. Test the weight of the spelter coating, according to AASHTO T 65.

2. AASHTO M 219/M 219M. Include fabrication details on the shop drawings.

3. Field Inspection and Acceptance of Plates. A field inspection will be made at the job site. Furnish an itemized statement showing the number, size, and certified chemical analysis of the plates in each shipment.

A plate will be rejected if it:

- fails to meet specifications,
- shows defective workmanship, or
- has a bruised or broken spelter coat.

(b) Other Materials.

- Class A Cement Concrete—Section 704
- Cement Concrete for Miscellaneous Drainage—Section 704
- Reinforcement—Section 709.3
- Coarse Aggregate—Section 703.2
- Selected Borrow Excavation—Structure Backfill. As shown on the Standard Drawings.
- Structural Steel—Section 1105.02(a)2
- Emulsified Asphalt Class RS-1(E-1A) or CRS-1(E-1C) (Mop Coat on Concrete Paving)—Section 702
- Asphalt Coating—AASHTO M 243. Certify as specified in Section 106.03(b)3.
- Asphalt Material—(For sealing the groove, metal bearing channel or angle or arches, as required.) Class BF-1 Asphalt Cement, Section 702.

- Hook Bolts—Section 1105.02(d). Certify as specified in Section 106.03(b)3.
- Metal Bearing Materials—AASHTO M 183/M 183M, galvanized as specified in Section 1105.02(s) (AASHTO M 232). Certify as specified in Section 106.03(b)3.
- Curing and Protective Covers—Section 711.1

603.3 CONSTRUCTION—

(a) General. Provide shop drawings for review and acceptance. Show physical properties of plates and the proposed joint design on the drawings.

Inspect metal plate culverts as specified in Section 601.3(n) and provide remediation as specified in Section 601.3(o).

(b) Placing and Erecting. Excavate, as shown on the Standard Drawings. Place and erect as follows, unless an alternate method from the manufacturer is accepted:

1. Metal Plate Pipes and Pipe-Arches. Form the bed and trench, as shown on the Standard Drawings. Place plates "shingle-wise" to allow water to flow over, not against, the edges of plates, except for haunch plates for pipe-arches. Haunch plates may require placement inside or outside of adjacent haunch plates. When indicated, place washers under nuts. Use sufficient bolts to hold plates of the pipe or pipe-arch in position until the structure is completed. Place the bottom two rows of bolts with the threaded end inside the structure to facilitate tightening. Place bolts on other seams alternately, so nuts are always on the crests of corrugations, first inside, then outside, the culvert. Do not draw bolts and nuts tight until the structure is finished. Draw bolts and nuts tight before backfilling.

1.a Elongation. Elongate round pipes vertically 5%, using acceptable shop methods, or 3%, using timber strutting in the field, unless otherwise indicated.

Submit a plan for review before placing timber strutting, showing strut sizes, spacing, and jacking methods. A tolerance of ±25% of the specified amount of elongation will be permitted. Complete the field strut before backfilling around the pipe.

Place struts for pipe-arches when directed, to retain the size.

Uniformly strut from end to end of pipes and pipe-arches without endwalls. If endwalls are used, do not elongate the ends of pipes or pipe-arches. Leave struts in place until the roadway embankment is complete and compacted, unless otherwise directed.

1.b Asphalt Coating. Clean and dry plates and field apply an asphalt coating, if indicated, at the proper temperature. Provide a coating with a minimum thickness of 0.05 inch, measured on the crest of corrugations, to the lower inside one-half of the pipe or pipe-arch.

1.c Concrete Paving. If indicated, pave inverts of pipes and pipe arches with Class A cement concrete, reinforced with 6 inches by 6 inches, 10 gage, steel wire fabric (WWR 152 x 152 - MW9 x MW9 and/or WWF 6 x 6 - W 1.4 x W 1.4). Anchor reinforcement to the structure. Cover 25% of the periphery of pipes and 40% of the periphery of pipe-arches to a thickness of 2 inches above the crests of corrugations. If asphalt coating and concrete paving are both indicated, pave with concrete first. Do not apply asphalt coating on the paved portion. Tamp the concrete to the required thickness and contour. After initial set, cover concrete with a heavy spray or mop coat of emulsified asphalt, Class E-1.

2. Metal Plate Arches. Construct the concrete foundation, as indicated and as specified in the applicable parts of Section 1001.3. Place the metal channels or angles in the concrete foundation, as indicated.

Erect metal plates one course at a time and hold in place temporarily, beginning at the sides, with lower plates fitted into their channels. Progress to the top or center of the arch. Portions of the arch may be assembled and lifted into place, if directed.

Place downstream plates outside adjoining upstream plates, with each rise plate outside the adjoining lower plate and all placed "shingle-wise", or as recommended by the manufacturer. When indicated, place washers under

each nut. Use enough bolts to hold arch plates in position until the structure is formed. Then, place and tighten the remaining bolts. Place nuts on the crests of corrugations, alternately inside and outside of the arch. Draw all bolts tight before backfilling.

After the arch has been completely placed, but before backfilling, fill the groove or channel used for the bearing area of the arch with asphalt material. If an angle is used for the bearing area, seal the intersection of the arch and angle with asphalt material.

(c) Backfilling.

1. Metal Plate Pipes and Pipe-Arches. After plates are satisfactorily erected, place fill material around the pipe or pipe-arch, as specified in Section 601.3(f).

2. Metal Plate Arches. Carefully place selected borrow excavation-structure backfill, as shown on the Standard Drawings and as specified in Section 1001.3(q)2.b when the substructure concrete has attained the required strength and plates have been erected, unless otherwise directed.

Place backfill in layers not exceeding 4 inches in depth, alternately on each side of the arch, or on each side of each arch in the case of a multiple installation. Compact with mechanical tampers until a power roller may be used, then place the remainder of the embankment, as specified in Section 206.3.

When filling around and over arches, before endwalls are constructed, place the first fill material midway between the arch ends, forming as narrow a ramp as possible until the top is reached. Build the ramp evenly from both sides, compacting fill material while placing it. After the ramps have been built to the arch top, deposit the remainder of fill material from the top, in both directions, from the center to the ends, as evenly as possible on both sides.

If endwalls are built before any fill material is placed around and over the arch, place fill material adjacent to one endwall until the arch top is reached, then dump fill material from the top toward the other endwall, using care to deposit material evenly on both sides of the arch.

For a multiple installation, follow the procedure specified above, but bring material up evenly on each side of each arch, avoiding unequal pressure.

Tamp the fill material thoroughly, but not excessively. Do not puddle the material with water.

Remove fill material causing excessive distortion of plates. Brace plates into correct position, then replace fill material. Remove bracing, as directed.

Conform to additional requirements from the manufacturers.

603.4 MEASUREMENT AND PAYMENT—

(a) Metal Plate Pipes and Pipe Arches. Linear Foot

Measured along the centerline of culverts with square or skewed vertical ends; the average length along the centerline of culvert with square or skewed beveled ends.

Bedding, backfill, concrete paving, if indicated, and inspection of culverts, including personnel and equipment, is incidental.

(b) Metal Plate Arches. Linear Foot

Measured along the centerline of culverts with square or skewed vertical end; the average length along the centerline of culverts with square or skewed beveled ends.

(c) Excavation. Cubic Yard

For the class indicated.

(d) Cement Concrete for Miscellaneous Drainage. Section 601.4(c)

The unit price does not include concrete paving, if indicated.

(e) Selected Borrow Excavation-Structure Backfill. Section 1001.4(g)

SECTION 604—COMBINATION STORM SEWER AND UNDERDRAIN

604.1 DESCRIPTION—This work is construction of combination storm sewer and underdrain.

604.2 MATERIAL—

(a) Pipes. Section 601.2(a)1 and (a)2 and as follows:

1. Nonmetal Pipes.

1.a General. When indicated provide a minimum water inlet area of 1.4 square inches per linear foot of pipe.

1.b Reinforced Concrete (RC) Pipe. Section 601.2(a)3. Where specified, provide RC pipe with specified water inlet area according to Pennsylvania Installation Direct Design (PAIDD) computer program, other Department accepted software program, and Publication 280.

1.c Group IP. Section 601.2(a)6.a

1.d Group IIP. Section 601.2(a)6.b

1.e Group IIIP. Section 601.2(a)6.c, and as follows:

1.e.1 Polyethylene. Add the following:

- AASHTO M 294, Type S, Class 1 perforations, provide specified water inlet area.

1.e.2 Polyvinyl Chloride. Add the following:

- AASHTO M 304, Class 1 perforations, provide specified water inlet area.

1.f Group IVP. Section 601.2(a)6.d, and as follows:

1.f.1 Polyethylene. Add the following:

- AASHTO M 294, Type S, Class 1 perforations, provide specified water inlet area.

1.g Group VP. Section 601.2(a)6.e, and as follows:

1.g.1 Polyethylene. Add the following:

- AASHTO M 294, Class 1 perforations, provide specified water inlet area.

1.h Group VIP. Section 601.2(a)6.f, and as follows:

1.h.1 Polyethylene. Add the following:

- AASHTO M 294, Class 1 perforations, provide specified water inlet area.

1.h.2 Polypropylene. Add the following:

- AASHTO M 330, Class 1 perforations, provide specified water inlet area.

2. Metal Pipes.

2.a General. Perforate pipe with Class 1 perforations, according to AASHTO M 36, M 196, or M 245, except provide a minimum water inlet area of 1.4 square inches per linear foot of pipe.

2.b Corrugated Steel Pipe, Metallic Coated. AASHTO M 36, Types I and IR; AASHTO M 218; AASHTO M 274; and AASHTO M 289

2.c Corrugated Steel Pipe-Arch, Metallic Coated. Section 602.2(a)

2.d Corrugated Aluminum Alloy Pipe. AASHTO M 196, Types I and IR

2.e Corrugated Aluminum Alloy Pipe-Arch. AASHTO M 196, Types II and IIR

2.f Coated Corrugated Galvanized Steel Pipe. Section 601.2(a)4.d

2.g Coated Corrugated Galvanized Steel Pipe-Arch. Section 602.2(c)

(b) Other Material.

- Coarse Aggregate—Type C or better, No. 57, Section 703.2.
- Geotextile—Class 1, Section 735.

604.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Laying Pipe. Section 601.3(c), except as follows:
Lay pipe with perforations facing upwards. Place rigid non-metal pipe, keeping the portions of the joints in contact with the coarse aggregate clean, and providing a minimum water inlet area of 1.4 square inches per linear foot by either blocking open, furnishing pipe manufactured with the required water inlet area provided, or by other acceptable means. For Reinforced Concrete Open Joint Pipe, provide joint openings as noted in Table A. Fill the remainder of the joint, as specified in Section 601.3(d).

TABLE A
Joint Tolerances for Reinforced Concrete Open Joint Pipe**

Pipe Diameter Or Equivalent (inches)	Minimum Joint Opening (inches)	Maximum Joint Opening (inches)
18-24	0.625	1.000
27-36	0.500	1.000
≥ 42	0.375	1.275

**Special design joints will be subject to manufacturer submittal and individual review and approval. If the bell depth is greater than the tongue depth, include the difference between these depths to the maximum joint opening.

(b) Geotextiles, Class 1. Section 212.3(b)

(c) Backfilling Trench. After the pipe is satisfactorily laid, backfill, as specified in Section 601.3(f). Obtain suitable impervious material, as required.

(d) Pipe Inspections. Inspect pipes as specified in Section 601.3(n) and Section 601.3(o).

604.4 MEASUREMENT AND PAYMENT—

(a) Pipe. Linear Foot
Measured to the point of centerline intersection of "T," "Y," "K," and other branches. The unit price includes the excavation, the removal and disposal of existing pipe, the impervious material, the pipe, connecting bands, geotextile,

and the coarse aggregates for backfill as shown on the Standard Drawings or as indicated. Furnishing personnel and equipment for dewatering operations, inspection of pipes, and all remedial measures are incidental to the pipe items.

SECTION 605—ENDWALLS, INLETS, MANHOLES, AND SPRING BOXES

605.1 DESCRIPTION—This work is construction and/or cleaning of endwall, inlet, manhole, and spring box structures of the type indicated.

605.2 MATERIAL—

(a) Inlet Grates and Frames. As shown on the Standard Drawings, either structural steel, as specified in Section 1105.02(a)3.c, or gray, malleable, or ductile iron as specified in Section 1105.02(h). For Type M Frames, provide either structural steel as specified in Section 1105.02(a)2 or gray, malleable, or ductile iron as specified in Section 1105.02(h). Certify as specified in Section 106.03(b)3.

Coat structural steel grates with asphalt paint in the shop or in the field, before placement. Coat structural steel frames with asphalt paint when placing in the concrete inlet top. Cover frames and grates completely with no pin holes or voids. As an alternative to asphalt paint, hot dip galvanize structural steel grates and frames as specified in Section 1105.02(s).

(b) Manhole Frames and Covers. As shown on the Standard Drawings, either gray, malleable, or ductile iron, as specified in Section 1105.02(h). Machine-grind the metal-bearing contact areas to fit in pairs. Matchmark each pair with notches to ensure satisfactory seating.

(c) Manhole Steps. Certify as specified in Section 106.03(b)3. As shown on the Standard Drawings, conforming to the vertical design load and the horizontal pull out design load requirements of ASTM C478; and made of one of the following materials:

- Corrosion-resistant steel alloy bars containing 1.65% to 1.85% nickel and 0.8% to 0.9% copper, having a minimum tensile strength of 50,000 pounds per square inch and a minimum yield strength of 37,000 pounds per square inch, with a minimum elongation of 30% over a 2-inch gage length.

- Deformed Wire, according to ASTM A1064, Epoxy-Coated according to ASTM A934, encased in a co-polymer polypropylene shell that conforms to ASTM D4101, Table PP, Group 03, Class 4, Table B Designation B44744.

- Deformed reinforcement bars, according to AASHTO M 31, Grade 40, galvanized after bending, according to ASTM A787.

- Deformed reinforcement bars, according to ASTM A615, Grade 60, coated with copolymer polypropylene plastic that conforms to ASTM D4101; Table PP; Group 03 Copolymer or Impact Modified; Class 2, 3, or 4; any of grades 1 through 9.

- Gray, malleable or ductile cast iron, as specified in Section 1105.02(h).

- Aluminum alloy according to ASTM B221, 6061-T6, 6005-T5, or 6351-T6, with a protective coat applied to the portion to be embedded in the concrete.

- Fiberglass-reinforced polyester, according to ASTM D2444 and D635.

- Fabricate manhole steps free from sharp edges, burrs, and hazardous projections.

(d) Precast Concrete Top Units for Inlet Boxes, Inlet Boxes, Manholes, Grade Adjustment Rings, Top Slabs, and Transition Slabs.

- Class AA Cement Concrete Modified – Provide cement concrete as specified in Section 704; except, with a minimum 28-day compressive strength of 4,000 pounds per square inch.

(e) Concrete Top Units for Inlet Boxes.

- Structural Steel Angles and Plates – Section 1105.02(a)2 galvanized after fabrication as specified in Section 1105.02(s)
- Welded Studs – Section 1105.02(e)1

(f) Other Material.

- No. 2A Coarse Aggregate – Section 703.2
- Class A Cement Concrete—Section 704
- Epoxy Bonding Compound – Section 706.1
- Reinforcement—Section 709
- Gaskets – Section 705.5
- Mortar—Section 705.7
- Caulking Compound – Section 705.8(a)
- Precast Concrete Units—Section 714
- Concrete Curing Compounds—Section 711.2(a)
- Curing and Protecting Covers—Section 711.1
- Non-Shrink Grout – Section 1080.2(c)
- Asphalt Paint—According to AASHTO M140 (emulsified asphalt) meeting the requirements listed in Bulletin 25 and from a supplier listed in Bulletin 15, Section 702-EM. Certify as specified in Section 106.03(b)3.
- Zinc Chromate Primer—Federal Specification TT-P-645. Certify as specified in Section 106.03(b)3.

605.3 CONSTRUCTION—Before construction or fabrication, obtain acceptance of shop drawings, if required.

(a) Construction of Drainage Structures. Construct as indicated, as shown on the Standard Drawings, as shown on the accepted shop drawings, and as follows:

- Cement Concrete Structures—As specified in Section 1001.3.

Excavate for the structure as required.
Place No. 2A Coarse Aggregate and compact as specified in Section 350.3(e), if specified.
Place concrete foundations and walls monolithically, except if otherwise allowed.
Carefully remove existing castings that are to be reused. Clean and transport to the new location.
Construct new inlet or manhole walls and bottoms to accommodate the dimensions of the existing castings.
Set frames, concrete top units, and grade adjustment rings (if required for inlets and manholes) on a bed of non-shrink grout to provide full bearing on the supporting surface.
Set pipes in inlets and manholes, flush with the inside structure face. For pipes protected by endwalls, set flush with the exposed structure face.
If constructing structures in conjunction with existing pipe culverts and drains, provide for satisfactory connections, as specified for new construction of a similar type.

Backfill excavated spaces around the structure, with acceptable embankment material, as specified in Section 206.3(b)4. Satisfactorily dispose of unsuitable and surplus materials.

Brick and Brick and Mortar are not allowed for grade adjustments.

Coat all aluminum surfaces to be embedded in concrete with one coat of zinc chromate primer, or a coat of asphalt paint. Allow to dry completely before placing concrete.

(b) Cleaning of Drainage Structures. Clean drainage structures, as indicated, including inlets, manholes, endwalls, spring boxes, grates, and scuppers. Repair any damage resulting from the cleaning operations. Prevent material cleaned from structures from entering streams or other bodies of waters, and dispose of this material in a satisfactory manner.

605.4 MEASUREMENT AND PAYMENT—

(a) Manhole. Each

The price for the manhole includes excavation, compacted No. 2A coarse aggregate, manhole, concrete for channel, transition slab, if required, top slab, if required, backfill, and any other miscellaneous items required for the construction of the manhole. The height is measured from the Finished Grade Elevation to the bottom of the bottom slab elevation.

(b) Manhole Frame and Cover. Set

The price includes frame, cover, and grade adjustment rings, if required.

(c) Reuse Existing Manhole Frame and Cover. Set

The price includes removing the existing frame and cover and installing the frame and cover on a new structure. Also includes grade adjustment rings, if required.

(d) Spring Boxes. Each

The price includes excavation, spring box, reinforcement, if required, backfill, and any other miscellaneous items required for the construction of the spring box.

(e) Endwalls. Each

For the type indicated.

(f) Endwall Excavation. Cubic Yard

For the Class of excavation, as indicated.

(g) Grates. Each

(h) Concrete Top Units and Grates. Set

The price includes top unit, grate, and grade adjustment rings, if required.

(i) Concrete Top Units Using Existing Grates. Set

The price includes top unit and grade adjustment rings, if required.

(j) Frames and Grates. Set

The price includes frame, grate, and grade adjustment rings, if required.

(k) Frames Using Existing Grates. Set

The price includes frames and grade adjustment rings, if required.

(l) Inlet Boxes. Each

The price for the inlet box includes excavation, compacted No. 2A coarse aggregate, inlet box, concrete for channel, transition slab, if required, top slab, if required, backfill and any other miscellaneous items required for the construction of the inlet box. The height is measured from the Finished Grade Elevation to the bottom of the bottom slab elevation.

(m) Concrete for Miscellaneous Drainage. Section 601.4(c)

(n) Cleaning of Drainage Structures. Each
For the type indicated.

(o) Stormwater Basin Outfall Structure. Each
For the type indicated.

(p) Inlet Cap. Each

SECTION 606—GRADE ADJUSTMENT OF EXISTING MISCELLANEOUS STRUCTURES

606.1 DESCRIPTION—This work is the grade adjustment of existing inlets, manholes, or utility boxes for a vertical height of 6 inches or less.

606.2 MATERIAL—

(a) Manhole and Inlet Extensions. From a manufacturer listed in Bulletin 15 or have the type of extension accepted by the LTS before use.

Use extensions composed of gray, malleable, or ductile iron conforming to the requirements of Section 1105.02(h); structural steel, Section 1105.02(a)2; or merchant quality steel conforming to ASTM A 575.

Fabricate the extensions to conform to the shape of the original manhole or inlet castings. They may be either welded in place or secured by a swedge fit. Weld according to the manufacturer's recommendations. Provide a locking device to ensure the swedge fit is permanent. Coat steel extensions with an asphalt paint, as specified in Section 605.2(a).

(b) Additional Material. Conforming to the requirements specified for new structures.

(c) Certification. Section 106.03(b)3

606.3 CONSTRUCTION—

(a) General. Excavate as necessary. Carefully remove and clean existing castings. Construct the structure walls to the required elevation, as specified in Section 605.3, conforming to the type of construction and dimensions of the existing structure.

Replace castings on a full mortar bed, as required.

Remove existing walls if the existing structure elevation is higher than the proposed elevation or if directed because the walls are in an unsatisfactory condition. Rebuild as specified.

Backfill as required. Repair or replace existing pavement, curb, and sidewalk damaged due to rebuilding. Satisfactorily dispose of unsuitable and surplus materials.

Upon completion, clean each structure of accumulations of debris, mortar, or foreign matter, including existing material, and keep clean until final acceptance.

(b) Adjustable Extensions. Before placing pavement material, set the adjustable extension unit in the existing inlet or manhole frame with the section resting on the flange. Secure the unit in place, according to the manufacturer's recommendations. Set the manhole cover or inlet grate in the flange formed by the adjustable extension unit.

606.4 MEASUREMENT AND PAYMENT—Set

SECTION 607—REBUILT MISCELLANEOUS STRUCTURES

607.1 DESCRIPTION—This work is rebuilding of existing inlets, manholes, or utility boxes of the types indicated for vertical heights in excess of 6 inches.

607.2 MATERIAL—Section 605.2

607.3 CONSTRUCTION—Section 606.3(a). Install necessary additional manhole steps as required.

For inlets and manholes, reset the existing top unit, castings, frames, covers and grates at each location. If the top unit or grate is damaged during removal, replace the top unit or grate at no additional cost to the Department.

607.4 MEASUREMENT AND PAYMENT—Vertical Foot

The Department will measure and pay to the nearest 0.1 foot, except that heights less than 1 foot will be paid for as 1 foot vertical.

SECTION 608—MOBILIZATION

608.1 DESCRIPTION—This work is the assembly and set-up of the general plant required to comply with the contract and with local and State laws and regulations. General plant includes Contractor's offices, shops, plants, storage areas, and sanitary or other facilities. This work includes obtaining the required permits, insurance, bonds, and any other initial items required for the start of the work.

When developing agreements with DBE subcontractors, include an opportunity for the DBE to identify an item for their mobilization. List the agreed to amount for each DBE subcontractor on the DBE Participation for Federal Projects form specified in the "Disadvantage Business Enterprise Requirements" Designated Special Provision in Appendix C of Publication 408.

608.2 MATERIAL—Furnish adequate material and furnishings required. These material and furnishings will not be considered a part of the other completed contract items.

608.3 CONSTRUCTION—Construct the required facilities.

608.4 MEASUREMENT AND PAYMENT—Lump Sum

The Department will pay for mobilization, as specified in Section 110.05, and according to the following schedule:

(a) Final Payment Calculation. Final Payment will be based on 0.2% of the contract amount capped at a minimum of $10,000 and no greater than $25,000. In addition, if the contract lump sum amount bid for mobilization exceeds 6% of the sum of the total amounts bid for all other items, excluding mobilization in the bid proposal, the excess will be paid on completion of the project.

(b) Payment Schedule. The Department will pay for mobilization, as specified in Section 110.05, and according to the following schedule.

1. One half (50%) of the contract lump sum amount bid for mobilization excluding the final payment amount will be released with the first estimate payable.

2. An additional 50% of the contract lump sum amount bid for mobilization excluding the final payment amount will be released after 10% of the original total contract amount, including payments for delivered materials but excluding mobilization, is earned.

3. When all physical work has been satisfactorily completed and the following certificates and documents, as required, have been properly furnished, the final payment will be made as specified in Section 608.4(a):

- Certified Payroll Records;
- Final DBE/DB payment amounts and, if necessary, shortfall justification;
- Material Certifications;
- Form CS-4225H, Highway Lighting In-Service Guarantee Notification;
- As built drawings for Design/Build projects;
- Form RW-397A, Right to Enter (a property) and Release Form from property owner, if applicable;
- Form CS-4345, Borrow And/Or Waste Management;
- Contractor Evaluations of the design of the project; and
- Work Order Information (i.e. Force Account documentation).

(c) DBE Payment Schedule. Within the Schedule submitted as specified in Section 108.03, indicate the starting date of work subcontracted to DBEs. One month before the scheduled start of subcontracted DBE work, but not earlier than the Notice to Proceed, pay 25 percent of the amount shown for mobilization on the applicable DBE

Participation for Federal Projects form. Pay the remaining 75 percent of the amount shown for mobilization on the applicable DBE Participation for Federal Projects form, in three equal payments, when subcontracted DBE work is 25 percent, 50 percent, and 75 percent complete. Pay the affected DBE within 7 days of its reaching the specified milestones for percentage of work completed.

SECTION 609—INSPECTOR'S FIELD OFFICE AND INSPECTION FACILITIES

609.1 DESCRIPTION—This work is furnishing, setting up, maintaining, and removing a field office of the type indicated and, if indicated, a field laboratory, proportioning plant office, and/or equipment package for the exclusive use of Department personnel. If Section 609 is excluded or waived from the contract, the requirement for providing sanitary facilities, as specified in Section 107.06, are not waived.

609.2 MATERIAL—

(a) General. Provide offices and laboratories having the minimum floor space specified, along with all required furnishings, equipment, and materials. Furnish office and laboratory facilities that conform to applicable occupational safety and health regulations, including, but not limited to, those governing sanitation, illumination, ventilation, means of egress, medical services and first aid, and fire protection. Ensure that offices and laboratories have at least 7-foot ceilings, locking windows, adequate electric lighting, an adequate number of storage cupboards and closets, a mail slot or drop box, and a private entrance secured with lock and key. Ensure that stairway systems installed for access to offices and laboratories include a handrail and non-skid treads. Provide systems to heat and cool interior spaces, as necessary, to maintain an ambient temperature between 65F and 75F. Maintain acceptable sanitary toilet facilities, for exclusive use by Department personnel, near or within offices and laboratories. Ensure that the number of sanitary toilet facilities furnished is sufficient based on the size of the Department inspection staff that will likely be stationed in the indicated office or laboratory. Maintain acceptable lavatory (wash-up) facilities near or within sanitary toilet facilities. If the field office is located in an existing building ensure that lavatory facilities are equipped with hot and cold (or tepid) running water: hand soap or similar cleansing agents; and clean, sanitary, cloth or paper hand towels or warm air blowers. If a construction trailer is used as a field office, ensure that a sanitary toilet facility is located near the field office and ensure that it is equipped with waterless hand soap. Ensure that the electric supply service is of sufficient capacity to allow unrestricted operation of all indicated electronic systems, appliances, and equipment. Furnish documentation certifying that indicated equipment requiring calibration has been calibrated within the last 12 months, and continue to have such equipment recalibrated annually for the duration of the project. If required furnishings and/or equipment being provided have been previously used, ensure that such items are in satisfactory condition and fully functional as of the scheduled start of work. Whenever practical, obtain maintenance agreements for communications, electronic, and/or specialized equipment that provide for on-site repair service. If malfunctioning equipment cannot be repaired on site, provide a replacement within a 24 hour time frame based on the relative importance of the piece to the timely performance of required project management functions as determined by the Representative.

1. Inspector's Field Office. Set up the indicated field office in an acceptable weatherproof building or trailer. Situate the field office in an acceptable location on or in the immediate vicinity of the project, separate from other construction offices. For field offices where multiple individual partitioned rooms are indicated, submit a floor plan showing the layout of the interior space for approval. Equip the field office according to Table A.

2. Proportioning Plant Office. If indicated, provide an office at the proportioning plant. Set up the indicated plant office in an acceptable weatherproof building or trailer. Equip the office according to Table A.

3. Field Laboratory. If indicated, provide a laboratory for materials and soils testing. Set up the indicated field laboratory in an acceptable weatherproof building or trailer situated in an acceptable location. Supply a gravity or pressure potable water system having at least a 100-gallon capacity and connected to a service sink with a faucet and acceptable outside drain. Do not drain or discharge wastewater into the surrounding environment; use a container of sufficient size to collect all drained or discharged wastewater and transport and dispose of wastewater at an approved site for handling such wastewater. Equip the field laboratory according to Table A.

4. Nuclear Gauge Temporary Storage. If indicated, provide a temporary storage location within the Inspector's Field Office or Field Laboratory for temporary storage of moisture density nuclear gauges by a Department Representative. Provide a temporary storage location consisting of an enclosed closet with a minimum area of 9 square feet and secured with two independent locks and keys. Provide all keys to only the licensed Department nuclear gauge operator. Do not provide keys to any other persons. Where possible, locate the closet at least 20 feet from a

permanent work station (i.e., desk area). Where a 20 feet minimum distance from a permanent work station is not reasonably possible, the Department licensed nuclear gauge operator will temporarily store the nuclear gauge within the storage location following current Department policy and procedures to prevent radiation exposure to the public.

(b) Testing Equipment. On projects where a Field Laboratory is indicated, furnish and maintain the following equipment for required testing of soil or aggregates:

Number of Each	Equipment
1	C.A. Mechanical Sieve Shaker with Timer
1	F.A. Mechanical Sieve Shaker with Timer
1	Set Standard Sieves for C.A.
1	Set Standard Sieves for F.A. and Soils
1	Unit Mass (Weight) Metal Container 1 cubic foot
1	Unit Mass (Weight) Metal Container 1/2 cubic foot
1	Platform Scale, 200-pound capacity, sensitive to 0.01 pound
1	Balance, 70.5-ounce capacity, sensitive to $3.5x10^3$ ounce, with one complete set of Masses (Weights).
1	Exhaust Fan (for venting Mechanical Shakers)
1	Density Sample Extruder
1	Proctor Mold and Rammer
1	12-inch Steel Straightedge
2	Mixing/Drying Pans
1	Mixing Spoon
1	Broom & Dust Pan

In addition, on projects where a Field Laboratory is indicated and cement concrete, asphalt concrete, and/or construction aggregates are to be used; furnish and maintain the equipment specified in Section 704.2(a), in the plant requirements of Bulletin 27, and/or in Sections 703.1(b) and 703.2(b), respectively.

When specified, provide an on-site Cylinder Breaking Testing Machine that meets the requirements of PTM 604 of Publication 19 – "Field and Laboratory Testing Manual", for use by Contractor's Certified Technicians and Department personnel to determine the compressive strength of molded concrete cylinders. The testing machine is to be calibrated annually, every time it is moved to a new location, immediately after making repairs or adjustments which may affect the operation of the system, and whenever there is any reason to doubt the accuracy of the Testing Machine.

(c) Communications Equipment. When indicated, provide the communications equipment specified in the proposal. Furnish communications equipment in the quantity indicated and meeting the following requirements:

1. High Capacity Multifunctional Device (MFD): Copier, Scanner, Fax, and Printer. A network enabled digital color laser copier, with automatic document feeder, having reduction/enlargement functions capable of accepting maximum 11–inch by 17-inch size originals and producing 11–inch by 17-inch size copies at a minimum rate of 45 letter size copies per minute. Device will have three paper drawers to accommodate letter, legal, and tabloid paper sizes. Include sufficient imaging cartridges (toner/drum/developer) to yield a minimum of 5,000 copied pages, as well as printer driver software to install on the computer devices. Device will have air print (wireless) capability.

2. Low Capacity Multifunctional Device (MFD): Copier, Scanner, Fax, and Printer. A network enabled digital color inkjet copier, with automatic document feeder, having reduction/enlargement functions capable of accepting maximum 11-inch by 17-inch size originals and producing 11-inch by 17-inch size copies at a minimum rate of 35 letter size copies per minute. Device will have two paper drawers to accommodate letter, legal, and tabloid paper sizes. Include sufficient imaging cartridges (toner/drum/developer) to yield a minimum of 5,000 copied pages, as well as printer driver software to install on the computer devices. Device will have air print (wireless) capability.

3. Cellular Phone. A portable, handheld unit capable of providing wireless communications within a 50-mile radius of the project. Include a carrying case with belt loop/clip, cigarette lighter adapter, and an AC charger. Arrange for a cellular service plan that includes a voice mail option, call waiting, and 400 peak minutes of unrestricted use per month, for each device supplied, for the duration of the project.

(d) Specialized Equipment. When indicated, provide the specialized equipment specified in the proposal. Furnish specialized equipment in the quantity indicated and meeting the following requirements:

1. Surveyor's Level and Measuring Rod. A standard, waterproof, surveyor's leveling instrument having, as a minimum, 20x magnification and a sighting range of up to 200 feet; with a job accuracy range within 1/4 inch at 75 feet. Include a 25-foot minimum, fiberglass measuring rod, folding leg tripod, rain cover, and carrying case.

2. Electronic Digitizer. A stationary or portable, high performance digitizer system capable of electronically measuring the exact, net area and perimeter of linear shapes on plan drawings at any scale, and converting those measurements to areas and volumes. Furnish electronic digitizer having a tablet with a minimum 22-inch by 36-inch active area. Include necessary cabling, carrying case, and all other operating essentials.

3. Digital Display Level. A durable level with automatic calibration function, that reads angles with precision and digitally displays readings in degrees, percent slope, and pitch to within 1/10 degree accuracy. Include battery(ies).

4. Infrared Thermometer. A hand-held, portable, non-contact thermometer capable of measuring temperatures between – 4F and 482F and with a field of view (i.e., spot ratio) of at least 6:1. Include protective case, battery(ies) and all other operating essentials.

5. Laser Range Finder. A self-contained, light-weight, hand-held instrument that measures and records distances in feet, yards, or meters; having a maximum range of 750 feet to an uncooperative, non-reflective target; LCD display; and shock/water resistant housing. Include battery(ies), cabling, carrying case, and all other operating essentials.

6. Paper Shredder. Lightweight, crosscut shredder capable of shredding 10 sheets at one time.

7. Digital Camera. A minimum 12-megapixel image resolution digital camera having 5X optical zoom capability and capable of producing pictures in JPG/JPEG file format. Include two sets of rechargeable batteries and a compatible battery charger capable of recharging one set of batteries. Furnish a 32 GB (minimum) removable SD memory card having the appropriate format for use with the camera; an external USB cable capable of connecting the camera to the computer to transfer the data from the memory card and any other operating essentials. Must be compatible with the Microcomputer System specified in Section 688.2.

(e) Internet Service. For each type Field Office indicated, purchase a subscription to a wired broadband Internet service, for exclusive use by Department personnel, for the duration of the project. Choose a service that provides the fastest available high-speed wired broadband internet access, with a minimum connection of 10 Mbps, to the account by means of a Cable or Digital Subscriber Line (DSL). Provide a wireless broadband router, with a minimum security setting of WPA2, to connect to the provided wired broadband. Based on the specific type of high-speed connection provided, furnish a compatible modem with built-in hardware firewall protection. Purchase a separate Internet service subscription for the Proportioning Plant Office, if indicated, as specified in Section 609.2(e).

If such high-speed wired broadband connection is not attainable within the area where the project office is located alternate internet connectivity options must be submitted to the District IT Administrator for review and acceptance.

Demonstrate connectivity with the Internet Service Provider at the time of or immediately following microcomputer system installation.

(f) Miscellaneous Materials. For each microcomputer system that will be used on the project, as indicated in the proposal, at a minimum provide the following:

- Ten, recordable CD-R 700 MB (minimum) compact disks (CD's) with individual protective cases,
- Ten, rewritable CD-RW 700 MB (minimum) compact disks (CD's) with individual protective cases,

- One, CD-ROM drive cleaning kit,
- Two, Memory Flash Drives 32GB (minimum), encrypted to meet 2048-bit minimum.

All compact disks and flash drives become Department property.

In addition, at a minimum provide the following miscellaneous materials:

- Eight, 11-inch by 17-inch pressboard or plastic computer paper binders with plastic locking strips as required.
- Six, 3-inch, three D-ring binders, with vinyl covers, having dimensions of 8 1/2 inches by 11 inches.
- 8 1/2 -inch by 11-inch and 8 1/2-inch by 14-inch, and 11-inch by 17-inch 20# white bond paper for copiers and printers, as specified, sufficient for the life of the project. Providing only one ream of paper at a time is unacceptable.

All binders and paper become Department property.

609.3 CONSTRUCTION—Install the indicated facilities no later than 5 working days after the Notice to Proceed Date or 5 days before the scheduled start of work, whichever is sooner. Anchor the facilities to withstand high winds. Maintain the facilities from installation until 30 days after physical work (including completion of punch list items identified during the final inspection) has been satisfactorily completed, unless released earlier by the Representative. Satisfactorily clean or arrange for the indicated facilities to be cleaned at least once per week. Arrange for the weekly pick up and disposal of trash and recyclables including, but not limited to, paper, plastic, and ink/toner cartridges. Provide an adequate number of accessible parking spaces immediately adjacent or in close proximity to the offices or laboratory for exclusive use by Department personnel. Provide proper maintenance of parking areas. Ensure that there is sufficient lighting to illuminate the exterior of offices or laboratory and all parking areas. Designate a specific individual to serve as the contact person for service-related problems. After physical work has been completed, but before release by the Representative, arrange to meet with the Inspector-in-Charge to examine and determine the condition of all specialized equipment that is contractor-owned. Report any unresolved disputes over the condition of such equipment to the Representative. Failure to meet with the Inspector-in-Charge or to report problems with the condition of specialized equipment will create a presumption that, except for expected wear resulting from normal usage, the equipment is in good condition and remains fully functional. Specialized equipment that is lost or determined to be damaged beyond repair will be replaced or reimbursement will be made as specified in Section 110.03, provided such loss or damage is not the result of carelessness or negligence on the part of the Contractor or any other responsible third party.

The Representative may direct that the office or laboratory facilities and equipment package be maintained for more than 30 days after the date of physical work completion due to the Contractor's failure to submit, complete, and/or correct required certificates or documents, as established during the final inspection.

609.4 MEASUREMENT AND PAYMENT—Lump Sum

The proposal will include separate pay items for the Inspector's Field Office and Inspection Facilities, Field Laboratory, Proportioning Plant Office, and Equipment Package, as applicable.

Each contract item will be paid, as specified in Section 110.05, in two equal payments, according to the following schedule:

- When work is completed in an amount equivalent to at least 10% of the original contract amount, excluding the bid price for the applicable item, the first payment will be made.
- When work is completed in an amount equivalent to at least 60% of the original contract amount, excluding the bid price for the applicable item, the second payment will be made.

(a) Price Adjustments. Adjustments to the lump sum prices bid for the indicated office or laboratory facilities and equipment package, as applicable, will be made as follows:

1. Time Extensions and Reductions. In the event the time for completion of all work on the project is extended or reduced, as specified in Section 108.06, an appropriate adjustment (payment to the Contractor or rebate to the Department) will be made to the lump sum prices bid for the indicated office or laboratory facilities and equipment package, as applicable, for the days in excess of (payment) or less than (rebate) the original contract time, at the following daily rate:

$$\text{Daily Price Adjustment Rate} = \frac{75\% \text{ x Contract Lump Sum Price}}{\text{Original Contract Time in Days}}$$

2. Facilities Maintained for More than 30 Days After Physical Work Completion. In the event the Representative directs that the office or laboratory facilities and equipment package be maintained for more than 30 days after the date of physical work completion, as specified in Section 609.3, an appropriate adjustment (payment to the Contractor) will be made to the lump sum prices bid for the indicated office or laboratory facilities and equipment package, as applicable, for the days in excess of 30 until released by the Representative, at the Daily Price Adjustment Rate specified in Section 609.4(a)1.

No adjustment will be made if the Representative directs that the office or laboratory facilities and equipment package be maintained for more than 30 days after the date of physical work completion due to the Contractor's failure to submit, complete, and/or correct required certificates or documents, as established during the final inspection.

TABLE A

Office/Laboratory and Standard Equipment					
	Type A Field Office	Type B Field Office	Type C Field Office	Proportioning Plant Office	Field Laboratory
Floor Space square foot, out to out	1,300	650	240	150	150
Individual Partitioned Rooms	6	3	2	1	1
Conference Table & Chairs	1				
Desk(s) & Chair(s)	6	3	2	1	1
Office Chairs	15	9	6		
Plan Rack(s)	2	2	2		1
Work Table(s) (1)	5	3	2	1	1
Printer Stand(s) (2)	5	3	1		
4-Drawer File Cabinet(3)	4	3	2	1	1
2-Drawer File Cabinet(3)	2	1	1		
Sample Splitter (4)					1
Range (5)					1
Sanitary Electric Water Cooler	1	1	1	1	1
Individual Access Phone Line(s) (6)	4	4	4	3	
Surge Protectors (7)	6	4	4		
Telephone(s) w/ Answering Machine(s) or Voice Mail	2	2	2	1	

(1) Work Table. Minimum size: 2 1/2 feet by 7 feet by 2 1/2 feet high.
(2) Printer Stand. Specifically designed to accommodate laser and color printers, with paper storage/feeder tray. Minimum size: 18 inches by 18 inches by 2 1/2 feet high.
(3) File Cabinets. Fire resistant (D-Label), lockable, metal file cabinet.
(4) Sample Splitter. For coarse and fine aggregate, with adjustable chute opening.
(5) Range. Standard, 36-inch range, gas or electric, new or used, with oven capable of operating at 230F ± 9F.
(6) Individual Access Phone Line(s). The number indicated includes the phone line(s) needed for microcomputer system operation and Internet service.

(7) Surge Protector. A minimum of six AC outlets and one telephone outlet, with a 6 foot minimum length cord, having a line voltage regulator/conditioner that protects against chronic high voltage, voltage spikes, and radio frequency interference.

Appendix
TABLE A

EQUIPMENT PACKAGE	
Equipment	**Quantity***
Communications Equipment	
High Capacity MFD(1)	
Low Capacity MFD (1)	
Cellular Phone(s)	
Specialized Equipment	
Surveyor's Level & Measuring Rod	
Electronic Digitizer	
Digital Display Level	
Infrared Thermometer	
Laser Range Finder	
Paper Shredder	
Digital Camera	
Internet Service	
Internet Service Provider	Yes/No
Wireless Internet Broadband Router(2)	Yes/No
Miscellaneous Items	
Computer Media	Yes/No
High Yield MFD Ink/Toners Cartridges	Yes/No
Laboratory Equipment	
Concrete Cylinder Testing Machine	

* The special provision will be included in the proposal indicating the quantity of each type of communications, electronic, and/or specialized equipment to be furnished.

1. Unless otherwise approved, furnish a multifunction device in lieu of a separate copier, laser printer, color printer, scanner, and fax.

2. Provide compatible, powered internet hardware with firewall protection capable of wireless WPA2 security internet service and eight hardwired network ports, and pre-shared key. All cabling needed to interconnect network hardware and all microcomputer systems are required.

Microcomputer Systems. This information is being provided to assist Bidders in meeting the requirements as specified in Section 609.2(c), Communications Equipment, Section 609.2(e), Internet Service, and Section 609.2(f), Miscellaneous Materials. The special provision in the proposal will indicate the total number of microcomputer systems that will be used on the project.

Microcomputer systems may be furnished by the Department. If microcomputer systems are to be furnished by the Contractor, as part of the construction Contract, the bid will include applicable, 0688-XXXX bid items. When indicated, furnish microcomputer systems meeting the requirements as specified in Section 688.

SECTION 610—PIPE UNDERDRAIN AND PAVEMENT BASE DRAIN

610.1 DESCRIPTION—This work is construction of pipe underdrains, of the type and size indicated, and pavement base drains.

610.2 MATERIAL—

(a) Pipes. Section 601.2(a)1 and as follows:

1. General.

1.a Type. Use the type indicated. If not indicated, use any one of the types listed below.

1.b Size. For circular pipe, unless otherwise indicated, use pipe with a minimum inside diameter of 4 inches and sized in not less than 1-inch increments. For semi-circular pipe, unless otherwise indicated, use pipe with a smooth-walled bottom section and an average inside diameter of 4 5/8 inches.

1.c Perforations. Perforate a pipe to provide a minimum water inlet area of 1.4 square inches per linear foot of pipe and, unless otherwise specified, as follows:

- Cut perforations cleanly so as not to restrict the flow of water.
- Provide either circular or slotted perforations, except do not use slotted perforations in smooth walled pipe.
- For circular perforations, provide holes with a nominal diameter not less than 3/16 inch or greater than 3/8 inch. Also, provide similar rows of perforations on both sides of the pipe's vertical centerline, with the lower most rows separated by an arc of 60 degrees minimum.
- For slotted perforations, provide slots not exceeding 1/8 inch wide and a length not more than 10% of the average inside circumference for 4-inch to 8-inch diameter pipe and not exceeding 2 1/2 inches for pipes larger than 8 inches. Additionally, center the slots in the corrugation valleys and at maximum 120 degree intervals about the pipe circumference.

1.d Strength Test. As specified, except for plastic pipe test using the parallel plate load test, according to ASTM D2412.

1.e Infiltration Rate. For perforated or porous pipe, provide a minimum infiltration rate of 10 (gallons per minute) per linear feet of pipe, as determined according to AASHTO M 176M.

1.f Pipe Length. Flexible plastic pipe, 6 inches or less in diameter, may be supplied in specified coiled lengths or standard increments agreeable to the Department. The use of long coils, 3,000 feet to 4,000 feet in length, is allowed, provided placement is by equipment recommended by the manufacturer and the pipe is not stretched or damaged during handling or placement. Furnish flexible plastic pipe, larger than 6 inches in diameter, and all sizes of rigid pipe in maximum lengths of 20 feet. Furnish lengths not less than 99% of the stated quantity. Measure with any suitable device accurate to 1/4 inch in 10 feet (0.2%) while the pipe is stress-free and at rest on a flat surface in a straight line.

1.g Plastic Pipe. Furnish extruded or molded plastic pipe made of high density, flexible plastic.

Furnish pipe that is permanently marked, stenciled, or labeled with manufacturer's name, pipe trade name, or type, average size the specification designates, the plant designation code, and the date of manufacture all at intervals of no more than 10 feet.

2. Porous Concrete Pipe. AASHTO M 176M

3. Corrugated Polyethylene (PE) Pipe. AASHTO M 252 (pipes 4 inches through 10 inches) and AASHTO M

294 (pipes 12 inches through 15 inches), modified as follows:

- The Department will determine the lot size for acceptance.
- Minimum pipe stiffness for pipes 4 inches through 10 inches to be 30 pounds per square inch at 10% deflection, when tested according to ASTM D2412. Minimum pipe stiffness for pipes 12 inches through 15 inches to be 45 pounds per square inch at 5% deflection and 40 pounds per square inch at 10% deflection, when tested according to ASTM D2412.

4. Polyvinyl Chloride (PVC) Pipe. ASTM D3034, ASTM F758, Type PS46 or ASTM F949 modified as follows:

- Minimum pipe stiffness for pipes 4 inches through 10 inches, 35 pounds per square inch at 5% deflection, when tested according to ASTM D2412. Minimum pipe stiffness for pipes 12 inches through 15 inches, 45 pounds per square inch at 5% deflection, when tested according to ASTM D2412.
- Capable of being flattened to 40% of the original pipe O.D. without splitting, cracking, or breaking.

5. Acrylonitrile-Butadiene Styrene (ABS) Pipe. ASTM D2751, modified as follows:

- Minimum pipe stiffness for pipes 4 inches through 10 inches, 35 pounds per square inch at 5% deflection, when tested according to ASTM D2412. Minimum pipe stiffness for 12 inch pipe, 45 pounds per square inch at 5% deflection, when tested according to ASTM D412.
- Capable of being flattened to 60% of the original pipe O.D. without splitting, cracking, or breaking.

6. Perforated Plastic Semicircular Pipe. AASHTO M 278 or ASTM D2680, modified as follows:

- Smooth or corrugated top and a smooth semicircular bottom.
- Minimum pipe stiffness (PS), 35 pounds per square inch at 5% deflection, when tested according to ASTM D2412.
- Capable of being flattened to 40% of the original pipe outside-to-outside height for PVC or 60% for ABS without splitting, cracking, or breaking.

7. Corrugated Steel Pipe, Metallic Coated. AASHTO M 36, Type III with Class 1 perforations or Type IIIA; AASHTO M 218; AASHTO M 274; and AASHTO M 289.

8. Corrugated Aluminum Alloy Pipe. AASHTO M 196, Type III with Class 1 perforations or Type IIIA.

9. Prefabricated Pavement Base Drains.

9.a General. Use prefabricated pavement base drains consisting of an inert, plastic core, designed to carry water flow, wrapped in geotextile fabric for filtering purposes. Select from a manufacturer listed in Bulletin 15.

9.b Backfill. As indicated, fine aggregate, Type A, except limestone sand, Section 703.1.

9.c Core Materials. An inert, plastic material resistant to commonly encountered chemicals and substances, having the following properties:

- Tensile strength, ASTM D638—1,200 pounds per square inch, minimum

- Water absorption, ASTM D570—0.01% after 24 hours
- Fungus resistance, ASTM G21—no growth
- Crush strength, *GRI-GC4—40 pounds per square inch, minimum
- Flow rate, ASTM D4716—15 gallons per minute per foot of width, minimum
- Provide a minimum of 6% open core area on the pavement side face of the base drain and a minimum of 3% on the shoulder side face.
- Provide unobstructed inflow through a minimum of 50% of the geotextile area on the pavement side face of the base drain and 12% of the geotextile area on the shoulder side face, when stretched across the face of the core.

* Geosynthetic Research Institute, Drexel University.

9.d Geotextile Fabric. Provide geotextile, non-woven, needle punched, conforming to Table A. Resins are to be virgin materials, unless otherwise approved, and identified as such in the certification statement.

TABLE A
Prefabricated Pavement Base Drain - Geotextile Physical Requirements

Fabric Properties	Test Method	Required Value (1)
1. Grab Tensile Strength, lbs.	ASTM D4632	158
2. Grab Tensile Elongation, %	ASTM D4632	50
3. Puncture, lbs. (2-inch flat-end rod)	ASTM D6241	400
4. Trapezoid Tear Strength, lbs.	ASTM D4533	56
5. Apparent Opening Size (AOS), Sieve No.	ASTM D4751	100 to 50
7. Permittivity, sec^{-1}	ASTM D4491	1.1
9. Ultraviolet Resistance Strength Retention, %	ASTM D4355	70 @ 500 hrs.

(1) The numerical values indicate average minimum roll value or minimum to maximum range, except as noted.

9.e Approval. Approval will be based on certified test data submitted by the manufacturer or testing by LTS, or both, before being listed in Bulletin 15.

9.f Certification and Shipment to Project. Certify each shipment as specified in Section 106.03(b)3.

Clearly identify each roll of pavement base drain by affixing a tag or sticker containing the following information:

- Lot number
- Manufacturer's name and address
- Product type and designation
- Product identification including thickness, height, roll length, and roll weight
- Geotextile designation

9.g Wrapping of the Core. Wrap the geotextile completely around the drainage core with the seam along the length of the drain, on the shoulder side face, and preferably near the midpoint. Fabricate the seam using a non water-soluble adhesive, if adhesive is used. Firmly attach geotextile to the protrusions on the pavement side face of the drainage core and spot-bond on the shoulder side face, or submit results of flow tests on the drain under loading with the geotextile unattached, to ensure that the geotextile will not deform under continuous loading to the point where flow capacity is diminished and the specified minimum flow rate is not achieved.

9.h Splice Connections and Fittings. Provide standard fittings and splice connections along the pavement base drain, as indicated or as directed, of sufficient strength to withstand construction handling and permanent loading. Obtain approval for any nonstandard fittings and connections.

9.i Outlets. Section 615.2

(b) Aggregates.

1. Fine Aggregate. Type II backfill, natural or manufactured Type A sand, Section 703.1; rock, gravel, or blast furnace slag sand prepared from Type C, or better, coarse aggregate as specified in Section 703.2; except conform to the size and grading requirements for Type A sand, Section 703.1, with a maximum loss in soundness test not exceeding 20%.

2. Coarse Aggregate. Type C or better, Section 703.2, except that the percentage of crushed fragments for gravel is not required. Use No. 57 for Type I backfill and No. 8 for Type II backfill.

(c) Mortar. Section 705.7(a)

(d) Geotextiles, Class 1. Section 735

(e) Open Graded Subbase. Section 350

610.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Pipe, Trench, and Backfill. Place pipe underdrain after fine grading is completed.

Place pavement base drain after the adjacent roadway pavement is constructed, except when it is placed under curb sections or other special locations. Excavate pavement base drain trench without disturbing subbase under the roadway pavement.

Join underdrain or base drain to new or existing drainage structures with satisfactory connections. Use fittings with deflection angles of 45 degrees or less.

After completing the trench and the lower 2 inches of compacted backfill, lay the pipe and make the joints according to the manufacturer’s recommendations.

For perforated pipe, place the perforations down, unless otherwise directed. Lay semicircular pipe with the smooth, circular portion at the bottom.

Do not leave trenches open during periods of precipitation or overnight.

Seal the upgrade end of pipe underdrain or base drain to prevent entry of foreign material.

Complete backfilling after having the pipe inspected by the Inspector-in-Charge.

(b) Geotextiles, Class 1. Use Class 1 geotextile, as specified in Section 212.3(b), for all pavement base drain construction and if indicated for pipe underdrain construction.

(c) Prefabricated Pavement Base Drains.

1. General. At least 2 weeks before beginning installation, submit the proposed installation method to the Representative, in writing, and note any deviation from the plans or from the manufacturer's approved drawings. Upon request by the Representative, have a technical representative from the manufacturer present during installation.

2. Shipping and Storage. Ship drainage materials with protective covering and store in a manner so as not to damage or contaminate them. Visually inspect all materials, before placement, to ensure they are free from damage. Damaged drainage material will not be accepted. Store drainage material on an elevated platform and protect from weather and ultraviolet exposure. Do not remove material from the manufacturer's protective covering until ready to be installed. If material is rerolled and stored, use an approved protective covering equivalent to the manufacturer's original wrapping.

3. Excavation. Place prefabricated pavement base drain in a trench constructed adjacent to the roadway pavement edge as shown on the Standard Drawings. Construct trench without disturbing the pavement structure or subbase. Unless otherwise indicated or directed, provide trench having a width as shown on the Standard Drawings and a depth extending at least 2 inches into the subgrade.

4. Placement and Backfilling. Place prefabricated pavement base drain vertically in the trench as shown on the Standard Drawings. Place the first lift of backfill material simultaneously with drain install to ensure complete contact with the geotextile and the trench wall. Repair any tears in the geotextile according to the manufacturer's recommendation. If raised core projections protrude from only one side of the drain, place the projections toward the pavement side of the trench.

Backfill the trench with fine aggregate, Type A using 9-inch (maximum) hydraulically compacted lifts. Spray each lift with water at 1.0 gallon per linear foot.

Ensure that excavation, drain placement, and backfill operations are performed in sequence, with a minimum amount of trench open at all times. Do not leave trenches greater than 2 inches in depth open overnight. Barricade trenches at all times according to the requirements of 67 PA Code, Chapter 203.

If shoulder restoration is indicated, follow applicable specifications and standards to reconstruct the existing shoulder as specified in the contract documents.

5. Connections, Fittings, and Outlets. Fit splice connectors into the drainage core so that they do not restrict flow. Follow the manufacturer's approved connection details. Do not allow backfill material to enter the connector at any point. For drainage cores that splice using male-to-female overlapping, roll back the geotextile onto the in-place drainage core, make the splice, and rewrap the geotextile over the completed joint. Provide a minimum of 6 inches of geotextile overlap from one section to the next.

Install subsurface drain outlet pipe and fittings as specified in Section 615.3, concurrently with the pavement base drain, to establish positive drainage within 24 hours of the beginning of trenching for the installation of a given section of base drain. The Representative may restrict installation of additional sections of base drain until acceptable outlet installations are completed. Ensure transitions are smooth and nonrestricting to flow. Do not use "home-made" connections.

Install all fittings and connections to preclude soil intrusion into the drainage core or outlet piping and to provide continuity of drainage flow. Install fittings for positive, gravity flow, and outlet the drainage system as indicated or as directed. Furnish outlet pipes with galvanized wire mesh shields as shown on the Standard Drawings. If the drain is terminated without an outlet, provide a fitting to prevent soil intrusion into the end of the drainage core. Protect all joints and fittings from damage during construction.

610.4 MEASUREMENT AND PAYMENT—

(a) Pipe Underdrain, Types I and II Backfill. Linear Foot

(b) Pipe Underdrain, Types I and II Backfill, Including Shoulder Restoration. Linear Foot.

(c) Pavement Base Drain. Linear Foot

(d) Pavement Base Drain, Including Shoulder Restoration. Linear Foot

(e) Class 4 Excavation. Cubic Yard

For extra-depth pipe underdrain and extra-depth pavement base drain excavation in excess of that shown on the Standard Drawings.

(f) Fine Aggregate for Extra-Depth Pipe Underdrain. Cubic Yard

(g) Additional Coarse Aggregate for Extra-Depth Pipe Underdrain. Cubic Yard

(h) Additional Coarse Aggregate for Extra-Depth Pavement Base Drain. Cubic Yard

(i) Geotextiles, Class 1. Section 212.4(a)

(j) Prefabricated Pavement Base Drains. Linear Foot

(k) Subsurface Drain Outlets. Section 615.4

SECTION 612—SUBGRADE DRAINS

612.1 DESCRIPTION—This work is construction of subgrade drains.

612.2 MATERIAL—

- Asphalt Impregnated Paper—Section 727
- Coarse Aggregate, Type C or better (no steel slag), No. 57—Section 703.2, except that the soundness test is not required and the percentage of crushed fragments for gravel does not apply.
- Geotextiles, Class 1—Section 735

612.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Trench and Backfill. Excavate the trench, backfill, and adequately tamp the backfill.

Keep outlet ends of subgrade drains open during construction and until final acceptance of shoulders.

Extend subgrade drains a length sufficient to adequately drain the wet area. Construct subgrade drains under subbase after the subgrade has been completed but before the subbase is placed. Construct subgrade drains at right angles to the roadway centerline, or skew, as directed. Extend subgrade drains along the roadway, if necessary, to achieve a suitable outlet. Maintain a minimum slope of 1/4 inch per foot on the trench bottom through pavement and shoulder areas.

(b) Geotextiles, Class 1. Section 212.3(b), if indicated.

(c) Shoulder Restoration. If shoulder restoration is indicated, follow applicable specifications and standards to reconstruct the existing shoulder as specified in the contract documents.

612.4 MEASUREMENT AND PAYMENT—

(a) Subgrade Drains. Linear Foot

(b) Subgrade Drains, Including Shoulder Restoration. Linear Foot

(c) Geotextiles, Class 1. Section 212.4(a)

SECTION 613—STONE BACKFILL FOR MISCELLANEOUS DRAINAGE

613.1 DESCRIPTION—This work is the furnishing and placing of stone backfill for miscellaneous drainage.

613.2 MATERIAL—

- Coarse Aggregate, Type C or better (no steel slag), No. 1 and No. 57—Section 703.2
- Local Stone—If allowed, acceptable, clean, sound, hard, and durable slabs of stone, sharply broken, if required, and not more than 6 inches in any dimension.
- Geotextiles, Class 1—Section 735

613.3 CONSTRUCTION—Place No. 1 Coarse Aggregate or local stone backfill for miscellaneous drainage in sumps, springs, wells, sink holes, and other places, where indicated or directed. Place geotextiles, Class 1, as specified in Section 212.3(b).

If local stone is used, place a 6-inch layer of No. 57 coarse aggregate as the stone backfill top layer.

613.4 MEASUREMENT AND PAYMENT—Cubic Yard

SECTION 615—SUBSURFACE DRAIN OUTLETS

615.1 DESCRIPTION—This work is construction of subsurface drain outlets.

615.2 MATERIAL—

- Pipe—Section 610.2(a); except, without perforations. Unless otherwise directed, use outlet pipe of the same materials as the underdrain or pavement base drain. Provide smooth walled PE or PVC outlet pipe, for use with PE, PVC, or ABS underdrain or pavement base drain, conforming to the above requirements and having a minimum stiffness of 70 pounds per square inch at 5% deflection at all pipe diameters.

- Class A Cement Concrete—Section 704

- Red Subsurface Drain Outlet Marker—From a manufacturer listed in Bulletin 15. Reflective sheeting material is not required.

615.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

Excavate the trench, leaving the bottom uniformly firm and smooth, ensuring positive gravity flow in outlet. Lay pipe on top of 2 inches of satisfactorily tamped embankment material. Join pipe with connecting bands or with split couplings. After the outlet pipe has been laid and accepted, backfill the trench in 4-inch layers, using satisfactory embankment material, then thoroughly tamp. Compact the portion of the outlet under pavement or shoulder, as specified in Section 601.3(f). Provide outlet opening protection as shown on the Standard Drawings.

Connect to the pipe underdrain or pavement base drain using suitable couplings and fittings or special connectors; connect with a maximum 45-degree bend or series of 45-degree bends. If indicated or directed, provide satisfactory connections to join outlets to existing drainage structures.

If indicated, construct concrete endwalls to protect outlets not connected to new or existing drainage structures. If plastic pipe is used, protect ends from exposure to the deteriorating effects of sunlight, using satisfactory endwalls and trench backfill material.

Mark subsurface drain outlet using a red subsurface drain outlet marker on the side of opening facing approaching traffic. Embed the markers a minimum of 18 inches or as recommended by the manufacturer.

615.4 MEASUREMENT AND PAYMENT—

(a) Subsurface Drain Outlets. Linear Foot

(b) Class 4 Excavation. Cubic Yard
For subsurface drain outlet excavation in excess of that shown on the Standard Drawings.

(c) Subsurface Drain Outlet Endwall. Each

(d) Red Subsurface Drain Outlet Marker. Each

SECTION 616—END SECTIONS AND SLOPE PIPE FITTINGS

616.1 DESCRIPTION—This work is construction of end sections and slope pipe fittings.

616.2 MATERIAL—Manufactured or fabricated as specified in applicable portions of Section 601, as shown on the Standard Drawings, and as follows:

(a) Concrete End Sections. Section 601.2(a)3 except as follows:
Provide reinforcement per linear foot of end section, equal to the minimum steel requirements for circular reinforcement in a Type A Standard Installation Concrete Pipe having the internal diameter of the end section portion, withstanding a fill height greater than or equal to 36 inches and less than 82 inches.

(b) Steel End Sections, Metallic Coated. Section 601.2(a)4.b

(c) Aluminum Alloy End Sections. Section 601.2(a)4.c

(d) Steel Slope Pipe Fittings. Fabricated from sheet steel of the thickness indicated, as specified in Section 601.2(a)4.b for steel sheets, except that minor variations may be acceptable to allow use of the manufacturer's standard methods of fabrication.

(e) Coarse Aggregate. Section 703.2

(f) Thermoplastic End Sections–outlet ends only. Section 601.2(a)6

616.3 CONSTRUCTION—Install end sections as specified in the applicable requirements of Section 601.3 and as indicated.
Only use thermoplastic end sections on the outlet end of any thermoplastic pipe run.
Install slope pipe fittings as shown on the Standard Drawings.

616.4 MEASUREMENT AND PAYMENT—

(a) End Sections. Each
The price includes excavation and all backfill as indicated.

(b) Slope Pipe Fittings. Each
The price includes excavation and all backfill as indicated.

SECTION 617—SLOTTED DRAINS

617.1 DESCRIPTION—This work is construction of drains with continuous slotted openings.

617.2 MATERIAL—

- Slotted Drain—Fabricated from metallic-coated steel pipes specified in Section 601.2(a)4.b and structural steel conforming to the requirements specified in Section 1105.02(a)2 or precast polymer concrete troughs as listed in Bulletin 15 and certified as specified in Section 106.03(b)3.

- Coarse Aggregate—Section 350.2

617.3 CONSTRUCTION—Excavate the trench, as shown on the Standard Drawings for pipe and for precast polymer concrete sections according to the manufacturer's recommendations.

Install the drains according to the manufacturer's instructions or by another accepted method.

Place the drain to the line and grade indicated, adequately supported until adjacent construction is completed.

Provide temporary covers, as required, to prevent foreign material from entering the drain during construction. Before placing cement concrete or asphalt concrete adjacent to the drain, place adequate covers in or over the slot or grate to prevent entry of the paving material. If directed, remove and dispose of the temporary covers.

Backfill metal pipe as specified in Section 601.3(f) and precast polymer concrete sections according to the manufacturer's recommendations.

617.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 618—CONCRETE COLLAR FOR PIPE EXTENSION

618.1 DESCRIPTION—This work is the construction of a concrete pipe collar for extending existing pipe(s) from an endwall or other structure.

618.2 MATERIAL—

- Class A Cement Concrete—Section 704
- Mortar—Section 1001.2(e)
- Reinforcement Bars—Section 709.1(a)1

618.3 CONSTRUCTION—As shown on the Standard Drawings for pipe diameters up to 33 inches, as indicated for larger diameter pipe, and as follows:

(a) General. Remove a portion of the endwall footer, if required to obtain proper pipe alignment, using acceptable equipment and methods.

Obtain acceptance for drilling equipment and methods before drilling. Drill 1-inch holes in the existing structure with equipment that does not damage the existing structure. Clean material from the full depth of the holes before placing the reinforcement and grout. Grout the reinforcement in place, using non-shrinking mortar placed to ensure complete bonding of the reinforcement to the grout and the existing structure. Completely fill all holes with mortar, and after placing the reinforcement remove excess mortar protruding from the structure. Obtain acceptance for adjustments required to obtain final horizontal and concentric alignment.

(b) Cement Concrete. Construct the collar, as specified in Section 1001.3, after placing the pipe extension, as specified in Section 601.3(i).

(c) Excavation and Backfill. Excavate as required. Backfill excavated spaces around the collar, as specified in Section 206.3(b)4, using acceptable embankment material. Satisfactorily dispose of unsuitable and surplus material.

618.4 MEASUREMENT AND PAYMENT—Each

SECTION 619—PERMANENT IMPACT ATTENUATING DEVICES

619.1 DESCRIPTION—This work is furnishing and installing of permanent impact attenuating devices, including all appurtenances and hardware, as indicated.

619.2 MATERIAL—

- Permanent impact attenuating devices from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

619.3 CONSTRUCTION—

(a) General. Submit shop drawings as specified in Section 105.02(d).

(b) Installation. Install according to the manufacturer's specifications and installation instructions for full depth embedment only, and as follows:

Drive posts mechanically, unless otherwise directed by the Representative. Do not cut, batter, burr, separate galvanizing from steel, or distort the post. Driven post must be plumb. As directed, remove and replace posts bent or otherwise damaged.

In areas where random boulders, hardpan, or bedrock are encountered and the specified post cannot be driven to full depth embedment, remove the post, then drill a 12-inch minimum diameter hole to the required depth, as per manufacturer's recommendation for full depth embedment. Reset the post in the hole to the proper elevation and backfill to the ground line, using an acceptable embankment material thoroughly compacted in maximum 6-inch layers. If the placed material around the post cannot be satisfactorily compacted, backfill the hole in maximum 6-inch layers thoroughly compacted to ground line, and then redrive the post to proper elevation.

Type B flowable backfill as specified in Section 220 Table A can be used to backfill the hole after resetting the post in place.

619.4 MEASUREMENT AND PAYMENT—Each

The price includes tail end treatment when required.

SECTION 620—GUIDE RAIL

620.1 DESCRIPTION—This work is construction of new guide rail of the type indicated, re-setting of existing guide rail, removal of a concrete end anchor, and removal of existing guide rail, including all appurtenances and hardware.

620.2 MATERIAL—

(a) Guide Rail. Section 1109 and Section 1119

(b) Other Material.

- Class A Cement Concrete—Section 704
- Reinforcement Bars—Section 709.1
- Delineators – Section 937.2(b)

(c) Certification. Section 106.03(b)3

620.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) New Guide Rail.

1. General. Set posts plumb at the spacing shown. Minor adjustments in spacing may be allowed to clear objects or to fit between fixed ends.

Use bolts that are long enough to extend at least 1/4 inch beyond the nuts. Draw bolts tight, except if required for expansion.

Before installation, apply acceptable galvanizing paint to repair portions of posts to be placed underground. After installation, apply two coats of the galvanizing paint to guide rail or related appurtenances, including threaded portions of fittings, fasteners, and the cut end of bolts, that have been abraded or cut, exposing the base metal.

If guide rail is installed under traffic conditions, conform to the following requirements:

- Perform work only within those areas protected by temporary traffic control devices.
- Attach guide rail on posts driven during the day, before the end of that day.
- Provide satisfactory protection at exposed, unfinished ends of guide rail.

Join new and existing guide rail, if required, as indicated or directed.

Construct concrete parts of guide rail, if required, as specified in the applicable parts of Section 1001.3.

2. Posts and Offset Brackets. Drill or punch holes suitable to the type of guide rail indicated. Drive posts mechanically, unless otherwise directed. Do not batter, burr, separate galvanizing from steel, or distort the post. As directed, remove and replace posts bent or otherwise damaged. Install offset brackets, if required.

In areas where random boulders are encountered and the post cannot be driven to grade, remove the post, then drill or excavate a hole of suitable dimensions and depth to place the post at grade. Reset the post and backfill to the ground line, using No. 57 Coarse Aggregate and an acceptable embankment material, thoroughly compacted in 6-inch layers as shown on the Standard Drawings.

In areas where bedrock is encountered, and the post cannot be driven to grade, remove the post, then drill or excavate a hole of suitable dimensions to the required depth. Reset the post and backfill to the ground line, using No. 57 Coarse Aggregate and an acceptable embankment material, thoroughly compacted in 6-inch layers as shown on the Standard Drawings. If an underground feature, such as a low-fill culvert or underground utility line, prevents post(s) from being driven, posts may be skipped up to a 25-foot span as shown on the Standard Drawings.

3. Rail Elements. Do not allow the free end of Types 2-W and 2-WC rail elements to swing free and cantilever from the 5/16-inch mounting bolt. Rest the free end on temporary 1/2-inch support bolts and nuts or temporary drift pins until the 5/16-inch mounting bolts are torqued.

Splice by lapping in the direction of traffic. Provide full contact between the rail elements in the overlap, between the center and both edges of the element, and between the bracket or post, as the case may be.

Use suitable shop-formed guide rail or rubbing rails on curves having a radius of less than 150 feet.

4. Delineators. Install as specified in Section 937.3(a) and 937.3(c) for all W-beam guide rail and transition types.

5. Terminal Sections, Strong Post Anchor Terminals, Strong Post In-Line Anchors, and End Treatments. Install, where indicated.

6. Over Underground Structures. Install, where indicated, using Class A Cement Concrete, reinforcement bars, anchor bolts, nuts, and washers.

(b) Guide Rail to Bridge Barrier Transition.

1. Typical and Alternate Concrete Bridge Barrier Transition. Install approach end guide rail transition at structure barrier, with or without inlet placement as indicated, as shown on the Standard Drawings.

2. Thrie-Beam to PA Type 10M Bridge Barrier Transition. Install approach end guide rail transition at structure barrier, with or without inlet placement as indicated, as shown on the Standard Drawings.

3. Thrie-Beam to Vertical Wall Bridge Barrier Transition. Install approach end guide rail transition at structure barrier as shown on the Standard Drawings.

4. Thrie-Beam to PA Bridge Barrier Transition. Install approach end guide rail transition at structure barrier as shown on the Standard Drawings.

(c) Reset Guide Rail. Carefully remove existing guide rail and reset at locations indicated, as shown on the Standard Drawings. Do not reset posts in same locations. The Department must approve the condition of the in-situ barrier components to determine if they are able to be reused. Ensure guide rail conforms to the Standard Drawings, including guide rail height and splice locations.

Replace steel offset brackets and backing plates with routed wood, plastic, or composite offset brackets from a supplier listed in Bulletin 15. Properly dispose of steel offset brackets and backing plates.

Repair or replace rail element, posts, hardware, or other materials damaged during this operation.

When resetting posts for Type 2 Weak Post guide rail, replace posts that are less than 65 inches in length.

(d) Remove Existing Guide Rail. Dispose of all excess material created by the removal, reset, or repair work, except for the material that the Representative determines salvageable for Department use. Satisfactorily backfill holes in preparation of driving new posts, as required.

1. Remove Existing Guide Rail (Contractor Property). Remove existing guide rail from locations indicated, and then dispose of the material outside the right of way.

2. Remove Existing Guide Rail (Department Property). When indicated, the guide rail will be retained by the Department. Carefully remove the existing guide rail from locations indicated. Completely dismantle, unbolt, and remove guide rail in a manner that permits reuse of the components from locations indicated. Do not disassemble by burning or cutting. Neatly bundle the galvanized steel posts, offset brackets, and galvanized rail elements. Separate the individual elements, (rail elements, posts, offset blocks) as directed. Bundle and deliver to designated stockpile. The proposal/contract will include a special provision that identifies where the guide rail is to be stockpiled, as well as the approximate distance (miles) from project site to designated stockpile location. Advance notification of a scheduled delivery of guide rail to designated stockpile is to be provided to the individual whose name and telephone number are listed in the special provision.

(e) Structure-Mounted Guide Rail. Install as indicated.

(f) Remove Concrete Anchorage. Remove and satisfactorily dispose of concrete end anchor from the locations indicated. Backfill anchorage area with suitable material.

620.4 MEASUREMENT AND PAYMENT—

(a) Guide Rail. Linear Foot
For the type indicated. Includes nested guide rail as indicated.

(b) Terminal Section. Each
For the type indicated.

(c) Type 31 Strong Post Anchor Terminal. Each
The price includes steel foundation tubes, short breakaway timber posts, ground strut, terminal rail element, soil plate, anchor cable bearing plate, post sleeve, anchor plate, swaged cable assemblage, hex bolts, washers, and nuts.

(d) Type 31 Strong Post End Treatment. Each

(e) Type 2 Weak Post End Treatment. Each

(f) Type 2 Weak Post, Driveways and Openings. Each

(g) Reset Guide Rail. Linear Foot
The price includes height adjustment, W-beam splice location adjustments, new offset brackets and backing plates.

(h) Structure Mounted Guide Rail. Linear Foot

(i) Delineators. Section 937.4. For the type and color indicated

(j) Remove Existing Guide Rail. Linear Foot
If guide rail is retained by the Department, the unit price includes the cost of delivering guide rail material to the designated stockpile.

(k) Guide Rail to Bridge Barrier Transition. Each
For the type indicated.

(l) Inlet. Section 605.4

(m) Remove Concrete Anchorage. Each

(n) Guide Rail Post. Each

(o) Offset Bracket. Each

(p) Type 31 Strong Post In-Line Anchor. Each
The price includes steel foundation tubes, short breakaway timber posts, ground strut, terminal rail element, soil plate, anchor cable bearing plate, post sleeve, anchor plate, swaged cable assemblage, hex bolts, washers, and nuts.

(q) Curved W-Beam Guide Rail at Intersections. Linear Foot
The price includes W-beam rail elements, long breakaway timber posts, hex bolts, washers, and nuts.

SECTION 621—METAL MEDIAN BARRIER

621.1 DESCRIPTION—This work is construction of new metal median barrier of the type indicated, resetting of existing metal median barrier, and removal of existing metal median barrier.

621.2 MATERIAL—

(a) Metal Median Barrier. Section 1109

(b) Other Material.

- Class A Cement Concrete—Section 704
- Joint Sealing Material—Section 705.4(b) or (c)
- Asphalt Wearing Course— Section 413.2 (Not RPS)
- Reinforcement Bars—Section 709.1
- Asphalt Cement—Class PG 64S-22 or PG 58S-28

(c) Certification. Section 106.03(b)3.

621.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Metal Median Barrier.

1. General. Section 620.3(a)1, except substitute median barrier for guide rail.

2. Posts. Drill or punch holes.

Drive posts, as specified in Section 620.3(a)2, or set manually.

As directed, either form holes before placing concrete, or cut or drill holes in existing or newly placed concrete to accommodate the installation. Do not make holes any larger than necessary to install the post. Drive the post to grade after the hole is cut or drilled; backfill the hole with either hot or cold asphalt wearing course material and fill the void around the post with Asphalt Cement, Class PG 64S-22 or PG 58S-28.

In areas where random boulders are encountered and the post cannot be driven to grade, remove the post, then drill or excavate a hole of suitable dimensions and depth to place the post at grade. Reset the post and backfill to the ground line, using an acceptable material, thoroughly compacted in 4-inch layers. If a hole has been cut or drilled in paved areas, backfill the hole for the full paved depth, using hot or cold asphalt wearing course material, finish to a flush elevation, then seal the top with joint sealing material.

In areas where bedrock is encountered and the post cannot be driven to grade, remove the post, then drill or excavate a hole of sufficient dimensions to the required depth. Fill the hole with Class A Cement Concrete, set the post to grade, then plumb and secure until the concrete has set.

3. Rail Elements. Support rail elements and splice, as specified in Section 620.3(a)3. Use suitable shop-formed rail on curves having a radius of less than 150 feet. Do not punch, drill, cut, or weld in the field, except if directed for special conditions.

4. Cement Concrete Anchor Blocks. Section 620.3(a)4

(b) Reset Metal Median Barrier. Section 620.3(c), except substitute median barrier for guide rail.

(c) Remove Existing Median Barrier. Section 620.3(d), except substitute median barrier for guide rail.

621.4 MEASUREMENT AND PAYMENT—

(a) Metal Median Barrier. Linear Foot

(b) Metal Median Barrier End Treatment. Each

(c) Metal Median Barrier End Treatment, Driveways and Openings. Each

(d) Metal Median Barrier, Structure Mounted. Linear Foot

(e) Reset Metal Median Barrier. Linear Foot

(f) Remove Existing Metal Median Barrier. Lump Sum or Linear Foot

SECTION 622—CONCRETE GLARE SCREEN

622.1 DESCRIPTION—This work is construction of cement concrete glare screen of the type indicated.

622.2 MATERIAL—

- Class AA Cement Concrete—Section 704, except use Class AAA Cement Concrete as specified in Section 704, for pre-cast barrier.
- Class AA Cement Concrete (Slip-Forming)— Section 704, except:
  The slump criteria for acceptance specified in Table A, Section 704.1 does not apply. Establish a target slump value to control the consistency of the concrete and action points and rejection points and include in the QC Plan. Perform slump testing at the frequency established in the QC Plan.
- Premolded Expansion Joint Filler—Section 705.1
- Reinforcement—Section 709.1, 709.3, or 709.4
- Curing and Protecting Covers—Sections 711.1 and 711.2(a)
- Joint Sealing Material (Longitudinal Joints)—Section 705.4(b) or (c)
- Mortar—Section 1001.2(d)
- Coarse Aggregate—Section 703.2
- Precast Concrete Barrier—Section 714
- Protective Coating for Concrete—Section 503.2
- Dowel Holes—Section 1003
- Nonshrink Mortar—Section 1001.2(e)
- Subbase Material—Section 350.2
- Structural Steel (Plates for Joints)—Section 1105.02(a)2. Galvanized as specified in Section 1105.02(s) or coated as specified in Section 605.2(a).
- Intermediate Curing Compound—Section 711.2(c)
- Caulking Compound (Vertical Joints)—Section 705.8(b)

622.3 CONSTRUCTION—As shown on the Standard Drawings and as specified in the applicable parts of Sections 623.3 and 1001.3.

622.4 MEASUREMENT AND PAYMENT—

(a) Concrete Glare Screen. Linear Foot

(b) End Transition. Each

(c) Concrete Glare Screen, Structure Mounted. Linear Foot

SECTION 623—CONCRETE MEDIAN BARRIER

623.1 DESCRIPTION—This work is construction of cement concrete median barrier.

623.2 MATERIAL—

(a) Preformed Fabric Filter Drain.

1. General. Use prefabricated pavement base drains consisting of an inert, plastic core, designed to carry water flow, wrapped in geotextile fabric for filtering purposes.

2. Geotextile Fabric. Non-woven, clog resistant, geotextile that does not reduce core flow capacity by creeping or deforming. Has the equivalent life of the core material.

3. Approval. Approval will be based on certified test data submitted by the manufacturer, or testing by LTS, or both.

4. Certification and Shipment to Project. Certify each shipment as specified in Section 106.03(b)3.

(b) Other Material.

- Class AA Cement Concrete—Section 704, except use Class AAA Cement Concrete, as specified in Section 704, for pre-cast barrier.
- Class AA Cement Concrete (Slip-Forming)—Section 704, except:
  The slump criteria for acceptance specified in Table A, Section 704.1 does not apply. Establish a target slump value to control the consistency of the concrete and action points and rejection points and include in the QC Plan. Perform slump testing at the frequency established in the QC Plan.
- Premolded Expansion Joint Filler—Section 705.1
- Reinforcement, Epoxy Coated or Galvanized—Section 709.1, 709.3, or 709.4
- Curing and Protecting Covers—Sections 711.1 and 711.2(a)
- Joint Sealing Material (Longitudinal Joints)—Section 705.4(b) or (c)
- Mortar—Section 1001.2(d)
- Coarse Aggregate—Section 703.2
- Subbase Material—Section 350.2
- Precast Concrete Barrier—Section 714
- Structural Steel (Plates for Joints)—Section 1105.02(a)2. Galvanized as specified in Section 1105.02(s).
- Protective Coating for Concrete—Section 503.2
- Intermediate Curing Compound—Section 711.2(c)
- Caulking Compound (Vertical Joints)—Section 705.8(b)

623.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in the applicable parts of Section 1001.3, as follows:

(a) General. Submit proposed standard design modifications to the District Executive for review and acceptance before starting work.

Fill surface blemishes larger than 1/2 inch with mortar, as directed.

Install barrier mount delineation devices, as directed or according to the manufacturer's recommendations.

For sections of barrier indicated as removable sections, install a bond breaker, such as asphalt impregnated paper or polyethylene, to facilitate removal. Provide suitable lifting methods for handling, installing, and removing the barrier units. If not in use, plug lifting devices with removable plastic or other acceptable plugs.

Join new concrete median barrier and existing barrier, where indicated and as directed.

If required, construct structure mounted median barrier, as indicated.

Precast concrete median barrier used in temporary installations, as specified in Section 627, may later be placed in a permanent installation, as specified here, provided barrier sections are not identified as being for temporary use only, are free from damage, and are otherwise acceptable.

Construct cast-in-place barrier and slip-form barrier according to the weather restrictions specified in Section 501.3(b).

Cure cast-in-place barrier and slip-form barrier as specified in Section 1001.3(p)3.a or Section 501.3(l) except white membrane curing compound may be used to cure barrier subject to the application of protective coatings and the first paragraph specified in Section 501.3(l)1.c does not apply.

Apply a protective coating to barriers, a minimum of 28 days after concrete placement, as specified in Section 503.3(b). Before application, thoroughly dry and clean concrete surfaces of dirt, debris, oil, grease, and foreign matter that would prevent protective coating penetration, adhesion, or drying.

Do not apply protective coating to precast barrier units produced specified in Section 714.

(b) Slip-Form Method. If the barrier is cured by a method other than a liquid membrane curing compound, apply an intermediate monomolecular film curing agent as specified in Section 516.3(j) immediately after the extruded concrete surface leaves the slip form machine or immediately after necessary offsets and fins are removed by light troweling.

Do not touch the barrier extruded concrete surface as it leaves the slip-form machine, except to immediately remove offsets and fins by light troweling.

Make adjustments in the operation to correct any condition causing surface blemishes larger than 1/2 inch. If the adjustments do not correct the condition within 30 linear feet, halt the operation until the condition is corrected, either by adjustments to the operation or by adjustments to the concrete mix.

Do not use an intermediate curing compound or water on the completed barrier to correct imperfections.

(c) Joints. Form contraction joints, by hand or saw, 3/16 inch wide and 2 inches deep, at 20-foot intervals. Saw as soon as possible after the concrete sets sufficiently to preclude raveling during the sawing, before any shrinkage cracking occurs in the concrete. The depth of saw cut may be decreased at the edge adjacent to the pavement to obtain a maximum depth without pavement damage.

Tool the construction joint edges.

Place 3/4-inch premolded, expansion-joint material, cut to conform to the cross sectional area, at structures and at the end of the workday.

Construct longitudinal joints a maximum of 1/4 inch wide on both sides of the barrier, as indicated. For precast units on curved sections, the Representative will allow a maximum 1/2-inch longitudinal joint. For curves with radii less than 765.5 yards (For curves greater than 2 degrees 30 minutes), use shorter precast barrier lengths to maintain longitudinal joint tolerances.

Seal the longitudinal joint as specified in Section 501.3(n). Seal all vertical contraction and construction joints with an approved caulking compound. Trim 3/4-inch premolded expansion-joint material at construction joints to create a notch for caulking compound. Do not seal the joints between precast barrier sections. Place precast barrier sections so that transverse joints are reasonably tight, but do not result in damage to barrier edges during placement.

(d) Removal of Forms. Do not remove forms until at least 12 hours after placing the concrete. Do not rub to correct irregularities until the full curing period has elapsed. Correct any irregular surface by rubbing with a carborundum stone. Do not brush finish or plaster. After removing the forms, fill minor defects with mortar. Promptly remove and replace rejected barrier.

(e) Testing and Acceptance. Have the finished barrier conform to the dimensions of the design template within 1/4 inch in all directions and across the joints. Test the top and side surfaces using a 10-foot straightedge. Hold the straightedge in successive positions for the entire length of the barrier and advance in stages of not more than 5 feet. Remove and replace barrier with deviations in excess of 1/4 inch as measured from the testing edge of the straightedge.

(f) Single Face Concrete Barrier. If single face concrete barrier is specified for use as a retaining wall, and drainage treatment is necessary, construct a preformed fabric filter drain as indicated.

623.4 MEASUREMENT AND PAYMENT—

(a) Concrete Median Barrier. Linear Foot

(b) End Transition. Each

(c) Concrete Median Barrier, Structure Mounted. Linear Foot

(d) Single Face Concrete Barrier. Linear Foot

(e) Flared End Transition. Each

SECTION 624—RIGHT-OF-WAY FENCE

624.1 DESCRIPTION—This work is construction of right-of-way fence of the type indicated.

624.2 MATERIAL—

(a) Right-of-Way Fence. Section 1110

(b) Packaged Dry Concrete. ASTM C 387, normal strength concrete; Type IA, IIA, or IIIA cement; 28-day compressive strength of 3,000 pounds per square inch.

(c) Other Material.

- Class A Cement Concrete—Section 704
- Mortar—Section 1001.2(e)
- Ground Rod—Acceptable 1-inch by 10-foot copper clad rod with suitable clamps
- Ground Wire—No. 4 AWG solid copper

(d) Certification. Section 106.03(b)3

624.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) General. Clear and grub to construct the right-of-way fence and to provide a reasonably smooth ground profile at the fence line, unless otherwise directed. Cut, trim, and remove vegetation, as specified in Section 810, as required for right-of-way fence installation.

Excavate or construct compacted embankment a maximum depth of 6 inches and a minimum width of 18 inches, with 2:1 side slopes, unless otherwise directed to obtain the desired elevations. Fill minor ground depressions that are not water courses.

Restore areas disturbed by grading operations as specified in Section 105.14.

Join new and existing right-of-way fence as indicated or directed.

Complete the fence true to line, plumb, taut, rigid, and erected in conformance with established practices for the type specified.

(b) Posts. Orient posts with sections that have a major and a minor bending axis, with the major axis parallel to the fence line. Place corner posts with the major axis parallel to one of the lines of the fence.

Drive line posts, except when concrete footings are required. Obtain acceptance for the method of driving and of protecting the post. Remove and replace posts with battered heads, bent, or otherwise damaged posts as directed.

Furnish and place longer line posts where indicated to suit field conditions.

If rock is encountered, drill a hole with a diameter that is 1/2 inch larger than the post's maximum dimension, at least 12 inches into the rock, and then grout the post in place with mortar.

(c) Anchorages. Construct concrete footings or install acceptable drive anchors. Construct concrete footings, using Class A Concrete or packaged dry concrete. Concrete footings do not require forming. Finish the footing tops to drain water away from the posts. Do not place the fabric until the concrete has cured for a minimum of 72 hours.

(d) Fabric. Firmly fasten wire fabric to the posts using aluminum or galvanized bands or clamps, or by other acceptable methods.

Splice fabric using an acceptable method that develops the full fabric strength.

Place fabric on the side of the fence toward the highway unless otherwise indicated or directed. At corner posts and on curves, place the fabric so it pulls against the post.

If supplied with both knuckled and barbed selvages, install fabric with the barbed selvage on the fence top edge.

(e) Gates. Install gates where indicated or directed.

(f) Electrical Grounds. Install an electrical ground directly under areas where electrical transmission, distribution, or secondary lines cross over the right-of-way fence. Drive a 10-foot copper clad rod, a minimum of 1 inch in diameter, vertically until the top is approximately 6 inches below the ground elevation. Bronze clamp a No. 4 AWG solid-copper conductor to the rod and to the fence so each fence element is grounded.

624.4 MEASUREMENT AND PAYMENT—

(a) Right-of-Way Fence. Linear Foot

(b) End Post, Corner Post, Pull Post and Line Post. Each

(c) Gate. Each

(d) Class 2 Excavation. Cubic Yard

Excavation and embankment within the specified depth of 6 inches is incidental to this work. If the Representative directs additional excavation and/or embankment beyond the 6-inch depth indicated, the Department will pay for additional quantities as Class 2 Excavation.

(e) Fabric. Linear Foot

SECTION 625—CRIBBING

625.1 DESCRIPTION—This work is constructing precast reinforced concrete or metal cribbing as indicated.

625.2 MATERIAL—

(a) Reinforced Concrete Cribbing.

1. Material.

- Class A Cement Concrete—Section 704
- Reinforcement Bars—Section 709.1
- Steel Welded Wire Fabric—Section 709.3
- Premolded Expansion Joint Filler—Section 705.1
- Asphalt Material—Asphalt Cement RC-1, Section 702
- Drift Bolts—3/4-inch diameter, galvanized steel, of the required length. Certify as specified in Section 106.03(b)3.
- Casings for Drift Bolts—1 1/4 inch inside diameter, galvanized steel pipe. Certify as specified in Section 106.03(b)3.
- Rock—Rock or rock spalls not exceeding 8 inches in their greatest dimension, or stone backfill, as specified in Section 613.2. Obtain backfill from available excavation if possible, otherwise provide foreign borrow material. Provide backfill of acceptable quality, sound, free from structural defects and foreign substances. Unless backfill is from an approved Type A source, submit samples to the LTS.

2. Fabrication. Submit a concrete design (based upon compressive strengths) and shop drawings of the cribbing members to the Department for review and acceptance. Use a concrete design mix which when molded, cured, and tested in accordance with Department procedures, has a minimum 28-day compression cylinder strength of 5,000 psi.

Fabricate and cure sufficient test cylinders, for design verification and for production control of members, in the same manner as the cribbing members. Do not ship cribbing until it has attained the minimum 28-day compressive strength. One day's production will represent a lot. Lot acceptance will be based upon average strength of at least one set of cylinders.

Mix concrete with an air content of 5.5% (± 1.5%), a minimum cement factor of 7.0 bags per cubic yard of concrete, and a slump between 1 1/2 inches and 2 1/2 inches. Use a minimum quantity of water per bag of cement to obtain workable concrete of the specified minimum strength. Do not exceed 5 gallon of water per bag of cement. Mix and proportion concrete, as specified in Section 704. Place concrete and cure, in accordance with AASHTO M 170.

Embed the casings for drift bolts and lift hooks in the members where required. Do not place more than two handling lift hooks in each member. Use members true to form, free from depressions, spalls, patched or plastered surface edges. Cracked or otherwise defective crib members will be rejected. Fully enclose the equipment and facilities for manufacture of the members in a building available for Department inspection. Crib members will be inspected for acceptance before being placed in the work.

Mark each member with the following information:

- Date of Manufacture.
- Name or trademark of the manufacturer.
- Letter "F" on face of each stretcher.

Certify each project shipment of concrete cribbing, as specified in Section 106.03(b)3.

(b) Metal Cribbing.

1. Material. Certify as specified in Section 106.03(b)3.

- Galvanized Metal Sheets and Base Plates. AASHTO M 218, U.S. Standard or thicknesses (gages) as required, but not thinner than No.16 gage, except for base plates do not use thinner than No. 1 gage.
- Galvanized Bolts and Nuts. 5/8-inch diameter and 1 3/4 inch minimum length, bolts, furnished by the manufacturer.

2. Fabrication. Units of the same nominal size are to be fully interchangeable. Replace units with improper holes or otherwise defective. Maintain a minimum forming radius of 3/4-inch. However, for units formed with less than 3/4-inch radius, galvanize after forming.

Completely fabricate individual members before shipment.

(c) Other Types of Cribbing. Submit shop drawings and methods to the Department for review. Do not start work until written acceptance is received.

(d) Footings.
Class A Cement Concrete - Section 704

625.3 CONSTRUCTION—

(a) Reinforced Concrete Cribbing. Cushion bearing surfaces between crib members and their supports with 1/4-inch expansion joint filler over the full bearing area. Satisfactorily and firmly compact the cribbing foundation. Do not place the cribbing members until the foundation is accepted.

Handle and place crib members carefully. Remove and replace cracked or damaged members.

Fill the interior of the bins and the space behind the cribbing with rock.

Thoroughly compact the rock in layers having a maximum depth of 12 inches. Erect the units and place and compact the backfill simultaneously.

(b) Metal Cribbing. Excavate the foundation area to the finished ground line elevation at the cribbing face. Below this elevation, excavate trenches 18 inches in width, to the depth required, for all bin sides. Provide acceptable bearings at the bin corners, firm and to grade, before the crib erection.

Place metal base plates, if required, and erect the units. Do not drill, punch, or use drift pins to correct manufacturing defects. Handle members carefully. Hold members securely in place using bolts and nuts provided. Remove and replace members that become deformed or damaged.

Field coat metal cribbing with asphalt material, when indicated.

Satisfactorily backfill the bins and the space behind the cribbing.

(c) Other Types. In accordance with the reviewed shop drawings and methods.

(d) Footings. Provide concrete footings as required. Mix, place, and cure the concrete, as specified in the applicable parts of Section 1001.3.

625.4 MEASUREMENT AND PAYMENT—

(a) Reinforced Concrete Cribbing. Square Foot
Measured on the completed cribbing face.

(b) Metal Cribbing. Square Foot
Measured on the completed cribbing face.

(c) Class A Concrete. Cubic Yard

(d) Excavation. Cubic Yard
For the class indicated.

(e) Borrow Excavation. Cubic Yard
For the type indicated and if required for backfilling.

SECTION 626—GABIONS

626.1 DESCRIPTION—This work is the furnishing, assembling, filling, and placing of open mesh wire baskets with aggregate, forming gabions of the type indicated.

626.2 MATERIAL—

(a) Aggregate. Type A, Section 703.2 and as follows:

Gabion Height	Minimum Aggregate Size*	Maximum Aggregate Size*
Less than 1 foot	3 inches	5 inches
1 foot or over	4 inches	8 inches

* Measure longest side.

(b) Geotextiles. Class 4, Type A. Section 735

(c) Gabion Baskets. Provide materials as shown on the Standard Drawings and fabricated from one of the following:

1. Galvanized. Use Galvanized Gabions and Gabion (Revet) Mattresses conforming to the following:

- ASTM A974, Standard Specification for Welded Wire Mesh Fabric Gabions and Gabion Mattresses (Metallic-Coated or Polyvinyl Chloride (PVC) Coated), Zinc Coated

  OR

- ASTM A975, Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with Polyvinyl Chloride (PVC) Coating), Zinc Coated

2. Corrosion Resistant. Use Corrosion Resistant Gabions and Gabion (Revet) Mattresses conforming to the following:

- ASTM A974, Standard Specification for Welded Wire Mesh Fabric Gabions and Gabion Mattresses (Metallic-Coated or Polyvinyl Chloride (PVC) Coated), Zinc Coated and overcoated with PVC

  OR

- ASTM A975, Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with Polyvinyl Chloride (PVC) Coating), Zinc Coated and overcoated with PVC.

3. Certification. Section 106.03(b)3. Certify each shipment delivered to the job site. A shipment consists of material arriving at the job site at approximately the same time.

(d) Hardwood Stakes. Section 808.2(i)1

(e) Steel Pins. Section 212.2

626.3 CONSTRUCTION—As shown on the Standard Drawings, as indicated, and as follows:

(a) Excavation. Excavate as required to place gabion baskets. Undercut areas of unsuitable material and replace with acceptable material. Scarify depressions and add acceptable material. Thoroughly compact entire gabion area and finish to a firm, even surface, free of vegetation, large stones, and other debris. Dispose of unsuitable or excess material.

(b) Geotextile. For channel lining or slope wall, place Class 4, Type A geotextile as specified in Section 212. For retaining walls, drape Class 4, Type A geotextile over surface of gabions to receive backfill without stretching as indicated.

(c) Gabions.

1. Assembly.

1.a Woven Wire Gabion. Unfold and assemble woven wire gabion basket using interlocking fasteners or continuous tie wire lacing. Overlap ends of tie wire lacing equal to two loop coils to start next length of tie wire.

1.b Welded Wire Gabion. Unfold and assemble welded wire gabion basket using temporary or spiral fasteners. Place spiral fasteners and secure as indicated.

2. Placement of Gabions. Place assembled gabion baskets to the line and grade as indicated. Join assembled gabion baskets using the type and number of fasteners or tie wire lacing indicated. Maintain shape and alignment of gabion baskets using standard fence stretcher, chain fall, or iron bar. Place cross ties as shown on Standard Drawings. Do not damage corrosion resistant wire mesh or fixtures. Fill Type A gabions by hand with coarse aggregate along all exposed faces for a uniform appearance. Fill Type B gabions by hand placement or use small power equipment to place coarse aggregate. Overfill gabion baskets approximately 1 1/2 inches and fasten lid to diaphragms, sides, and ends of gabion basket using tie wire lacing. When stacking of gabions is indicated, offset ends of individual gabion baskets from ends of gabion baskets on underlying course. Adjust size of gabion basket to provide offset.

3. Backfill. Backfill excavated areas around gabions with acceptable backfill material to the limits shown on the plans. Place backfill material for each course of gabion baskets and compact before starting succeeding course. In areas inaccessible to self-propelled compaction equipment, place material in uniform loose layers of 4 inches maximum depth and compact using mechanical vibration tampers.

4. Acceptance. Correct any damage to gabions during construction at no cost to the Department, as directed by the Representative. This includes broken wires, missing or damaged coatings, broken or cracked welds, or other damage resulting from installation of the gabions. Construct gabions so that faces have a smooth, uniform appearance and are positioned at the proper lines, grades, and batter. Remove and replace gabions deemed unacceptable by the Representative.

626.4 MEASUREMENT AND PAYMENT—Cubic Yard

SECTION 627—TEMPORARY BARRIER

627.1 DESCRIPTION—This work is the furnishing, placing, maintaining, and removing of temporary barrier or glare screen, as indicated, for maintenance and protection of traffic during construction.

627.2 MATERIAL—

- **Precast Concrete Barrier or Glare Screen—**Barrier fabricated as shown in the Standard Drawings and as specified in Section 714 or certify each shipment with a copy of FHWA's eligibility letters indicating the barrier has passed the NCHRP 350 or MASH test.
    - Mortar—Section 1001.2(d)
    - Structural Steel—Section 1105.02(a)2
- **Steel Barrier—**As listed in Bulletin 15
- **Water Filled Barrier—**As listed on Bulletin 15
- **Warning Lights—**67 PA Code, Chapter 213 and from a manufacturer listed in Bulletin 15.
- **Barrier Mount Delineation Devices—**Section 937.2(a)
- **Waterborne Pavement Markings**—Section 962

627.3 CONSTRUCTION—

(a.) General. Place clean barriers on a stable base. Then, properly join and align the barriers at the required locations. If indicated, bury approach blunt ends of the temporary barrier into an existing backslope 3:1 or steeper. Install top and side delineators as shown on the Standard Drawings. Install warning lights as directed and according to the manufacturer's recommendations. Maintain alignment, delineation, warning lights, and condition of the barriers as necessary, for the duration of the project. Remove the barriers from the project upon project completion, or when directed. Clean and remove conflicting pavement markings.

To minimize eradication of paint lines within the work zones, paint continuous white or yellow 6" wide pavement marking on the barrier as shown on the Standard Drawings. Water blast the temporary barrier with a minimum of 3,000 psi before painting.

Immediately replace or repair barriers showing signs of damage that would hinder its performance, as determined by the Representative.

627.4 MEASUREMENT AND PAYMENT—

(a) Temporary Barrier. Linear Foot

(b) Temporary End Transition. Each

SECTION 628—RESET TEMPORARY BARRIER

628.1 DESCRIPTION—This work is the resetting of a temporary barrier from one construction area to another within the project limits.

628.2 MATERIAL—Section 627.2

628.3 CONSTRUCTION—Section 627.3

Reset barrier if construction operations require a change in protection or traffic or as directed. Store or transport the barrier, as required.

628.4 MEASUREMENT AND PAYMENT—

(a) Reset Temporary Barrier. Linear Foot

(b) Reset Temporary End Transition. Each

SECTION 630—PLAIN CEMENT CONCRETE CURB

630.1 DESCRIPTION—This work is construction of plain cement concrete curb, plain cement concrete depressed curb for curb ramps, and reinforced cement concrete depressed curb for driveways.

630.2 MATERIAL—

- Class A Cement Concrete—Section 704
- Class A Cement Concrete (Slip-Forming)— Section 704, except with a maximum slump of 1 1/2 inches.
- Premolded Expansion Joint Filler—Section 705.1
- Covers for Curing and Protection—Section 711.1
- Curing Compound—Section 711.2(a)
- Mortar—Section 1001.2(d)
- Caulking Compound—Section 705.8
- Reinforcement Bars—Section 709.1(a)

630.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in Section 501.3, and as follows:

(a) Excavation. Saw cut and excavate as required. Remove existing curb, pavement, and sidewalk to neat lines if indicated. Then, compact the material, upon which the curb is to be constructed, to a firm even surface.

(b) Forms. Use acceptable metal forms as specified in Section 501.3(d). Use wood forms on sharp curves and short tangent sections. Use forms that will not discolor the concrete.

(c) Placing, Finishing, and Curing Concrete. Conform to weather restrictions for concrete placement as specified in Section 501.3(b). Place the concrete in the forms in layers not exceeding 5 inches in depth if spading, or layers not exceeding 15 inches in depth if using a vibrator to eliminate voids. Provide drainage openings through the curb, at the elevation and of the size required, where indicated or directed. Smoothly and evenly finish the top surface of the curb using a wood float. Round the edges of the face and back of the curb top while the concrete is still plastic. Place depressed curbs for drives or curb ramps, where indicated or directed. Place bars as indicated for depressed curb at drives as specified in Section 1002.3. Cure concrete as specified in Section 501.3(l)

(d) Curb Machine. The concrete curb may be placed with an acceptable, self-propelled machine.

Uniformly feed the concrete to the machine so it maintains the shape of the section without slumping after extrusion.

The Representative will not allow voids or honeycomb on the surface of the finished curb. Immediately after extrusion, perform any additional surface finishing.

(e) Joints. Form or saw contraction joints to dimensions as shown on the Standard Drawings and as specified in Section 501.3(i)2. Place 3/4-inch premolded expansion joint material conforming to the cross-sectional area of the curb where indicated and at the end of the workday.

Prepare and caulk joints according to caulking manufacturer's recommendations.

(f) Removal of Forms. Do not remove forms until such time that it will not be detrimental to the concrete. Correct irregular surfaces by rubbing with a carborundum stone. Do not brush finish or plaster. Fill minor defects with mortar.

(g) Backfilling and Embankment. As soon as possible after the removal of forms, backfill the voids in front and back of the curb, using acceptable embankment material, as specified in Section 206.3(b)4.

Complete embankments in back of raised curbs, as indicated, and as specified in Section 206.3, except carefully compact the embankment by means of mechanical tampers, or rollers, if allowed, not exceeding 8 tons.

Replace existing pavement and sidewalk damaged or removed during construction.

Dispose of unsuitable and surplus material.

(h) Curb Modification. Modify curb construction within existing pavement limits and existing structures, where indicated or directed. Drill holes and insert dowel bars with non-shrink mortar, as required.

(i) Depressed Curb. Construct depressed curb with sloped sides as shown on the Standard Drawings.

1. Driveways. Construct reinforced cement concrete depressed curb as indicated or directed. Place reinforcement bars to extend the entire length of the depressed curb and sloped sides.

2. Curb Ramps. Construct plain cement concrete depressed curb with a level surface that extends across the curb width as indicated or directed. Construct the depressed curb flush with the adjacent roadway surface elevation.

Install depressed curb for all curb ramps and at median or traffic refuge island access openings where the opening meets adjacent roadway pavement.

The contractor may place cement concrete for depressed curb monolithically with curb ramps, side flares or both. Do not place cement concrete curb monolithically with other cement concrete sidewalk.

630.4 MEASUREMENT AND PAYMENT—Depressed curb will be measured and paid for as full depth curb of the type indicated. If depressed curb is placed monolithically with curb ramps, side-flairs or both, the depressed curb will be measured and paid separately from the curb ramps and side flairs."

(a) Plain Cement Concrete Curb. Linear Foot

(b) Plain Cement Concrete Curb, Including Removal of Existing Curb. Linear Foot

(c) Class I Excavation. Section 203.4

SECTION 633—PLAIN CONCRETE MOUNTABLE CURB

633.1 DESCRIPTION—This work is construction of plain concrete mountable curb of the type indicated.

633.2 MATERIAL—As specified in Section 630.2 and as follows:

- **Subbase**. Section 350
- **Joint Sealing Material.** Section 705.4(a), (b), or (c)
- **Preformed Cellular Polystyrene.** ASTM C 578

633.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in Section 501.3, and as follows:

(a) Excavation. Excavate, if necessary, as specified in Section 630.3(a).

(b) Forms. Use forms as specified in Section 630.3(b).

(c) Placing, Finishing, and Curing Concrete. Place, finish, and cure concrete as specified in Section 630.3(c).

(d) Curb Machine. Use a curb machine as specified in Section 630.3(d).

(e) Joints. As specified in Section 630.3(e), except use 1/2-inch premolded expansion joint material as shown on the Standard Drawings. Seal joints as specified in Section 705.4.

(f) Removal of Forms. As specified in Section 630.3(f).

(g) Backfilling and Embankment. As specified in Section 630.3(g).

(h) Curb Modification. Modify curb construction within existing pavement limits and existing structures, where indicated or directed. Drill holes and insert dowel bars with nonshrink mortar, as required.

(i) Premolded Expansion Joint Filler—Section 705.1. Place premolded expansion joint filler material 1/2-inch thick or polystyrene bond breaker 1/4-inch thick adjacent to new or existing curbs, plain cement concrete pavements or islands, concrete, sidewalks, and other structures and at the end of the work day as shown on Standard Drawings.

633.4 MEASUREMENT AND PAYMENT—

(a) Plain Concrete Mountable Curb. Linear Foot

(b) Class 1 Excavation. Section 203.4

(c) Subbase. Section 350

SECTION 636—ASPHALT CONCRETE CURB

636.1 DESCRIPTION—This work is construction of a hot-mixed, hot-laid, asphalt concrete curb on a completed asphalt surface.

636.2 MATERIAL— Section 413.2, except that the mixture design controls do not apply.

(a) Asphalt Material. Asphalt Cement, Class PG 64S-22 or PG 58S-28.

(b) Aggregate. Fine Aggregate, Section 703.1.

(c) Filler (Drawn Polyester Fibers). Provide a supplier certification with each shipment as specified in Section 106.03(b)3. The supplier shall certify that the filler conforms to the following requirements:

Average Length	0.25 inch ± 0.06 inch
Average Diameter	0.0004 inch minimum
Specific Gravity	1.34 to 1.40
Melting Temperature	480F minimum
Tensile Strength	70,000 pounds per square inch minimum

(d) Composition of Mixture. Combine fine aggregate, asphalt, and fiber in proportions that produce a mixture conforming to composition by weight percentages within the limits of Table A and as directed. Add approximately 0.3% asphalt cement per 0.12% by weight of polyester fibers.

TABLE A
Asphalt Concrete Curb
(Percentages by Weight Passing Square Opening Sieves)

Passing Sieve	Required Composition of Mixture
3/8-inch	100
No. 4	90 - 100
No. 8	70 - 100
No. 16	50 - 80
No. 30	35 - 60
No. 50	20 - 45
No. 100	10 - 30
No. 200	5 - 20
Asphalt Cement, % by Weight	6 - 13
Drawn Polyester Fiber, % by Weight of Total Mix	0.12 - 0.38

(e) Asphalt Tack Coat. Section 460.2

636.3 CONSTRUCTION—

(a) Asphalt Mixing Plant. Obtain the asphalt mixture from a plant conforming to Chapter 1, Bulletin 27, except that three bins are not required.

(b) Hauling Equipment. Section 413.3(d)

(c) Asphalt Paver. Use an acceptable, self-propelled, extruding curb-paver.

(d) Preparation of Surface. Before placing curb, clean the asphalt surface and apply a tack coat, as specified in Section 460.3.

(e) Placing and Compacting. Place the curb in a continuous operation. The Representative will determine the mixture temperature from within the range of 290F to 315F based on weather conditions and workability requirements at the time of placement. Maintain the mixture temperature within a tolerance of 15F of the mixture temperature.

Place the hot asphalt mixture in the hopper of the curb-paver without segregation and then extrude the mixture through the mold to provide the proper compaction and surface texture.

Properly support and mass-load the curb-paver during operation along the edge of pavement. Guide the paver along string or chalk lines to maintain proper alignment and grade of the completed curb.

Where indicated or directed, make drainage openings through the curb.

Remove and replace completed curbs that show signs of sagging, cracking, or distortion; do not conform to lines, grades, or cross sections; and that cannot be satisfactorily repaired.

(f) Joints. If placing of curb is interrupted and the mixture cools below 275F cut a vertical joint in the curb. Just before placing the curb resumes, paint the joint with a thin, uniform coat of hot Asphalt Cement, Class PG 64S-22 or PG 58S-28.

(g) Curing. Protect newly completed curb from traffic or any other disturbance for at least 12 hours.

(h) Backfilling. Immediately after the curing period and where necessary, backfill and compact acceptable material behind the curb up to the required elevation and cross section.

636.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 640—PLAIN CEMENT CONCRETE GUTTER

640.1 DESCRIPTION—This work is construction of plain cement concrete gutter.

640.2 MATERIAL—

- Class AA Cement Concrete—Section 704
- Asphalt Cement—Class PG 64S-22 or PG 58S-28
- Joint Sealing Material—Sections 705.4(b) or (c)
- Caulking Compound—Section 705.8
- Covers for Curing and Protection—Section 711.1
- Curing Compound—Section 711.2(a)

640.3 CONSTRUCTION—As shown on the Standard Drawing, as specified in the applicable parts of Section 501.3, and as follows:

(a) Foundation. Form the foundation for the gutter bottom at the required depth below the finished surface as indicated. Remove unsuitable materials, replace with acceptable embankment material, as specified in Section 206.2(a), and then compact thoroughly to a firm, even surface.

(b) Forms. Use acceptable forms of wood or metal.

(c) Placing and Finishing Concrete. Place the concrete on a moist foundation between the forms, consolidate, and then strike off to the required shape. Finish smoothly and evenly with a wood float. Where the gutter joins other structures, seal the adjacent edges with an approved Asphalt Cement. Tool the gutter edge to the radius indicated.

(d) Joints. Form or saw contraction joints to dimensions as shown on the Standard Drawing and as specified in Section 501.3(i).

Place 3/4-inch premolded expansion joint material that is cut to the cross section of the gutter at structures and where gutter placement ends each work day.

Prepare and seal or caulk joints, according to manufacturer's recommendations.

(e) Backfilling. After the concrete has hardened sufficiently, backfill the spaces adjacent to the gutter with acceptable embankment material, as specified in Section 206.3(b)4.

640.4 MEASUREMENT AND PAYMENT—

(a) Plain Cement Concrete Gutter. Square Yard

(b) Class 1 Excavation. Cubic Yard

SECTION 641—PLAIN CEMENT CONCRETE CURB GUTTER

641.1 DESCRIPTION—This work is construction of plain cement concrete curb gutter.

641.2 MATERIAL—

- Mortar—Section 1001.2(d)
- Class AA Cement Concrete—Section 704
- Asphalt Cement—Class PG 64S-22 or PG 58S-28
- Joint Sealing Material—Sections 705.4(b) or (c)
- Caulking Compound—Section 705.8
- Covers for Curing and Protection—Section 711.1
- Curing Compound—Section 711.2(a)

641.3 CONSTRUCTION—As specified in Section 640.3 and as follows:

Do not rub forms to correct irregularities until they have been removed and the full curing period has elapsed. Correct irregular surfaces by rubbing with a carborundum stone. Do not brush finish or plaster. Fill minor defects with mortar. Place depressed curb gutter where indicated or directed.

Prepare and seal or caulk joints according to manufacturer's recommendations.

641.4 MEASUREMENT AND PAYMENT—Square Yard

The Department will not adjust the area for depressing the curb portion.

SECTION 643—TEMPORARY CONCRETE BARRIER, STRUCTURE MOUNTED

643.1 DESCRIPTION—This work is the furnishing, placing, maintaining, and removing of precast temporary concrete barrier, structure mounted; temporary concrete median barrier, structure mounted; or temporary concrete glare screen median barrier, structure mounted, as indicated, for maintenance and protection of traffic during construction using bolt through anchors, adhesive anchors, or pin connected drop-pin anchors, as shown on the Standard Drawings, to attach the barrier to existing hardened concrete structure(s). Temporary concrete barrier applies to bridge construction projects that extend continuously for a maximum of three construction seasons.

643.2 MATERIAL—

(a) Barrier. Section 714

(b) Bolt Through Anchor.

1. Anchor. ASTM F1554-99 Grade 105, 105 kips per square inch or ASTM A193/A193M - 01b Grade B7, 105 kips per square inch anchor bolt - 1 inch diameter; hot-dipped galvanized according to the requirements of Class C of ASTM A153. Additional requirements for both ASTM F1554-99 and ASTM A193/A193M includes ASTM F1554 supplement S5 Grade 105, 105 kips per square inch Charpy Impact Requirements at -20F.

2. Nuts. Heavy hex nuts as specified in Section 1105.02(c)3.a or according to ASTM A194/A194 Grade 7, Supplement S3 at -20F; hot-dipped galvanized according to the requirements of Class C of ASTM A153. Provide zinc coating, overtapping of the nut, and lubrication requirements according to ASTM A563.

3. Washers. 3 inch diameter by 1/4 inch thick Grade 250 (Grade 36) Plate Washer with a 1 1/8 inch diameter hole in the middle. All other washers are according to ASTM F436/F436M Type 1. Washers are to be hot-dipped galvanized according to the requirements of Class C of ASTM A153.

4. Structural Steel. Section 1105.02(a)2

5. Grout. Section 1080.2(c)

(c) Adhesive Anchor.

1. Anchor. Provide the results of testing performed by an independent testing facility for review and approval of a bolt equivalent to an ASTM A193/A193M - 01b Grade B7, 105 kips per square inch anchor bolt - 1 inch diameter; hot dipped galvanized according to the requirements of Class C of ASTM A153. Additional requirement for ASTM A193/A193M includes ASTM F1554 supplement S5 Grade105, 105 kips per square inch Charpy Impact Requirements at -20F. If using bolts treated for future removal, provide manufacturer recommendations to the Representative and include manufacturer's test data to ensure this operation will not affect the physical properties of the anchor/adhesive combination.

2. Nuts. Heavy hex nuts as specified in Section 1105.02(c)3.a or according to ASTM A194/A194 Grade 7, Supplement S3 at -20F; hot-dipped galvanized according to the requirements of Class C of ASTM A153. Provide zinc coating, overtapping of the nut, and lubrication requirements according to ASTM A563.

3. Washers. 3 inch diameter by 1/4 inch thick Grade 36 Plate Washer with a 1 1/8 inch diameter hole in the middle. All other washers are according to ASTM F436/F436M Type 1. Washers are to be hot-dipped galvanized according to the requirements of Class C of ASTM A153.

4. Structural Steel. Section 1105.02(a)2

5. Grout. Section 1080.2(c)

6. Adhesive. Use adhesive bonding material systems specified herein and as listed in Bulletin 15 specifically

for this application. Use material designed for installation type, spacing and minimum temperature considerations. Provide a bonding material that is either a glass/soft-skin capsule or two-component system contained in pre-packed injection (coaxial or side by side) cartridges and that is inserted into the hole using a manufacturer approved dispensing gun and replaceable mixing nozzle.

6.a Performance Requirements. Provide independent test results from the adhesive bolt manufacturer, of the following properties, for review and approval by LTS.

6.b Physical Properties. Determine physical properties in 3000 ±500 pounds per square inch concrete (cured for 28 days minimum) at a maximum depth of 6.5 inches with a 1 inch diameter anchor bolt of equal or greater tensile strength to an ASTM A193/A193M - 01b Grade B7 anchor bolt. Meet the minimum acceptance criterion of one or more of the following categories as shown in the Standard Drawings.

6.b.1 Tension. ASTM E1512, Procedure - Static Tests, modified for testing at the following temperatures: 32F±1.8F, 73.5F±3.5F, and 125F±5F, and to meet and be classified as per the tension minimums as shown in the Standard Drawings. Apply test loads to confined specimens to preclude concrete failure but allow bond failure. Concrete specimen size may be modified if necessary.

6.b.2 Shear (Continuous Load Application). ASTM E488, Shear Test; to meet and be classified as per the shear minimums in.

6.b.3 Shock. ASTM E488, Modified for testing as follows:

Number of samples: n=5

Number of shocks of test sample: 3

Shock duration: 0.1 seconds

Conduct the shock test at the following temperatures: 32F±1.8F, 73.5F±3.5F, and 125F±5F, to meet and be classified as per the tension minimums in. Apply test loads to confined specimens to preclude concrete failure but allow bond failure.

6.b.4 Short Term Cure. Perform static tension testing 24 hours after installation as per the procedure for tension testing in ASTM E1512, modified for testing at the following temperatures: 32F±1.8F, 73.5F±3.5F, and 125F±5F, and to meet and be classified as per the tension minimums in. Apply test loads to confined specimens to preclude concrete failure but allow bond failure.

6.b.5 Freeze Thaw. ASTM E1512, to meet and be classified as per the tension minimums in. Apply test loads to confined specimens to preclude concrete failure but allow bond failure.

6.b.6 Damp Hole Installation. ASTM E1512, to meet and be classified as per the tension minimums in. Before testing blow out the hole with dry compressed air for 1 to 1 1/2 minutes. Apply test loads to confined specimens to preclude concrete failure but allow bond failure.

6.b.7 Test on Effect of Reduced Temperature on Curing. ASTM E1512 modified as follows: Conduct installation/application at the lowest temperature of use specified to meet and be classified as per the tension minimums in. Perform test loads at 75F±10F before application of the loading and at the specified minimum installation/application temperature. Apply test loads to confined specimens to preclude concrete failure but allow bond failure.

6.c Chemical/Compositional Properties. Provide manufacturer's data indicating the adhesive system is resistant to gasoline, diesel oil, acids, and caustics. Perform testing according to ASTM D543.

The following materials requirements are:

- Concrete Temperature at time of installation:

Minimum	41F*
Maximum	109F

*Adhesives designed for installation below 41F may be submitted and evaluated for approval if the lowest temperature of use specified is the installation/application temperature for physical properties testing.

- Installation time at 75F±10F:

Minimum Set time of	0.1 hrs
Maximum Set time of	6.0 hrs
Maximum Cure time of	24.0 hrs

Provide the following testing information for the tests listed below to the LTS. The information requested will be used to identify, characterize, and classify the material for proper use and to verify composition:

- ASTM D1875 - "Standard Test Method for Density for Adhesives in Fluid Form." Provide production ranges for each component of the system in terms of weight per gallon or specific gravity.
- ASTM D1252 - "Standard Practice for General Techniques for Qualitative Infrared Analysis." Provide an infrared analysis of each of the components, and of representative specimen of the cured final product of the adhesive system.
- ASTM D482 - "Ash Filler Content." Provide a value in terms of percent.
- ASTM D570 - "Water Absorption." Provide a value in terms of percent.
- ASTM D1084 - "Viscosity of Adhesives"
- The LTS must approve this information before the product is used.

6.d Storage of Materials. Store materials delivered to the job-site in the original unopened containers within a facility capable of maintaining storage conditions consistent with the manufacturer's recommendations.

6.e Certification, Shipment to Project, Packaging, and Marking. Certify each shipment as specified in Section 106.03(b) 3.

Deliver the adhesive bonding material system to the project site in original unopened containers with the manufacturer's label identifying the product. Clearly mark each package with the following information:

- Manufacturer's name and address
- Product name
- Manufacturer Expiration Date
- LOT Identification Number
- Storage and Handling Requirements

Include in each package a copy of the manufacturer's instructions for anchor and installation. Provide instructions that include at least the following information:

- Diameters of drilled holes for applicable anchor and anchor sizes.
- Cleaning procedure for drilled holes, including a description of permitted and prohibited equipment and techniques.
- Allowable temperature ranges for storage, installation, curing, and in-place performance.
- Identification of acceptable mixing/dispensing nozzles.
- Fabrication requirements for anchors.
- Description of tools permitted or required for installation.
- Method of identifying properly proportioned and mixed adhesive materials.
- Time and temperature schedule for initial and set and full-strength cure.
- Special requirements for special installation conditions such as damp holes, or low temperatures, etc.
- Release agents, if used.

(d) Pin Connected Drop-Pin Anchor.

1. Drop-Pin Anchor. ASTM A36/A36M, Grade 250 (36 kips per square inch) – 1 1/2 inch diameter rod; head plate: 1/2 inch thick; hot-dipped or mechanically galvanize as specified in Section 1105.02(s) after head plate is welded to drop-pin anchor.

2. Connection Pin. ASTM A449-07b, Type 1, unthreaded rod (straight) - 1 inch diameter; hot-dipped or mechanically galvanize as specified in Section 1105.02(s) after plate washer is welded to rod.

3. Plate Washers. ASTM A36/A36M, Grade 250 (36 kips per square inch), plate - 1/4 inch thick; hot-dipped or mechanically galvanize as specified in Section 1105.02(s) after plate washer is welded to connection pin rod.

(e) Waterborne Pavement Markings—Section 962.2

(f) Barrier Mount Delineation Devices—Section 937.2

643.3 CONSTRUCTION—

Install top and side delineators as shown on the Standard Drawings. Install warning lights as directed and according to the manufacturer's recommendations. Maintain alignment, delineation, warning lights, and condition of the barriers as necessary, for the duration of the project. Remove the barriers from the project upon project completion, or when directed.

To minimize eradication of paint lines within the work zones, paint continuous white or yellow 6” wide pavement marking on the barrier as shown on the Standard Drawings. Water blast the temporary barrier with a minimum of 3,000 psi before painting and if applicable, remove the existing contrasting paint color.

(a) Bolt Through Anchor. Prepare and install bolt through anchors in hardened concrete as indicated in BC-719M and as directed by the Representative.

1. Placement of Temporary Concrete Barrier. Ensure the concrete deck receiving bolt through anchors is structurally sound and free of cracks in the vicinity of the anchor to be installed. During the initial barrier layout, use a metal detector specifically designed for locating steel in concrete to minimize conflicts with existing steel reinforcement. Move the barrier parallel to the direction of traffic up to 2 inch and perpendicular to traffic up to 1 inch if conflicts with the existing steel reinforcement occur.

Maintain a smooth barrier face to traffic along the entire barrier length. Use a rotary drill and bit for drilling the hole for a 1 inch diameter bolt. Drill into the deck using the holes in the temporary barrier as a template. The drill may be located anywhere within the 2 inch slot, but must be maintained vertically (± 1º) and at a 5º cant ± 1º to the vertical from the front face to rear face of the barrier.

Drill into the deck using methods that will not shatter/damage the concrete surface adjacent to the holes or result in concrete spalling at the underside of the deck. Notify the Representative if spalling occurs. Patch areas of spalling immediately. If reinforcement is encountered during drilling, before the specified depth is attained, notify the Representative immediately. The hole may be repositioned within the slot in the barrier to avoid damaging the deck reinforcement during drilling; however, the hole must remain vertical. Patch unused or partially drilled holes as specified in Section 643.3(b)7.

2. Installing Anchors. Install the anchors in the hole with plate washers and channels if required. Snug tighten heavy hex nuts.

(b) Adhesive Anchor. Prepare and install adhesive anchors in hardened concrete as shown on the Standard Drawings, as directed by the Representative, according to manufacturer's instructions, and as specified herein.

1. Equipment. Use equipment meeting the manufacturer's recommendations for installation of adhesive anchors.

2. Placement of Temporary Concrete Barrier. Ensure concrete deck receiving adhesive anchors is structurally sound and free of cracks in the vicinity of the anchor to be installed. During the initial barrier layout, use a metal detector specifically designed for locating steel in concrete to minimize conflicts with existing steel reinforcement whenever placement tolerances and edge clearances allow. Move the barrier parallel to the direction

of traffic up to 2 inch and perpendicular to traffic up to 1 inch if conflicts with the existing steel reinforcement occur. Maintain a smooth barrier face to traffic along the entire barrier length.

Unless otherwise specified, use the depth of hole and the installation procedure recommended by the manufacturer to conform to BC-719M and the depth of the deck. Provide a copy of the manufacturer's recommended installation procedure, including depth, to the Representative at least 2 days before the start of work. Use rotary drill and bit as recommended by the adhesive manufacturer. Drill holes to the manufacturer's recommendation for a 1 inch diameter bolt. Drill into the deck using the holes in the temporary barrier as a template. The drill may be located anywhere within the 2 inch slot, but must be maintained vertically (± 1º) and at a 5º cant ± 1º to the vertical from the front face to rear face of the barrier.

Drill into the deck using methods that will not shatter/damage the concrete surface adjacent to the holes or penetrate the bottom of the bridge deck resulting in concrete spalling at the underside of the deck. Notify the Representative if spalling occurs. Patch areas of spalling immediately; use a bolt through connection for that hole location. If reinforcement is encountered during drilling, before the specified depth is attained, notify the Representative immediately. The hole may be repositioned within the slot in the barrier to avoid damaging the deck reinforcement during drilling; however, the hole must remain vertical. Patch unused or partially drilled holes as specified in Section 643.3(b)7.

Dry the drilled holes completely before cleaning and installing the anchors. Ensure drilled holes are cleaned in according to the manufacturer's instructions and are completely dry at the time of placing the adhesive bonding material and anchors. As a minimum, remove loose particles from drilling, brush inside surface to free loose particles trapped in pores, then remove the remaining loose particles to avoid contamination of the adhesive bonding material. Use a non-metallic bristle brush and avoid over-brushing to prevent polishing the inside surface of the drilled hole. Protect holes from contamination and moisture.

3. Installing of Anchors. Immediately before installation of anchors, dry the drilled holes completely by blowing out the drilled hole with dry compressed air. Ensure the drilled holes are cleaned in according to the manufacturer's instructions and are completely dry at the time of placing the adhesive bonding materials and anchors.

Install anchors as shown on the Standard Drawings, the structure drawings, and the manufacturer's instructions with particular attention to requirements and limitations due to anchor position, dampness, ambient temperature, and curing. Do not install anchors below 41F or above 109F unless manufacturer data can be provided and LTS has approved and listed the material in Bulletin 15 in advance.

Use adequate quantities of the adhesive bonding material to fill the drilled hole to within 1/4 inch of the concrete surface, measured after placement of the anchor.

For encapsulated systems, mix materials inside the drilled hole as the capsule and its contents are crushed by the anchor rod, driven by a rotating drill as directed by manufacturer's technical/application data sheets.

For pre-packed injection cartridge systems, fill hole completely (without gaps, air bubbles, etc.) from bottom as directed by manufacturer's technical/application data sheets. Insert anchor by hand, turning clockwise to coat threads and remove air bubbles.

Support the anchor as necessary to maintain alignment/orientation and prevent movement during curing. Maintain undisturbed until the adhesive has cured the minimum time specified by the manufacturer.

Anchors that are improperly bonded, as determined by the Representative, will be rejected. If removal of adhesive anchors is required, perform under the direction of the Representative, and provide manufacturer test data to support that this operation will not damage the surrounding concrete. If possible (>1 foot anchor spacing), drill new anchor holes in both adjacent barrier anchor locations to account for rejected anchors. Otherwise, re-drill holes to remove adhesive bonding material residue and clean as specified in Section 643.3(b)2. Do not reuse failed anchors. Perform all work necessary to correct improperly bonded anchors at no additional cost to the Department.

If adhesive anchors cannot be used, use bolt through anchors as specified in Section 643.3(a).

4. Field Testing of Anchors. Perform field testing of the installed anchors in according to ASTM E488 and ASTM E1512, in the presence of the Representative. In addition, orient the field test load equipment to provide a field load at the same angle and orientation as the anchor being tested.

If electing to use another type of field testing equipment, submit details to the BOPD for review and conceptual approval with field verification by the Contractor. Provide documentation that all field test equipment has been calibrated to the requirements of ASTM E488 and E 4. Perform restrained static tension tests to prevent damage to the surrounding concrete. Test individual anchors to the values shown in BC-719M, Table 2; values in Table 2 are based on 85% of the adhesive anchor tensile capacity.

The anchors will be divided into lots for testing and acceptance. Each lot will contain a maximum of 100 anchors, of the same embedment length and adhesive bonding material system. Ten percent of the anchors in each lot will be

randomly selected for testing, according to PTM No.1, with a minimum of five tests per lot, unless otherwise directed by the Representative. Submit test results to the Representative for each lot. Acceptability of the field tests will be determined according to ASTM E488 and the tension requirements of Table 1. For every failed field test, perform two additional field tests on adjacent untested anchors within the lot. Continue additional field tests until no additional test failures occur, or all anchors within the lot are tested. Remove and replace failed anchors as specified in Section 643.3(b)5.

Provisionally approved adhesive anchor systems will be evaluated randomly, for specification compliance, at job completion by secondary field proof load testing immediately before barrier removal.

5. Removal and Replacement of Failed Test Specimens. Remove all anchors failing the field test, without damage to the surrounding concrete. If possible, installing new replacement anchors, use adjacent barrier anchor slots as specified in Section 643.3(b)2. Otherwise, re-drill holes to remove adhesive bonding material residue and clean as specified in Section 643.3(b) 2. Reinstall new anchors as specified in Section 643.3(b)3. Do not reuse the failed anchors. Install anchors utilizing a new lot of adhesive bonding material, at the same embedment and field test as specified in Section 643.3(b)4.

If adhesive anchors cannot be used, use bolt through anchors as specified in Section 643.3(a).

6. Opening of Work Zone to Traffic. If removal operations of the structure have commenced or safety barriers have been removed on the inactive side of the newly placed temporary concrete barrier, do not open the work zone to traffic until all adhesive anchors have been successfully tested. Otherwise, the opening of the work zone to traffic will be allowed by the Representative before field-testing of the adhesive bonded anchors. Note cure time will be significantly modified by environmental conditions such as surface temperature, humidity, etc. In these cases, conduct field-testing after the required cure time of the adhesive.

7. Removal, Replacement, and Repair of Temporary Concrete Barrier, Structure Mounted. Immediately replace or repair barriers showing the following signs of damage:

- Fractures or cracks, that, in the opinion of the Representative, will hinder the adhesive/barrier performance; or
- Broken or cracked ends where such damage would, in the opinion of the Representative, prevent making a satisfactory joint.

Provisionally approved adhesive anchor systems will be evaluated randomly, for specification compliance, at job completion by secondary field proof load testing immediately before barrier removal.

If removal, repair, or replacement of anchors is required, provide the manufacturer's recommendations to the Representative, and include manufacturer's data to support that this operation will not damage the surrounding concrete. Following anchor bolt removal (before sealing of anchor bolt holes) clean out the interior of the bolt holes, in such a manner to remove all adhesive/removal materials, that would reduce the performance of the sealing operation.

Maintain alignment, delineation, warning lights and condition of the barriers throughout the life of the project. Upon project completion, or when directed, remove the barriers from the project. Following barrier removal, treat anchors and anchor bolt holes as shown on the Standard Drawings.

(c) Pin Connected Drop-Pin Anchor. Prepare and install drop-pin anchor in hardened concrete as indicated in BC-719M and as directed by the Representative.

1. Placement of Temporary Concrete Barrier. Ensure the concrete deck receiving drop-pin anchor is structurally sound and free of cracks in the vicinity of the anchor to be installed. During the initial barrier layout, use a metal detector specifically designed for locating steel in concrete to minimize conflicts with existing steel reinforcement.

Maintain a smooth barrier face to traffic along the entire barrier length. Use a rotary drill and bit for drilling a 1 3/4 inch hole for a 1 1/2 inch diameter drop-pin anchor. Drill into the deck using the 3 3/4 inch slot in the temporary barrier as a template. The drill may be located anywhere within the slot, but must be maintained 40 degrees (± 2º) from the bridge deck. In addition the drill is to be positioned at ± 2º from vertical in a plane parallel to the longitudinal axis of the barrier.

Drill into the deck using methods that will not shatter/damage the concrete surface adjacent to the holes or result in concrete spalling at the underside of the deck. Notify the Representative if spalling occurs. Patch areas of spalling

immediately. The hole may be repositioned within the slot in the barrier to avoid damaging the deck reinforcement during drilling. Patch unused or partially drilled holes as specified in Section 643.3(b)7.

2. Installing Drop-Pin Anchors. Immediately before installation of drop-pin anchor, clean the drilled holes completely of all loose debris. Ensure the drilled holes are cleaned and completely dry at the time of installing the drop-pin anchors. Install drop-pin anchor as shown on the Standard Drawings and verify the head plate is resting flush on the face of barrier.

3. Opening of Work Zone to Traffic. If removal operations of the structure have commenced or safety barriers have been removed on the inactive side of the newly placed temporary concrete barrier, do not open work zone to traffic until all drop-pin anchors have been successfully installed.

4. Removal, Replacement, and Repair of Temporary Concrete Barrier, Structure Mounted. Immediately replace or repair barriers showing the following signs of damage:

- Fractures or cracks, that, in the opinion of the Representative, will hinder the pin connected drop-pin anchor barrier performance; or
- Broken or cracked ends where such damage would, in the opinion of the Representative, prevent making a satisfactory joint.

Provisionally approved pin connected drop-pin anchor barrier systems will be evaluated randomly, for specification compliance.

If removal, repair, or replacement of drop-pin anchor is required, reinstall as specified in Section 643.3(c)1 and 2. Do not damage the surrounding concrete during this operation. Following drop-pin anchor removal (before sealing of drop-pin anchor hole) clean out the interior of the holes, in such a manner to remove all removal materials, that would reduce the performance of the sealing operation.

Maintain alignment, delineation, warning lights and condition of the barriers throughout the life of the project. Upon project completion, or when directed, remove the barriers from the project. Following barrier removal, treat drop-pin anchor holes as shown on the Standard Drawings.

643.4 MEASUREMENT AND PAYMENT—

(a) Temporary Concrete Barrier, Structure Mounted. Linear Foot

(b) Temporary Concrete Median Barrier, Structure Mounted. Linear Foot

(c) Temporary Concrete Glare Screen Median Barrier, Structure Mounted. Linear Foot

(d) Incidental Work.

Adhesive anchor systems will be measured and paid for incidental to the temporary concrete barrier, structure mounted; temporary concrete median barrier, structure mounted; and temporary concrete glare screen median barrier, structure mounted.

Labor, materials, tools, equipment, and incidentals; all work involved in drilling holes, bonding anchors and coring through concrete and reinforcement; and removal of barrier and subsequent repair of deck are included in contract unit price. Removal of unacceptable or failed field tested anchors, as well as all patching/repair of cracked/damaged concrete will be at no additional cost to the Department.

Pin connected drop-pin anchor systems will be measured and paid for incidental to the temporary concrete barrier, structure mounted; temporary concrete median barrier, structure mounted; and temporary concrete glare screen median barrier, structure mounted. Labor, materials, tools, equipment, and incidentals; all work involved in drilling holes and coring through concrete and reinforcement; and removal of barrier and subsequent repair of deck are included in contract unit price.

SECTION 644 - TEMPORARY CONCRETE BARRIER, STRUCTURE MOUNTED, RESET

644.1 DESCRIPTION - This work is the resetting of a temporary concrete barrier, structure mounted; temporary concrete median barrier, structure mounted; or temporary concrete glare screen median barrier, structure mounted from one construction area to another within the project limits. Temporary concrete barrier applies to bridge construction projects that extend continuously for a maximum of three construction seasons.

644.2 MATERIAL - Section 643.2(b), Section 643.2(c), Section 643.2(d), Section 643.2(e), and Section 643.2(f).

644.3 CONSTRUCTION - Section 643.3

Reset barrier if the construction operations require a change in protection of traffic or as directed. Store or transport the barrier as required.

644.4 MEASUREMENT AND PAYMENT –

(a) Temporary Concrete Barrier, Structure Mounted, Reset. Linear Foot

(b) Temporary Concrete Median Barrier, Structure Mounted, Reset. Linear Foot

(c) Temporary Concrete Glare Screen Median Barrier, Structure Mounted, Reset. Linear Foot

(d) Incidental Work.

Adhesive anchor systems will be measured and paid for incidental to the temporary concrete barrier, structure mounted, reset; temporary concrete median barrier, structure mounted, reset; and temporary concrete glare screen median barrier, structure mounted, reset.

Labor, materials, tools, equipment, and incidentals; all work involved in drilling holes, bonding anchors and coring through concrete and/or reinforcement; and removal of barrier and subsequent repair of deck are included in contract unit price.

Removal of unacceptable or failed field tested anchors, as well as all patching/repair of cracked/damaged concrete will be at the Contractor's expense with no additional cost to the Department.

Pin connected drop-pin anchor systems will be measured and paid for incidental to the temporary concrete barrier, structure mounted, reset; temporary concrete median barrier, structure mounted, reset; and temporary concrete glare screen median barrier, structure mounted, reset. Labor, materials, tools, equipment, and incidentals; all work involved in drilling holes and coring through concrete and/or reinforcement; and removal of barrier and subsequent repair of deck are included in contract unit price.

SECTION 651—PAVED SHOULDERS, TYPE 1, TYPE 1-F, TYPE 1-S, AND TYPE 1-SP

651.1 DESCRIPTION—This work is construction of paved shoulders, of the type indicated, on a prepared surface.

651.2 MATERIAL—

- Aggregate Base—Section 350.2
- Asphalt Surface Treatment—Section 480.2
- Slurry Seal—Section 482.2
- Superpave Asphalt Mixture Design, Asphalt Base Course—Section 313.2 and as follows: PG 64S-22, <0.3 million ESALs, or as indicated or directed.
- Superpave Asphalt Mixture Design, Asphalt Base Course—Section 313.2 and as follows: PG 64S-22, <0.3 million ESALs, or as indicated or directed.
- Superpave Asphalt Mixture Design, Asphalt Wearing Course, SRL-L—Section 413.2, Section 410.2, or Section 412.2 and as follows: PG 64S-22, <0.3 million ESALs, or as indicated or directed.
- Superpave Asphalt Mixture Design, Asphalt Wearing Course, SRL-L—Section 413.2, Section 410.2, or Section 412.2 and as follows: PG 64S-22, <0.3 million ESALs, or as indicated or directed.

651.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Combination Base Course.

1. **Aggregate Base.** Section 350.3
2. **Superpave Asphalt Mixture Design, Asphalt Base Course (for Type 1-SP).** Section 313.3

(b) Asphalt Surface Treatment (for Type 1). Section 480.3

(c) Double Slurry Seal (for Type 1-S). Apply a seal, as specified in Section 482.3.

(d) Superpave Asphalt Mixture Design, Asphalt Wearing Course (for Type 1-SP). Section 413.3

(e) Superpave Asphalt Mixture Design, Asphalt Wearing Course (for Type 1-F). Section 410.3 or Section 412.3

651.4 MEASUREMENT AND PAYMENT—Square Yard

SECTION 653—PAVED SHOULDERS, TYPE 3

653.1 DESCRIPTION—This work is construction of paved shoulders on a prepared surface.

653.2 MATERIAL—

- Aggregate Base—Section 350.2
- Asphalt Prime Coat—Section 461.2
- Asphalt Surface Treatment—Section 480.2

653.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Aggregate Base. Section 350.3; except, if granulated steel slag is used as a base material, construct the top 3 inches of the aggregate base using either stone, gravel, or air-cooled blast furnace slag aggregate.

(b) Prime Coat. Section 461.3

(c) Asphalt Surface Treatment. Section 480.3

653.4 MEASUREMENT AND PAYMENT—Square Yard

SECTION 654—PAVED SHOULDERS, TYPE 4

654.1 DESCRIPTION—This work is construction of paved shoulders, Type 4, and preparation of the underlying surface.

654.2 MATERIAL—

- Aggregate Base—Section 350.2
- Asphalt Prime Coat—Section 461.2
- Asphalt Surface Treatment—Section 480.2
- Shoulder Backfill Material—Section 350.2

654.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) General. Remove surplus material on existing shoulders to the bottom of the proposed base course or to a directed depth. If the existing guide rail is to remain in place, excavate the shoulder without disturbing the existing guide rail. Remove and shape material under and in back of existing guide rail to the elevation and slopes indicated or as directed. The Contractor is not required to compact behind the existing rail.

Satisfactorily repair existing guide rail damaged or destroyed by the construction operations, as directed.

Satisfactorily dispose of excess or unsuitable material, as directed.

(b) Scarifying. After removing surplus material and at directed locations, scarify existing shoulder areas to a maximum depth of 4 inches below existing grade or to the directed depth.

(c) Shaping and Compacting. Shape and compact existing shoulder areas and low areas filled with graded material from the shaping operation to the bottom elevation of the proposed base course. If there is insufficient graded material, provide aggregate base course material to fill low areas to the bottom elevation of the proposed base course. Compact graded material or aggregate base course material as specified in Section 654.3(f).

(d) Aggregate Base. Construct, as specified in Section 350.3, to the depth indicated.

(e) Excavation. Where indicated, excavate the shoulder area below the bottom of the proposed base course to the depth indicated or directed.

(f) Shoulder Backfill. Where the shoulder area was excavated below the bottom elevation of the proposed base course, backfill, shape, and compact aggregate base course material to the bottom elevation of the proposed base course. Compact using rollers as specified in Section 108.05(c)3.a, 3.b, 3.e, or 4. The material is satisfactorily compacted when it does not move under the compaction equipment.

(g) Prime Coat. Section 461.3

(h) Asphalt Surface Treatment. Section 480.3

654.4 MEASUREMENT AND PAYMENT—

(a) Paved Shoulders, Type 4. Square Yard

(b) Shoulder Backfill. Cubic Yard or Ton
The unit price includes excavation below the bottom of the proposed base course.

SECTION 656—PAVED SHOULDERS, TYPE 6, TYPE 6-F, TYPE 6-S, AND TYPE 6-SP

656.1 DESCRIPTION—This work is construction of paved shoulders, of the type indicated, and preparation of the underlying surface.

656.2 MATERIAL—

- Asphalt Surface Treatment—Section 480.2
- Shoulder Backfill (if required)—Section 350.2
- Slurry Seal—Section 482.2
- Superpave Asphalt Mixture Design, Asphalt Base Course—Section 313.2 and as follows: PG 64S-22, <0.3 million ESALs, or as indicated or directed.
- Superpave Asphalt_Mixture_Design, Aspahlt Base Course—Section 313.2 and as follows: PG 64S-22, <0.3 million ESALs, or as indicated or directed.
- Superpave Asphalt Mixture Design, Asphalt Wearing Course, SRL-L—Section 413.2, Section 410.2, or Section 412.2 and as follows: PG 64S-22, <0.3 million ESALs, or as indicated or directed.
- Superpave Asphalt Mixture Design, Asphalt Wearing Course, SRL-L—Section 413.2, Section 410.2, or Section 412.2 and as follows: PG 64S-22, <0.3 million ESALs, or as indicated or directed.

656.3 CONSTRUCTION—As shown on the Standard Drawings; as specified in Sections 654.3(a), (b), (c), (e), and (f); and as follows:

(a) Asphalt Surface Treatment (for Type 6). Section 480.3

(b) Double Slurry Seal (for Type 6-S). Apply a seal, as specified in Section 482.3.

(c) Superpave Asphalt Mixture Design, Asphalt Base Course (for Type 6-SP). Section 313.3

(d) Superpave Asphalt Mixture Design, Asphalt Wearing Course (for Type 6-SP). Section 413.3

(e) Superpave Asphalt Mixture Design, Asphalt Wearing Course (for Type 6-F). Section 413.3, Section 410.3, or Section 412.3

656.4 MEASUREMENT AND PAYMENT—

(a) Paved Shoulders. Square Yard

(b) Shoulder Backfill. Cubic Yard or Ton
The unit price includes excavation below the bottom of the proposed base course.

SECTION 657—PAVED SHOULDERS, TYPE 7

657.1 DESCRIPTION—This work is construction of paved shoulders.

657.2 MATERIAL—Same type as the material used to resurface the roadway, except use SRL-L.

657.3 CONSTRUCTION—As shown on the Standard Drawings.

657.4 MEASUREMENT AND PAYMENT—Square Yard

SECTION 658—CONCRETE SHOULDERS

658.1 DESCRIPTION—This work is construction of plain cement concrete (PCC) shoulders, of the type indicated, and roller compacted concrete (RCC) shoulders on a prepared surface.

658.2 MATERIAL—

(a) Plain Cement Concrete Shoulders.

- Class AA Cement Concrete—Section 704
- Joint Sealing Material—Section 705.4(a), (b), or (d)
- Covers for Curing and Protection—Section 711.1
- Concrete Curing Compound—Section 711.2(a)
- Concrete Admixtures—Section 711.3
- Base Courses—Sections 303.2, 350.2, and 360.2
- Deformed and Plain Bar Dowels—Section 709.1(a)
- Premolded Expansion Joint Filler—Section 705.1
- Longitudinal Joint Material—Section 705.2

(b) Roller Compacted Concrete Shoulders. Section 502.2

658.3 CONSTRUCTION—

(a) Plain Cement Concrete Shoulders. Construct PCC shoulders as shown on the Standard Drawing and as specified in Section 501.3, except as follows:

(f) Placement and Initial Strike-Off of Concrete. Revise the third paragraph of Section 501.3(f) as follows:
Do not damage the prepared surface while transporting or depositing concrete ahead of the paver. If the prepared surface is an asphaltic leveling course on rubblized concrete, treated base course of cement or asphalt, or a No. OGS subbase, travel on the prepared surface only in the immediate area of the paving operation for the purpose of depositing concrete ahead of the paver. Do not use the prepared surface for hauling. Repair or replace any damaged areas to the satisfaction of the Representative, at no additional cost to the Department.

(g) Slip-Form Paving Method. Revise Section 501.3(g)4 as follows:
4. Joints. Saw, cure, and protect transverse and longitudinal contraction joints, as specified in Sections 501.3(i) and (j).

(i) Transverse Joints. Revise Sections 501.3(i) as follows:
Delete the second paragraph.
Revise Section 501.3(i)2, first paragraph as follows:

2. Contraction Joints. Accurately mark, using tacks or other approved methods, the location for the center of the sawed transverse contraction joints. Saw joints with equipment having guides, a blade guard, watercooling system, and cut-depth control. Provide adequate, extra equipment and parts at the site, before placing concrete and during sawing operations.

(b) Roller Compacted Concrete Shoulders. Construct RCC shoulders as shown on the Plans and as specified in Section 502.3.

658.4 MEASUREMENT AND PAYMENT—

(a) Plain Cement Concrete Shoulders. Square Yard

(b) Roller Compacted Concrete Shoulders. Square Yard

SECTION 659—HIGH FRICTION SURFACE TREATMENT (HFST)

659.1 DESCRIPTION—This work consists of furnishing and applying a High Friction Surface Treatment (HFST) on asphalt and concrete pavements.

659.2 MATERIALS—

(a) Binder Resin System (Binder). Use a polymeric or methyl methacrylate resin Binder as specified in Table 1; and listed in Bulletin 15, or listed as an approved experimental evaluation resin by the Department's New Products and Innovative Section (NPI).

Table 1
Binder Requirements

Property	Requirement		Test Method
	Polymeric resin	MMA Resin	
Viscosity (poises)	Class C: 7 - 30	Class C: 12 - 20	ASTM D 2556*, mix for 2 to 3 minutes before testing. Use X1.1 for Spindle Selection. Perform testing at a temperature of 73 ± 2F.
Gel Time (minutes)	10 minimum	10 minimum	AASHTO M 235*, prepare a 60 g sample, test at 73 ± 2F.
Ultimate Tensile Strength (psi)	2,500-5,000	1,500-5,000	AASHTO M 235*, prepare Type I specimen according to ASTM D 638
Durometer Hardness (Shore D)	60 to 80	40 to 75	ASTM D 2240*, use the Type 1 Precision—Type D Durometer Method. Cure specimens for 7 days at 73 ± 2F and relative humidity at 50% ± 2%. Test specimens at 73 ± 2F without delay.
Compressive Strength (psi)	1,000 min. at 3 hours 5,000 min. at 7 days	1,000 min. at 3 hours 2,000 min. at 7 days	ASTM C 579*, prepare specimen according to Method "B", 2 inch x 2 inch cube, using 2.75 parts of sand to one part of mixed Binder by volume. Use sand meeting ASTM C 778, 20-30 sand. Cure specimens for 7 days at 73 ± 2F and relative humidity at 50% ± 2%. Test specimens at 73 ± 2F without delay.
Cure Rate (hours)	3 max.	3 max.	ASTM D 1640*, prepare a specimen of 50-55 wet mil thickness. Cure specimens for 3 hours max at 73 ± 2F and relative humidity at 50% ± 2%. Test specimens at 73 ± 2F without delay.
Water Absorption (%)	1 max.	1 max.	AASHTO M 235*, cure specimens for 7 days at 73 ± 2F and relative humidity at 50% ± 2%. Test specimens at 73 ± 2F without delay after immersion.
Adhesive Strength (psi) @ 24 hours	250 min. or 100% substrate failure	250 min. or 100% substrate failure	ASTM C 1583*, cure specimens for 24 hours at 73 ± 2F and relative humidity at 50% ± 2%. Test specimens at 73 ± 2F without delay.

*Prepare the samples according to the manufacturers' recommendations.

(b) Aggregate Surface Topping (Aggregate). Use clean, dry, high-friction bauxite aggregate that is free from foreign matter and meets the physical and chemical requirements of Table 2.

Table 2
Bauxite Aggregate Requirements

Properties	Test Methods	Specifications
Polish Stone Value	AASHTO T 279	38 min.
Resistance to Degradation	AASHTO T 96	20% max.
LA Abrasion Test	AASHTO T 96 "C" Grading (on parent aggregate)	20.0 max.
Moisture Content	AASHTO T 255	0.2% max.
Aluminum Oxide	ASTM C 25	87% min.
Aggregate Gradation	AASHTO T 27	

Sieve Designation	Total Percent Passing
No. 4	100
No. 6	95-100
No. 16	0-5

(c) Certification. Certify Binder resin as specified in Section 106.03(b)3.

For aggregate, provide independent testing to verify Table 2 requirements are met. Independent testing must be less than 12 months old at the time aggregate is furnished to the project. Submit for project specific, local approval by the Representative (i.e. at the District or project level) as specified in Section 106.02(a)2.c.

659.3 CONSTRUCTION—

(a) Qualification of the Installer. Submit to the Representative a minimum of three projects including the installer's contact information. The three projects must have a cumulative minimum of 10,000 square yards of HFST and must have been placed within the past three years. All submitted projects must have a friction reading of at least 65 SN40S within 90 days of the installation when tested according to ASTM E 274 (AASHTO T 242). An installer who does not meet these minimum requirements will be allowed to perform the installation operation if approved in writing by the Binder manufacturer.

(b) Quality Control (QC) Plan. As specified in Section 106.03(a)2.a, submit a project specific QC Plan for approval to the Assistant Construction Engineer/Manager before any material placement. Discuss the QC Plan at the pre-construction meeting. The QC Plan must include key personnel, equipment, materials, proposed methods of installation and operation, and the following requirements:

1. A designated QC Plan Administrator, who has full authority to institute all action necessary for the successful operation of the QC Plan and is responsible for the following:

- Identify and provide to the Representative, contractor procedures for:
  - Documenting quantities used for binder and aggregate at each HFST site so application rates may be confirmed to be meeting the requirements as specified.
  - Moisture control methods of aggregate.
  - Cleaning and maintenance schedule for machinery and equipment.
  - Corrective actions for unsatisfactory construction practices and deviations from the specifications. All deviations from the approved QC Plan will be cause for immediate suspension of operations.
- Contractor performance of required field QC sampling, testing and record keeping in conformance with the approved QC Plan and contract documents.
- Maintain and make available upon request, complete records of sampling, testing corrective actions, and QC inspection results.

2. A manufacturer's technical person, who is responsible for the following:

- Train and provide recommendations to construction personnel in the safe handling and proper application of materials before placing the HFST.

- Must be present at each site if the installer does not meet the minimum requirements specified in Section 659.3(a).
- Must be present for the first 2 days of installation, for installers that do meet the minimum requirements specified in Section 659.3(a).
- Must be present at any job site requiring corrective work due to unacceptable Skid Number (SN) values as specified in Table 6.
- Or must be present as otherwise approved by the Representative in the QC Plan.

(c) Delivery and Storage of Materials. Store materials in a clean, dry environment and according to the manufacturer's recommendations. Do not expose the aggregate to rain or moisture. Obtain and post at the storage areas the Material Safety Data Sheet (MSDS), Product Data Sheet, and other information from the manufacturer pertaining to the safe practices for the storage, handling, and disposal of the materials, and to their health hazards. Provide a copy of such information to the Representative. Storage containers must have the manufacturer's name, date of manufacture, batch/lot number, trade name, quantity, and mixing ratio printed on the label.

(d) Application Conditions. Do not apply the Binder on a wet surface, if the temperature is below manufacturer's recommendation, or if the anticipated weather conditions would prevent the proper application of the surface treatment.

(e) Surface Preparation.

1. General. Cover and protect all existing pavement markings and utilities (manholes/inlets) adjacent to the HFST site as directed before performing surface preparation. Remove pavement markings conflicting with the HFST installation as specified in Section 963.3.

Prepare all pavement surfaces immediately before the installation of HFST. Wash pavement surfaces with a mild detergent solution to remove oils, greases, or other deleterious materials that remained after the surface preparation, rinse with clean potable water, and dry using a hot compressed air lance.

If cracks are present, remove loose material with compressed air and pre-treat cracks 1/4 inch or greater in width with the mixed Binder. Do not overfill cracks, if cracks are overfilled scarify the material to make it flush with the adjacent pavement after the Binder material is cured. Install HFST after the Binder in the pre-treated cracks has gelled.

2. Asphalt Pavement. Clean asphalt pavement surfaces using mechanical sweepers and high pressure air wash with sufficient oil traps. Mechanically sweep all surfaces to remove dirt, loose aggregate, debris, and deleterious material. Vacuum sweep or air wash, using a minimum of 180 cubic feet per minute and 80 pounds per square inch of clean and dry compressed air, all surfaces to remove all dust, debris, and deleterious material.

Do not apply HFST applications on new asphalt pavements until after a mandatory 30-day cure period.

3. Concrete Pavement. Clean and prepare all concrete pavement surfaces by removing all curing compounds, loosely bonded mortar, surface carbonation, and deleterious material. Comply with the International Concrete Repair Institute (ICRI) standard for surface roughness (CSP) 5. Provide the necessary concrete surface profile chips to visually verify the surface preparation. After preparation, vacuum sweep or air wash using a minimum of 180 cubic feet per minute and 80 pounds per square inch of clean and dry compressed air, all surfaces to remove all dust, debris, and deleterious material.

Do not apply HFST on concrete surfaces or repairs that are less than 28 days of age.

(f) Application Method. Table 3 and Table 4 show the permissible main application methods, depending on the size and average daily traffic (ADT) of each individual HFST installation sites. Manual application is permissible at sites as a secondary method if, for reasons of access or geometry, the mechanized or semi-mechanized equipment cannot physically be used, as approved.

Do not allow the mixed Binder material to be exposed, separate, cure, dry, or otherwise harden in such a way as to impair retention and bonding of aggregate. Remove and replace all Binder that becomes contaminated at no additional cost to the Department.

Immediately remove loose aggregate that falls onto any part of an active adjacent travel lane after the traffic is temporarily held.

Equipment and traffic is not allowed on the HFST during the curing period.

Table 3
Permissible Methods of Application for Roads Under 25,000 ADT

Site Size (Square Yards)	Main Application Method
Less than 300	Section 659.3(f)1 Hand Mixing and Manual Application, Section 659.3(f)2 Semi Mechanized Application, or Section 659.3(f)3 Automated Continuous Application
300 and above	Section 659.3(f)2 Semi Mechanized Application or Section 659.3(f)3 Automated Continuous Application

Table 4
Permissible Methods of Application for Roads of 25,000 ADT and Above

Site Size (Square Yards)	Main Application Method
Less than 300	Section 659.3(f)1 Hand Mixing and Manual Application, Section 659.3(f)2 Semi Mechanized Application, or Section 659.3(f)3 Automated Continuous Application
300 to1,500	Section 659.3(f)2 Semi Mechanized Application or Section 659.3(f)3 Automated Continuous Application
Larger than 1,500	Section 659.3(f)3 Automated Continuous Application

1. Hand Mixing and Manual Application. Provide calibrated containers for proper proportioning of the Binder components. Provide a clean, dry, container large enough to blend and mix the proper proportions of the Binder.

Uniformly mix the Binder components to within ± 2% of the manufacturer's specifications (by volume) using a low-speed, high-torque drill fitted with a helical stirrer, moving the stirrer around to all the edges of the mixing container, or as approved by the manufacturer's technical person. Do not use wheel mixers or paddle mixers.

Hand squeegee the mixed components onto the prepared pavement surface using a serrated edge squeegee at a uniform application thickness of 50-65 mils (25-32 square foot per gallon).

Immediately after the Binder application, mechanically or manually spread the aggregate onto the wet, uncured Binder at a uniform rate of 12-15 pounds per square yard. Completely cover the wet, uncured Binder with aggregate to achieve a uniform surface with no exposed Binder remaining visible on the surface. Spread the aggregate without displacing the wet Binder film during placement. Minimize walking or standing on the Binder.

Do not allow loose aggregate onto any part of the adjacent, active travel lanes.

2. Semi Mechanized Application. Machine mixing of Binder, machine application of aggregate, hand squeegee work to apply mixed Binder.

Use equipment to continuously mix, meter, and monitor the Binder. If recommended by the Binder manufacturer, use a heated metering pump. Mix the Binder according to the manufacturer's specifications (± 2% by volume).

Hand squeegee the mixed Binder onto the prepared pavement surface using a serrated edge squeegee at a uniform application thickness of 50-65 mils (25-32 square foot per gallon).

Immediately after the Binder application, mechanically spread the aggregate onto the wet, uncured Binder at a uniform rate of 12-15 pounds per square yard. Do not allow loose aggregate onto any part of the adjacent, active travel lanes. Hand spread aggregate is allowed as a secondary method if, for reasons of access or geometry, the mechanized equipment cannot physically be used, as approved.

Completely cover the wet, uncured Binder with aggregate to achieve a uniform surface with no exposed Binder remaining visible on the surface. Spread the aggregate without displacing the wet Binder film during placement. Minimize walking or standing on the Binder.

3. Automated Continuous Application. Machine mixing and application of Binder, machine application of aggregate, no hand squeegee work allowed.

Perform automated application using equipment that mixes, meters, monitors, and applies the Binder followed by application of the aggregate by use of equipment capable of placing Binder and aggregate in one continuous pass up to a 12 foot width. If recommended by the Binder manufacturer, use a heated metering pump.

Blend and mix the Binder according to the manufacturer's specification (± 2% by volume) and place a uniform Binder thickness of 50-65 mils (25-32 square foot per gallon). Apply the aggregate mechanically at a rate of 12-15

pounds per square yard (achieving saturation) by vertical drop onto the wet, uncured Binder. Do not allow loose aggregate onto any part of the adjacent, active travel lanes.

Use equipment capable of continuously monitoring Binder and aggregate application rates, and capable of placing HFST at a minimum rate of 2,000 square yards per hour.

No walking or standing on the Binder is permitted.

(g) Aggregate Cleanup. After the Binder treatment has cured, and before opening to traffic, reclaim the surplus aggregate, including the shoulder area, by a vacuum sweeper. Collected aggregate can be reused if it is clean, uncontaminated and dry. If contaminated aggregate is mixed with virgin aggregate, all the aggregate in the container will be considered contaminated and not acceptable for use in the HFST.

Between 15 to 30 days after placing the HFST, reclaim all loose aggregate, including the shoulder area, using a vacuum sweeper. This reclaimed aggregate cannot be reused unless it is cleaned of all contamination, dry, and meets the requirements for virgin aggregate.

(h) Performance Testing/Acceptance. After second aggregate sweeping as specified in Section 659.3(g), at localized areas with poor aggregate retention where Binder material is visible, reapply the HFST as directed at no additional cost to the Department.

The Department will conduct a calibrated skid test between 45 and 120 days after the HFST is completed. The Engineering District will request the Skid Testing from the Department's Pavement Testing & Asset Management Section. Skid Testing for each HFST site will be performed according to ASTM E 274 (AASHTO T 242) using a smooth tire lock-wheel apparatus, and Table 5.

Table 5
Number of SN40S Skid Tests per HFST Site, per Lane

HFST Site Length	Number of Runs per Lane	Skid Tests to Obtain per Run
100* feet to 350 feet	2	Run 1 – 2 Skid Tests Run 2 – 1 Skid Test
Greater than 350 feet	1	3

*For sites less than 100 feet, skid testing is not required.

Acceptance payment will be determined utilizing the factors in Table 6.

Table 6
Acceptance and Payment Factor per HFST Site

Average SN40S (per HFST site)	HFST Acceptance	Item Pay Factor (%)
SN ≥ 70	Yes	100
SN 65 - 69	Yes	90
SN < 65	No	Remove and replace, or reapply, at no additional cost to the Department to obtain acceptable SNs. Manufacturer's technical person must approve all proposed reapplication treatments, and be present during all corrective work. Representative must approve all corrective work plans before implementation.

659.4 MEASUREMENT AND PAYMENT—Square Yard

SECTION 660—RUMBLE STRIPS

660.1 DESCRIPTION—This work is the construction of rumble strips of the type indicated.

660.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Equipment. Use a machine capable of providing a smooth cut without tearing or snagging, and producing rumble strips as shown on the Standard Drawings. Equip machine with guides to provide uniformity and consistency in alignment of each cut with respect to the roadway.

(b) Milling Operation. Before the construction of the rumble strips, meet on-site with the Representative to discuss rumble strip installation. Construct rumble strips to have finished dimensions and tolerances as shown on the Standard Drawings. After milling the first 100 feet of rumble strips, examine spacing, widths, length, and depths with straight edge. If adjustments are required, mill an additional 100 feet and confirm correct installation. After installation has been corrected, proceed as directed. Construct rumble strips prior to the placement of the permanent pavement markings.

If constructing rumble strips into new concrete, only construct after curing as specified in Section 501.3(l).

If constructing centerline rumble strips into asphalt pavement, construct before placement of the longitudinal joint sealing operation.

(c) Disposal of Milled Material. Satisfactorily remove milled material and clear areas disturbed by the milling operation of all loose material before opening roadway to traffic. Remove and dispose of milled material according to DEP Residual Waste Regulations.

660.4 MEASUREMENT AND PAYMENT— Linear Foot

For the type indicated.

Measured longitudinally along center of rumble strip pattern. The unit prices include removal and disposal of milled material.

SECTION 663—BRICK MASONRY

663.1 DESCRIPTION—This work is construction of brick masonry.

663.2 MATERIAL—

- Brick—Section 713.1
- Mortar—Section 705.7(b)

663.3 CONSTRUCTION—

(a) Excavation. Excavate for masonry structure footer, as required, to form a compacted, firm, even foundation surface as specified in Section 204 for Class 3 excavation. Remove unsuitable material as specified in Section 203.1(b).

(b) Footing. Construct masonry structure footer as detailed and as specified in Section 1001 using Class A cement concrete as specified in Section 704.

(c) Sample Panel. Construct an on-site, sample, masonry panel approximately 4 feet square, indicating the color range, texture, bonding pattern, mortar color, tooling, and workmanship of the proposed brick masonry structure. Obtain approval of the sample panel before erecting the brick masonry.

(d) Placing Brick. Lay brick with exposed surfaces true to line, in courses, in a full bed and head of mortar, and with joints not exceeding 3/8 inch in width. Do not furrow beds. Stagger head joints on adjoining courses one-half brick, as nearly as practicable. Make courses level, except as otherwise indicated or directed. Construct at least one course in every six entirely of headers, common bond, unless otherwise directed. Saturate bricks with water and ensure that bricks are surface dry before placement. Do not use broken or chipped brick in exposed faces. When making closures, do not use less than the width of a brick and lay whole brick, with the long side at right angle to the face.

(e) Pointing. Finish mortar joints with a concave pointing tool to a depth not exceeding 1/8 inch and to an approved appearance.

(f) Curing and Protection. Do not place mortar and bricks or point, in freezing weather, unless otherwise authorized in writing. Protect brickwork and other masonry from freezing until cured. Provide adequate protection from frost, and remove and replace work damaged by frost. Protect completed brickwork from the elements. Cure brickwork with water moisture for at least 3 days. Wet and clean the exposed brick faces with a 10% (by volume) solution of muriatic acid, applied with stiff fiber brushes.

(g) Select Borrow Excavation (Structural Backfill). Backfill as specified in Section 205.

663.4 MEASUREMENT AND PAYMENT—

(a) Brick Masonry. Cubic Yard

(b) Class A Cement Concrete. Cubic Yard

(c) Excavation. Cubic Yard
For the class indicated.

SECTION 664—MODULAR ARCHITECTURAL BLOCK SYSTEM

664.1 DESCRIPTION—This work is construction of a modular architectural block system. Modular architectural block systems may be used for nonstructural landscape architecture applications according to the manufacturer drawings and recommendations. An acceptable landscape architectural site cannot have structures with foundations above the aggregate base within 8 feet of the back of the block system. System construction is restricted to a height of 4 feet above grade.

664.2 MATERIAL—

(a) Modular Architectural Blocks. Certify as specified in Section 106.03(b)3, Section 713.2, and as follows:
Machine-made blocks uniform in color with a minimum compressive strength of 4,500 pounds per square inch and an absorption of 6% or less, when tested according to ASTM C 140, and a minimum durability factor of 80 when tested according to ASTM C 666, Procedure A.

(b) Geotextile. Class 4, Type A, non-woven-heat-bonded as specified in Section 735.

(c) Coarse Aggregate. AASHTO 8 and Section 703.2(c)2.

(d) Mortar. Section 705.7(b)

(e) Topsoil. Section 802

(f) Seeding and Soil Supplements. Section 804

(g) Rejection. Blocks exhibiting any of the following conditions are not accepted:

- Defects that indicate imperfect proportioning, mixing, and molding;
- Non-uniform or contrasting coloration as determined by the Representative; or
- Surface defects, such as honeycombing or open texture, or areas damaged beyond satisfactory repair.

664.3 CONSTRUCTION—As indicated on the shop drawings and as follows:
Excavate and place geotextile, Class 4, Type A, non-woven-heat bonded, to the limits specified in Section 212.3(a) and (c). After placing the geotextile, construct a level 8 inches thick aggregate base according to the shop drawings. Ensure that each block course placed is level and aligned correctly with uniform staggered butt joints. Provide a block layout so as not to use any block smaller than half of a block in size. Clean the foreign material from the lower block course to ensure alignment and stability of the subsequent block course. Place the coarse aggregate backfill in 6-inch maximum lifts behind each block course against the geotextile before placing subsequent block courses. Use a vibratory plate to compact the course aggregate backfill before placing subsequent block courses. Wrap the geotextile material over the top of the coarse aggregate as indicated. Place the cap block course on a bed of mortar. Ensure butt joints in cap block course do not align with butt joints in preceding block course. Place topsoil and apply seeding and mulching using material and formula, at rates typical for the project. The contractor must be familiar with the placement of these block systems and certified by the block manufacturer. If not familiar with the block systems and certified by the manufacturer, provide an on-site trained technician from the block manufacturer, at no expense to the Department, during installation until the Representative is satisfied with workmanship.

664.4 MEASUREMENT AND PAYMENT—Square Foot
Measured to equal the area of the vertical face of the blocks, including vertical face concealed by finished grade. Excavation is incidental to this item.

SECTION 665—MASONRY REPOINTING

665.1 DESCRIPTION—This work is cleaning and repointing of existing masonry joints of the type indicated.

665.2 MATERIAL—

(a) Type A Repointing. Mortar, Section 705.6(b) and as follows:

1. **Above Grade –** Use Type N Mortar
2. **Below Grade** – Use Type S Mortar
3. **Historical Bridges –** Use Type K Mortar, as specified

(b) Type B Repointing. Caulking compound, Section 705.7

(c) Type C Repointing. Pressure mortar, Section 1017.2

665.3 CONSTRUCTION—

(a) Type A Repointing. Clean exposed masonry joints of loose mortar and dirt to a depth of not less than twice the joint width. Saturate the joints with clean water the day before repointing. Bring wetted surfaces to a saturated surface dry (SSD) condition before filling with mortar and ram well in place. Finish with a pointing tool. Do not apply mortar to a dry surface or to a surface with free standing water. Do not point in freezing weather. Remove and replace work damaged by frost at no additional cost to the Department. Keep the wall in an SSD condition while pointing. Protect pointed masonry from the elements for a period of 3 days. Clean the exposed masonry faces.

(b) Type B Repointing. Clean exposed masonry joints of loose mortar to a depth of not less than 1½". Pressure-point caulking compound into the joints by an acceptable method and finish the joints. Protect the caulked pointing from the elements for 3 days. Clean the exposed masonry surface.

(c) Type C Repointing. Repoint masonry with mortar, applied under pressure, as specified in Section 1017.3. Fill voids full of mortar and flush with the adjacent structure face using acceptable pressure equipment. Clean the exposed masonry face. Cure as specified in Section 1017.3(g).

665.4 MEASUREMENT AND PAYMENT—

(a) Type A Repointing. Linear Foot

(b) Type B Repointing. Linear Foot

(c) Type C Repointing. Linear Foot

(d) Class 2 Excavation. Cubic Yard – If required to expose joints.

SECTION 667—CEMENT CONCRETE PAVING FOR STREAM BEDS

667.1 DESCRIPTION—This work is construction of reinforced cement concrete paving for stream beds.

667.2 MATERIAL—

- Class A Cement Concrete—Section 704
- Joint Sealing Material—Section 705.4(b) or (c)
- Premolded Expansion Joint Filler—Section 705.1
- Reinforcement—Sections 709.3 and 709.4
- Curing and Protecting Covers—Section 711.1
- Concrete Curing Compound—Section 711.2(a)

667.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in the applicable parts of Section 1001.3, and as follows:

(a) General. Excavate the streambed to the required dimensions. Remove unsuitable material below the paving bottom and replace with acceptable material. Compact the entire foundation and finish to a firm, even surface. Protect paving portions under construction from the elements, flowing water, or other disturbances until curing is completed.

(b) Reinforcement. Place reinforcement, as indicated, and then hold firmly in position during the placing of concrete.

(c) Joints. Form or saw contraction joints 3/16 inch wide and 2 inches deep. Saw as soon as possible after the concrete sets sufficiently to preclude raveling during sawing and before any shrinkage cracking occurs in the concrete. The depth of the saw cut may be decreased at the edge adjacent to the pavement if required to obtain a maximum depth without pavement damage.

Tool the edges of construction joints to a 1/4-inch radius.

Place 1/2-inch premolded expansion joint filler, cut to conform to the cross-sectional area at not more than 100-foot intervals, at the end of curve sections, at structures, and at the end of a day's work. Make the filler 1/2 inch less than the pavement depth.

Seal joints as specified in Section 501.3(n).

667.4 MEASUREMENT AND PAYMENT—

(a) Cement Concrete Paving for Stream Beds. Cubic Yard

(b) Excavation. Cubic Yard

For removal of unsuitable material of the same class of excavation for the ditch or channel above the paving.

SECTION 673—PRECAST CEMENT CONCRETE BLOCK SLOPE WALL CAST-IN-PLACE CEMENT CONCRETE SLAB SLOPE WALL

673.1 DESCRIPTION—This work is construction of precast cement concrete block or cast-in-place cement concrete slab slope walls.

673.2 MATERIAL—

- Class A Cement Concrete—Section 704
- Reinforcement—Sections 709.1 and 709.3
- Precast Cement Concrete Blocks—Section 713.2(a)
- Fine Aggregate, Type A—Section 703.1
- Premolded Expansion Joint Filler—Section 705.1
- Joint Sealing Material—Section 705.4(b) or (c)
- Caulking Compound—Section 705.8
- Waterstops—Section 705.5(c)
- Water—Section 720.2
- Mortar—Section 705.7(b)
- Concrete Curing Compound—Section 711.2(a)
- Curing and Protecting Covers—Section 711.1
- Geotextiles, Class 4, Type A—Section 735

673.3 CONSTRUCTION—As indicated, as shown on the Standard Drawings, and as follows:

(a) Precast Cement Concrete Block. Place Geotextiles, Class 4, Type A, as specified in Section 212.3(c). After placing the geotextiles, carefully spread and shape the sand on the graded area.

Except for cutoff walls, lay the concrete blocks with long dimensions parallel to the toe wall, bedded with 3/8-inch joints, staggered, and spaced as indicated. Straighten the courses by striking lightly with a sledgehammer against a suitable wood block placed against every fourth row. Maintain the specified gap between the blocks. Do not use cracked or defective blocks.

Roll or tamp the blocks to a firm, uniform elevation. Wet the joints with as much water as will be readily absorbed. Fill joints with mortar. Use mortar of as dry a consistency as practical and fill joints flush with the top surface of adjacent blocks. Strike off the mortar to form a smooth joint between the blocks. Pointing is not required. If the bond has breaks around a block, remove the block, along with the mortar from the joint, then clean and reset with fresh mortar as specified.

(b) Cast-In-Place Cement Concrete Slab. Place the concrete directly on the prepared graded area, without placing a sand bed. Construct the slabs of Class A Cement Concrete, 4 inches in depth, and of uniform dimension not over 16 feet in length or width, unless otherwise directed for closures.

Place indicated reinforcement midway between the top and bottom of the slabs. Score the slabs to a minimum depth of 1/2 inch in 4-foot squares, or as directed. Place 1/2-inch thick, premolded expansion joint filler, for the full depth, between adjacent slabs and at contact points between slabs and structures.

Construct a cutoff wall 6 inches wide and 16 inches deep, monolithically with the slabs, at each end of the slope paving. Construct toe walls to the dimensions indicated. Use Class A Cement Concrete for toe and cutoff walls. Finish and cure the concrete as specified in the applicable requirements of Sections 501.3(k) and (l). Seal the joints as specified in Section 501.3(n).

673.4 MEASUREMENT AND PAYMENT—

(a) Precast Cement Concrete Block Slope Wall. Square Yard

(b) Cast-In-Place Cement Concrete Slab Slope Wall. Square Yard

SECTION 674—STONE SLOPE WALLS

674.1 DESCRIPTION—This work is construction of plain or mortared stone slope walls.

674.2 MATERIAL—

(a) Stone. Use stones of acceptable quality, sound and free from structural defects and foreign substances. Submit samples to the LTS for petrographic examination before use, unless the rock comes from material providing an approved Type A aggregate. Use stones at least 3 inches thick, of a length at least three times the thickness, and of a width at least equal to the depth of the slope wall from the exposed surface of the slope wall to the subgrade, except for spalls for packing voids. For stones in excess of 6 inches thick, use stones at least twice as long as their thickness.

(b) Other Material.

- Class A Cement Concrete—Section 704
- Premolded Expansion Joint Filler—Section 705.1
- Mortar—Section 705.7(b), except use Type C, fine aggregate.
- Filler—Acceptable coarse sand, gravel, or other material.
- Geotextiles, Class 4, Type A—Section 735

674.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Plain Stone Slope Wall. Place geotextiles, Class 4, Type A, as specified in Section 212.3(c). After placing geotextiles, set stones by hand and firmly bed on the prepared graded area, with the length dimension approximately parallel to the toe wall foundation. Bed stones one against the other with ends and sides in contact, then break joints. Lay the stones flat in toe wall and cutoff wall areas. Set the stones on edge in anchor wall areas and on sloped areas.

Pack spaces between the larger stones with spalls, then ram into place. Tamp the whole area of the wall to a tight, even surface. Fill voids by sweeping filler over the surface.

(b) Mortared Stone Slope Wall. Set the stones as specified in Section 674.3(a). Fill the voids with mortar and spalls, as required, to within 1/2 inch of the surface of the adjacent stone. Use mortar with a stiff but workable consistency. Pointing is not required. Do not hammer, roll, or ram the stones after mortaring. If the bond around stones becomes broken, remove stones and mortar, reset the stones, and fill the voids with mortar, as specified.

Do not place mortar in freezing weather, unless permitted in writing, and then only with adequate protection.

Remove and replace work damaged by frost. Protect completed wall from the elements and cure with water for a period of at least 3 days.

(c) Toe Walls, Cutoff Walls, and Anchor Walls. Construct concrete toe, anchor, and cutoff walls as indicated and as specified in the applicable parts of Section 1001.3. Obtain approval.

674.4 MEASUREMENT AND PAYMENT—

(a) Plain Stone Slope Wall. Cubic Yard

(b) Mortared Stone Slope Wall. Cubic Yard

SECTION 675—RANDOM STONE SLOPE WALL

675.1 DESCRIPTION—This work is construction of random stone slope walls.

675.2 MATERIAL—

- Coarse Aggregate, Type A, No. 1 Stone—Section 703.2
- Class A Cement Concrete—Section 704
- Premolded Expansion Joint Filler—Section 705.1
- Joint Sealing Material—Section 705.4(b) or (c)
- Geotextiles, Class 4, Type A—Section 735

675.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

Construct concrete toe, anchor, and cutoff walls as specified in Section 1001.3. Where the wall butts another rigid concrete structure, place a 1/2-inch premolded, expansion joint filler. Seal the top 1/2 inch of the joint with joint sealing material.

Place rock and geotextiles as specified in Section 850.3.

Spot-check the finished surface with a string line. Fill depressions and cut high areas greater than 2 inches as required.

675.4 MEASUREMENT AND PAYMENT—Cubic Yard

The Department will measure to include toe, anchor, and cutoff walls.

SECTION 676—CEMENT CONCRETE SIDEWALKS

676.1 DESCRIPTION—This work is construction of cement concrete sidewalks and curb ramps on an aggregate bed.

676.2 MATERIAL—

- Class A Cement Concrete—Section 704
- Aggregate —Section 350.2
- Reinforcement Steel—Section 709.3
- Premolded Expansion Joint Filler—Section 705.1
- Concrete Curing Compound—Section 711.2(a)
- Curing and Protecting Covers—Section 711.1
- Mortar—Section 1001.2(d)
- Joint Sealing Material—Section 705.4 (a), (b), or (c)
- Boiled Linseed Oil—Section 1019.3(a)

676.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Preparation of Foundation. Saw cut as necessary, excavate existing concrete sidewalk as specified in Section 203.1(c), and form the foundation at a depth 10 inches parallel with the finished surface of the sidewalk. If directed, remove unsuitable material as specified in Section 203.1(b). Thoroughly compact the foundation; finish to a firm, even surface; moisten if required.

(b) Placing Aggregate for Bed. Spread aggregate on the prepared foundation to form a thoroughly compacted bed 6 inches deep. The area to be compacted is defined as the area directly under the sidewalk and 6 inches beyond each side of the sidewalk if right of way allows.

(c) Forms. Use acceptable wood or metal forms that extend the full depth of the concrete.

(d) Concrete. As specified in Section 1001.3.

Place concrete 4 inches deep. Strike off, finish, and test, as specified in Sections 501.3(k) and (p), except the contractor may use manual placement operations and apply a light broom finish to the cement concrete surface.

Form outside edges and joints with a 1/4-inch radius-edging tool.

Form transverse dummy joints at 5-foot intervals, approximately 1/8 inch wide, and at least 1 inch deep.

(e) Expansion Joints. Place 3/4 inch premolded, expansion joint material for the full depth of the sidewalk, opposite expansion joints in adjacent curb, between the sidewalk and curb, and between the sidewalk and rigid structures. Install dummy joint and eliminate premolded expansion joint material between depressed curb, curb ramp, and flares if placed monolithically.

1. Seal Joints. Clean joints of all scale, dirt, curing compound, and other foreign material with a mechanized wire brush.

Do not place poured joint-sealing material if the air temperature is less than 40F, unless allowed. Use heating equipment of an indirect heating type constructed as a double boiler. Provide positive temperature control and

mechanical agitation. Obtain the safe heating temperature and recommended pouring temperature from the manufacturer's shipping container. Place the material within this temperature range, but as close as possible to the recommended pouring temperature. Maintain a safe heating temperature. Maintain a single material batch at the pouring temperature for no more than 4 hours. Heat the material only once.

Fill the joint reservoir, created by the cleaning operation, with sealing material to a depth 1/8 inch below the top of sidewalk. Do not allow sealing material to spread over concrete surfaces.

(f) Removal of Forms. Do not remove side forms until at least 12 hours after placing concrete. After removal of forms, fill minor honeycombed areas with mortar. As directed, remove and replace defective major honeycombed areas. Apply boiled linseed oil to the entire surface of the concrete as specified in Section 1019.3(a). If curing was performed with a membrane-forming curing compound, remove the curing compound before placing the boiled linseed oil.

(g) Backfilling. After the concrete has cured for at least 72 hours, backfill spaces adjacent to the sidewalk, using acceptable embankment material, as specified in Section 206.3(b)4.

Repair or replace existing pavement, curb, and sidewalk damaged due to construction. Satisfactorily dispose of unsuitable and surplus materials.

(h) Curb Ramps. As required and indicated, construct cement concrete sidewalk for curb ramp configurations as shown on the Standard Drawings except for the detectable warning surface located at the bottom of each ramp. Construct the detectable warning surface as specified in Section 695.

Create a slip-resistant, textured surface for the full width and length of the curb ramp and side-flares excluding the detectable warning surface. Use a coarse, stiff-toothed broom to create a textured pattern worked perpendicular to the slopes of the curb ramp.

Shape rounded edges instead of sharp angled edges while the concrete is still plastic for all slope changes of the curb ramp especially where the top of the curb ramp meets adjacent sidewalk surfaces.

Embed detectable warning surface in fresh, plastic concrete at the proper location for the curb ramp before the plastic concrete has set.

The contractor may place cement concrete for depressed curb monolithically with curb ramps, side flares, or both. Do not place cement concrete curb monolithically with other cement concrete sidewalk.

(i) Sidewalks and driveway aprons through driveways.

1.Preparation of Foundation. Saw cut as necessary and excavate existing concrete sidewalk and driveway apron as specified in Section 203.1(c)and form the foundation at a depth 12 inches parallel with the finished surface of the sidewalk and driveway apron. If directed, remove unsuitable material as specified in Section 203.1(b). Thoroughly compact the foundation; finish to a firm, even surface; moisten if required.

2. Placing Aggregate for bed. Spread aggregate on the prepared foundation to form a thoroughly compacted bed 6 inches deep. The area to be compacted is defined as the area directly under the sidewalk, driveway apron, and 6 inches beyond each side of the sidewalk and driveway apron if right of way allows.

3. Forms. Use acceptable wood or metal forms that extend the full depth of the concrete.

4. Reinforcement Steel. Provide welded wire fabric reinforcement made of W4 or W4.5 wire at 6 inch centers transversely and longitudinally conforming to ASTM A 1064 Steel Wire and Welded Wire Reinforcement. Secure fabric reinforcement at half-depth of cement concrete.

5. Concrete. As specified in Section 1001.3. Place concrete 6 inches deep. Strike off, finish, and test, as specified in Sections 501.3(k) and (p), except the contractor may use manual placement operations and apply a light broom finish to the cement concrete surface. Form outside edges and joints with a 1/4-inch radius-edging tool. Form transverse dummy joints at 5-foot intervals, approximately 1/8 inch wide, and at least 1 inch deep.

676.4 MEASUREMENT AND PAYMENT—

(a) Cement Concrete Sidewalks. Square Yard. Boiled Linseed Oil is incidental.

(b) Class 1A Excavation. Cubic Yard

(c) Class 1B Excavation. Cubic Yard

(d) Sidewalks and driveway aprons through driveways. Square Yard**.**
Depressed curb and curb ramp are paid separately according to their unit of measurement.
If depressed curb is placed monolithically with curb ramps, side-flairs, or both, the depressed curb will be measured and paid separately from the curb ramps and side flairs.

SECTION 677—SELECTED MATERIAL SURFACING

677.1 DESCRIPTION—This work is the furnishing and placing of selected material on a prepared area.

677.2 MATERIAL—Section 703.3

677.3 CONSTRUCTION—Uniformly spread aggregate upon the prepared areas, in loose layers not exceeding 5 inches in depth, without segregation of coarse and fine material. Compact with a roller as specified in Section 108.05(c)3.a or 3.b.

Satisfactory compaction will be determined by the stability of the material under the specified compaction equipment. If material used does not contain sufficient fines to properly lock under the roller, add additional fines of the same material, or limestone fines, as necessary, to obtain the compaction and stability.

677.4 MEASUREMENT AND PAYMENT—Cubic Yard or Ton. Excavation, grading, and scarifying are incidental.

SECTION 678—PERMANENT BARRICADES

678.1 DESCRIPTION—This work is construction of permanent barricades.

678.2 MATERIAL—As shown on the Standard Drawings and as follows:

(a) Posts.

1. Wood Posts. No. 1 stress-rated Southern Pine; No. 1 Douglas Fir; Larch; select, structural Hem-Fir; Mountain Hemlock; Western Hemlock; or sound square edge Red Oaks; seasoned before treatment as required by AWPA or AWPB Standards; and pressure treated according to AWPA and AWPB Standards and as follows:

Treatment	Retention
(Species except Red Oaks)	**(pounds per cubic foot)**
Ammoniacal Copper Arsenite (ACA)	0.60
Pentachlorophenol	0.60
Chromated Copper Arsenate (CCA) Types A, B, or C	0.60
(Red Oaks)	
Pentachlorophenol	0.30

Certify as specified in Section 106.03(b)3.
A tolerance of 1/2 inch scant from nominal dimensions is required for the size of posts.
Do not use posts that, for any reason, prevent attachment of guide rail fittings or alignment with other posts.
Throughout the project, use posts treated with the same type of preservative.

2. Steel Posts. Section 1109

(b) Wood Planks. Seasoned No. 1, structural grade, Long Leaf Yellow Pine; or select, structural grade, Douglas Fir; pressure treated as specified. Certify as specified in Section 106.03(b)3.

(c) Class A Cement Concrete. Section 704

(d) Extruded Aluminum Channel. Section 1103.02(a). The Contractor may use an alternate channel section, of equal or greater section modulus, with suitable dimensions to utilize the mounting hardware. Certify as specified in Section 106.03(b)3.

(e) Aluminum Blanks (for Wood Barricade Panels). Section 1103.04(a), Alloy 6061-T6. Certify as specified in Section 106.03(b)3.

(f) Reflective Sheeting. Section 1103.04(c), Certify as specified in Section 106.03(b)3.

(g) Miscellaneous Material.

- Aluminum Hardware Items—Section 1103.11
- Aluminum Round Head Wood or Lag Screws—Section 1103.11
- Other Hardware Items—Section 1109.05

(h) Extruded Aluminum Channel and Aluminum Blank Preparation. Section 1103.02(b)

678.3 CONSTRUCTION—As shown on the Standard Drawings, using either aluminum channels or wood planks with wood or steel posts.

Apply the reflective sheeting to the aluminum channels as specified in Section 1103.02(c) or to the aluminum blank as specified in Section 1103.03(b).

The post spacing may vary to a maximum of 10 feet center-to-center. Mechanically drive posts or erect in concrete footings.

Cut and peen bolts against the faces of nuts.

After erection, treat galvanized components, including the cut ends of bolts, that are abraded or damaged as specified in Section 620.3(a)1.

678.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 679—SLAB STABILIZATION

679.1 DESCRIPTION—This work is the filling of voids beneath existing rigid base courses or pavements as specified in Section 516 and according to the Standard Drawings and at other locations as directed.

679.2 MATERIAL— Use either cement, asphalt or high density polyurethane grout to stabilize the slab.

(a) Cement Grout Stabilization.

1. Cement. Section 701

2. Water. Section 720.1

3. Admixtures. Section 711.3. A multiphase wetting agent and an expansive agent may be used. Use an accelerator if required.

4. Pozzolan. Section 724.2

5. Rapid Set Concrete Patching Materials. Supplied by a manufacturer listed in Bulletin 15. Use within the shelf life and temperature limitations set by the manufacturer.

6. Mix Design. Submit a mix design to the District Executive for review and acceptance before starting work. Include with the submittal: independent laboratory testing showing 1, 3, and 7-day compressive strengths; flowability; shrinkage and expansion results; and the time of initial set. Proportion the mix as follows:

One part cement (by volume)
Three parts pozzolan (by volume)
Admixtures—if required and accepted
Water—an amount such that the time of efflux is within 10 seconds to 15 seconds (ASTM C 939)

Furnish mix with an expansion of 0% to 10% (ASTM C 940), an initial setting time of 1 hour to 6 hours (AASHTO T 131) and bleeds no more than 2.5% of the volume (ASTM C 940).

A 7-day compressive strength of 700 pounds per square inch minimum is required, based on the average of five test cylinders (PTM No. 521).

Submit a new mix design if the source of any material is changed.

(b) Asphalt Grout Stabilization.

1. Asphalt Cement. According to ASTM D 3141 with a minimum flash point of 500F. Supplied by a manufacturer listed in Bulletin 15. Provide a supplier certification with each shipment as specified in Section 106.03(b)3.

2. Plugs, cylindrical plugs with tapered ends. As approved by the Representative.

3. Rapid Set Concrete Patching Materials. Supplied by a manufacturer listed in Bulletin 15. Use within the shelf life and temperature limitations set by the manufacturer.

(c) High Density Polyurethane Grout Stablization.

1. High Density Polyurethane. Supplied by a manufacturer listed in Bulletin 15 and provide a supplier certification with each shipment as specified in Section 106.03(b)3. Certify that the material conforms to the following requirements:

Density, lbs/cu. ft.	ASTM D 1622	min. 3.5
Tensile Strength, psi	ASTM D 1623	min. 60
Compressive Strength, psi	ASTM D 1621	min. 50
Shear Strength, psi	ASTM C 273	min. 40
Closed Cell Content %	ASTM D 6226	min. 85
Water Absorption %	ASTM D-2842	< 2

2. Plugs, cylindrical plugs with tapered ends. As approved by the Representative.

3. Rapid Set Concrete Patching Materials. Supplied by a manufacturer listed in Bulletin 15. Use within the shelf life and temperature limitations set by the manufacturer.

679.3 CONSTRUCTION—

(a) General. Do not begin this work until it is satisfactorily shown that qualified personnel, with successful experience, are available at the job. Assign a crew supervisor that has at least 5 years' experience in work on projects of similar size and character. Submit three references for crew supervisor and injection nozzle-men from people who were responsible for supervision of these projects.

Submit written documentation to the Representative at least 10 working days before start of work.

Do not perform work if daytime temperatures are below 35F40F or if the subgrade and/or base course material is frozen.

1. Field QC plan. Provide a field QC plan that contains the following:

- Provide details of proposed hole spacing, depth, diameter, drilling methods, and hole injection sequence for the stabilization operations.
- Provide details of method to locate pavement reinforcement prior to drilling, if applicable.
- Provide a list of the proposed equipment, including supply pumps, valves, mixing equipment, injection guns and other items required to complete the work.
- Provide details of proposed means of establishing and controlling line and grade of stabilized slabs.
- Provide details of methods for control and disposal of waste materials.
- Provide details of the curing period and open to traffic times.

Do not start work until the Representative has reviewed and approved all submittals.

2. Deflection Testing. If no preliminary testing was performed, test each joint and crack if directed by the Representative, and as follows:

Do not perform testing if air temperature is below 40F or exceeds 70F. Do not test during spring thaw conditions or if subgrade is frozen.

If the air temperature is not within the air temperature limits to perform deflection testing, then perform visual verification of pumping or poor joint performance before specifying slab stabilization.

Perform deflection testing according to ASTM D 4695. Provide to the representative the test data and the slabs recommended for stabilization 15 working days before start of work for approval.

Repeat this procedure at every transverse joint and crack.

Stabilize all joints or cracks that have a loaded slab corner deflection of 0.02 inch or more, and a joint efficiency at 65%* or more if approved by the representative.

Patch and stabilize all joints or cracks that have a loaded slab corner deflection of 0.02 inch or more, and a joint efficiency of less than 65% if approved by the representative.

Joint efficiency (JE) is defined as follows:

$$JE = \frac{\text{Unloaded Slab Corner Deflection}}{\text{Loaded Slab Corner Deflection}} \times 100$$

* Use the highest Loaded Slab Corner Deflection and the lowest joint efficiency at each joint or crack.

3. Safety. Observe all normal safety rules in the operation of pressure pumps and other equipment. Exercise

extra precautions in the handling of hot asphalt hose and nozzle. Provide hot asphalt workmen with safety masks, protective gloves, heavy clothing in two or more layers, closely fitted at the ankles, wrists and neck.

4. Pumping Operations. Stop pumping when any vertical movement is noted. In the event the Representative determines that continued material placement at any specified location is no longer economically feasible, or vertical movement is going to occur, the Representative may direct the Contractor to cease pumping at that location.

5. Correcting Panel Displacement. Grind pavement, raised in excess of the 0.05 inch allowable tolerance, to the correct grade. Grind as specified in Section 514.3, except grind into the high slab.

6. Radial Cracks. Radial cracks spreading outward from the grout injection holes indicate poor quality or improper methods. Stop work until the cause is determined and corrected.

7. Transverse Cracks. If transverse cracks develop between adjacent grout injection holes, replace the entire slab at no additional cost to the Department as specified in Section 516.

8. Hole Patching. Upon completion of the work, remove wooden plugs and patch drill holes full depth with a rapid set, non-shrink concrete patching material. Strike patches flush with the surface of the surrounding pavement.

9. Retesting. If directed, 24 hours after grouting and before acceptance, retest each stabilized joint or crack as specified in Section 679.3(a)2. Regrout slabs that deflect 0.02 inch or more and retest. The Representative may accept any slab that continues to show movement, in excess of that specified, after two properly performed groutings; or direct the removal and replacement, with a full depth concrete patch, as specified in Section 516 and paid for separately.

(b) Cement Grout Stabilization.

1. Equipment.

1.a Grout Plant. Provide a satisfactory positive displacement cement injection pump and a satisfactory mixing machine, capable of operating at a minimum speed of 800 rpm and a maximum speed of 2000 rpm.

1.b Water Tanker. Supply water from a water truck with adequate capacity and pressure for delivery to the grout machine.

1.c Drill. Provide generator, core drill, and diamond-tip core barrels, or other satisfactory equipment capable of drilling the grout injection holes through the pavement and base material; and equipment in satisfactory condition and operated to produce holes that are smooth, vertical, and do not break out the bottom of the slab.

1.d Vertical Movement Testing. Supply satisfactory equipment to measure slab lift, capable of detecting simultaneously the lift of the pavement edge, or of any two outside slab corners adjacent to a joint and the adjoining shoulder. Use equipment with a capability of making these measurements to within 0.001 inch.

1.e Miscellaneous. Provide necessary hoses, valving, and valve manifolds with positive cutoff and bypass provisions to control pressure and volume, pressure gauges with gauge protectors, expanding packers or hose for positive seal during grout injection, hole washing tools, drill steel, bits, and any other miscellaneous tools required.

2. Procedure.

2.a Drilling Holes. Drill grout injection holes in the pattern shown on the Standard Drawings, or as directed. Drill holes not larger than 1 ½ inches in diameter, vertical and round, and to a depth sufficient to penetrate any stabilized base.

2.b Mixing. Accurately measure the dry materials by mass, if in bulk, or provide them packaged in uniform volume sacks. Batch with water through a meter or scale that totals the day's consumption.

Do not hold mixed material in the mixer or injection pump sump for more than one hour after mixing.

Dispose of material held for longer times.

Make flowability measurements at least two times during each work shift.

2.c Cement Grout Injection. During the filling operation, use a positive means of monitoring lift as specified in Section 679.3(b)1.d. Upward movement of the pavement greater than 0.05 inch will not be allowed. Lower an expanding rubber packer or hose, connected to the discharge from the pump, into the hole. Do not extend the discharge end of the packer or hose below the lower surface of the concrete pavement. Pump each hole until maximum pressure is built up or material is observed flowing from hole to hole. Do not exceed a maximum pressure of 200 pounds per square inch, unless otherwise directed. Monitor the pressure in the grout line. Protect the gauge from the grout slurry. Allow the water, displaced from the void structure by the grout, to flow out freely. Excessive loss of the grout through the cracks, joints, or from back pressure in the hose or in the shoulder area will not be allowed.

2.d. Opening to Traffic. Do not open to traffic for a minimum of 12 hours after grouting operations have been completed, or according to the contractor's approved field QC plan, and according to Manufacturer's recommendations.

(c) Asphalt Grout Stabilization.

1. Equipment.

1.a Asphalt Transport Tanker. Use a fully insulated asphalt tanker with a removable access hatch, a 2 inch minimum size overflow pipe and suitable strainers at the outlet to the pumps. Heat the asphalt in the tanker to the application temperature and circulate it during the entire heating process. Provide necessary readout equipment for temperature in the cab of the tanker. Provide certification for the accuracy of the method used to measure the amount of asphalt used on the project.

1.b Asphalt Underseal Pump. Use a separate, self-contained reversible pump equipped with quick connectors. Use a pump a 1½ inch minimum size, flexible metal circulating hose with a quick cut off valve for recirculation when the asphalt is not being injected into the voids

1.c Pressure Water Distributor Trailer. Provide a pressure water distributor trailer with a minimum 50 gallon capacity. The unit may have its own pump system or be compatible with the air system on the transport tanker or as approved by the Representative.

1.d Compressor Unit. Provide compressor units capable of delivering a minimum of 100 cubic feet of air per minute to blow air into the cavities beneath the pavement.

1.e Drill. Provide generator, core drill, and diamond-tip core barrels, or other satisfactory equipment capable of drilling the grout injection holes through the pavement and base material; and equipment in satisfactory condition and operated to produce holes that are smooth, vertical, and do not break out the bottom of the slab.

1.f Asphalt Nozzles. Provide a tapered nozzle, tube or other mechanical device of sufficient length, approved by the Representative, that can be used to inject the asphalt under the pavement. Use a nozzle with a three way valve designed to circulate the asphalt back to the distributor tank when pumping operations are not in progress. Provide handles so that the operator can move the nozzle from hole to hole without touching the hot nozzle or hose.

1.g Pavement Plugs. Provide cylindrical plugs of sufficient length and diameter to plug the holes. Taper one end so that the plug can be driven a maximum of 2 inches into the hole.

1.h. Vertical Movement Testing. Supply satisfactory equipment to measure slab lift, capable of detecting simultaneously the lift of the pavement edge, or of any two outside slab corners adjacent to a joint and the adjoining shoulder. Use equipment capable of detecting slab lift to measurements of 0.001 inch.

1.i Miscellaneous. Provide necessary sprinkling cans, picks, shovels, water and any other miscellaneous tools required to perform the work.

2. Procedure.

2.a Drilling Holes. Drill grout injection holes in the pattern shown on the Standard Drawings, or as directed. Drill holes not larger than 1½ inches in diameter, vertical and round, and to a depth sufficient to penetrate any stabilized base.

2.b Blowing Holes. Blow compressed air into the hole, as the drill is being backed out, for approximately 5 to 15 seconds to clear the hole. When water or thin mud is encountered, blow air into the hole until water stops coming through adjacent holes and cracks.

2.c Preparation of Asphalt. Heat the asphalt to a temperature of 380F to 450F before pumping operations begin. Asphalt heated 500F or more will be rejected. Exercise extreme care to ensure that the asphalt does not contact an open flame. Circulate the asphalt prior to pumping to free and warm up the lines of the circulating hose.

2.d Asphalt Grout Injection. Apply water around the hole before pumping to prevent any seepage from sticking to the pavement. Erect a splash shield, no less than 15 square feet, of an approved dimension and stability, between the nozzle and passing traffic to prevent possible damage or injury from uncontrolled spraying of hot asphalt. Pump asphalt at a pressure of 25 pounds per square inch to 45 pounds per square inch. Control the amount of rise by regulating the rate of injection of the material. Use a positive means of monitoring lift, as specified in Section 679.3(c)1.h. Upward movement of the pavement greater than 0.05 inch is not allowed. If asphalt seeps from joints or cracks before undersealing is complete halt pumping until asphalt has congealed. Resume pumping until the slab lift limit is reached. When the nozzle is removed from the hole, remove any excess material from the area.

2.e Opening to Traffic. Do not open to traffic for a minimum of 30 minutes after grouting operations have been completed or according to the contractor's approved field QC plan and according to Manufacturer's recommendations.

(d) High Density Polyurethane Grout Stabilization.

1. Equipment.

1.a Pump Unit. As a minimum, provide a mounted unit capable of injecting the high density polyurethane material at a controlled rate, underneath the pavement and capable of controlling the rate of rise of the pavement. Equip the pumping unit with a calibrated meter to measure the amount of high density polyurethane materials injected at each location and capable of instantaneous control of the material flow to avoid lifting of the pavement slabs. Equip each pumping unit with a display output device capable of recording the amount of material used. The output display device needs to be capable of providing the amount of material used in pounds. Also equip each display output device with a manual reset button. Provide certification of the calibration testing showing that the unit has been calibrated within the last 12 months before the start of the project.
Provide pressure and temperature control devices capable of maintaining proper temperature and proportionate mixing of the polyurethane component materials.

1.b Drill. Provide generator, core drill, and diamond-tip core barrels, or other satisfactory equipment capable of drilling the grout injection holes through the pavement and base material; and equipment in satisfactory condition and operated to produce holes that are smooth, vertical, and do not break out the bottom of the slab.

1.c Pavement Plugs. Provide cylindrical plugs of sufficient length and diameter to plug the holes.
Taper one end so that the plug can be driven a maximum of 2-inches into the hole.

1.d. Vertical Movement Testing. Supply satisfactory equipment to measure slab lift, capable of detecting simultaneously the lift of the pavement edge, or of any two outside slab corners adjacent to a joint and the adjoining shoulder. Use equipment capable of detecting slab lift to measurements of 0.001 inch.

1.e Miscellaneous. Provide necessary hoses, valving, and valve manifolds with positive cutoff and bypass provisions to control pressure and volume, pressure gauges with gauge protectors, expanding packers or hose for positive seal during injection, hole washing tools, drill steel, bits, and any other miscellaneous tools required.

2. Procedure.

2.a Drilling Holes. Drill grout injection holes in the pattern shown on the Standard Drawings, or as directed. Drill holes not larger than 5/8 inches in diameter, vertical and round, and to a depth sufficient to penetrate any stabilized base.

2.b Preparation of Polyurethane. Mix components according to manufacturer's specification.

2.c Polyurethane Grout Injection. Inject the high density polyurethane material under the slab. Control the amount of rise by regulating the rate of injection of the material. Use a positive means of monitoring lift, as specified in Section 679.3(d)1.d. Upward movement of the pavement greater than 0.05 inch is not permitted. When the nozzle is removed from the hole, remove any excess material from the area. Stop pumping when any vertical movement occurs. The Inspector-in-Charge may direct pumping to cease if no vertical movement occurs.

2.d Opening to Traffic. Do not open to traffic for a minimum of 30 minutes after grouting operations have been completed, or according to the contractor's approved field QC plan and according to Manufacturer's recommendations.

679.4 MEASUREMENT AND PAYMENT—

(a) Cement Grout Stabilization.

1. Deflection Test. Each

2. Holes Drilled. Each.
The price includes patching of the hole.

3. Grout Material. Bags of Cement
The unit price includes an accelerator, if required. For each 5 linear feet of radial cracking, as specified in Section 679.3(a)6, the Department will reduce this pay item by one bag of cement. The Department will not pay for any wasted grout material.

(b) Asphalt Grout Stabilization.

1. Deflection Test. Each

2. Holes Drilled. Each.
Includes plugs and patching of the hole.

3. Asphalt. Gallons
Measured by calibrated flow meter. The Department will not pay for any wasted grout material.

(c) High Density Polyurethane Grout Stabilization.

1. Deflection Test. Each

2. Holes Drilled. Each. Includes plugs and patching of the hole.

3. Polyurethane. Pounds
Measured by calibrated flow meter. The Department will not pay for any wasted grout material.

SECTION 680—WATERPROOFING

680.1 DESCRIPTION—This work is the furnishing and placing of adhesive preformed membrane waterproofing systems to concrete or other surfaces as indicated.

680.2 MATERIAL—Unless specified or shown on the plans, select from the waterproofing systems listed in Bulletin 15.

(a) Adhesives, Conditioners, Primers, Mastics, Two-Part Liquid Urethane Membranes and Sealing Tapes. As recommended for use with the respective preformed membrane sheet materials. Contact the membrane manufacturer or its representative for instructions.

(b) Adhesive-Backed Preformed Membrane Sheet. Furnish Adhesive-Backed Preformed Membrane Sheet consisting of a sheet of rubberized asphalt or polymer modified asphalt permanently applied to a polyethylene film, or reinforced with a stitch-bonded polyester/polypropylene fabric, or reinforced with a fiberglass mesh and conforming to the minimum requirements specified in Table A.

(c) Protective Covers. Provide a 1/8-inch thick, asphalt protective board or 65-pound roofing material without mica coating, or approved equal that furnishes equivalent protection to the membrane from being cut, scratched, or otherwise damaged from the backfill or equipment.

For bridge deck surfaces, the asphalt overlay is the protective cover.

(d) Bonding Material. Section 460 and as recommended by the manufacturer.

(e) Manufacturer Technical Representative. Ensure that a trained Manufacturer's Technical Representative is present during every phase of application, unless applied by a factory trained licensed installer, as indicated by written approval from the material supplier. The Manufacturer's Technical Representative will provide training and technical assistance on surface preparation, equipment, mixing of components, type, and method of application, and finish.

(f) Certification. Certify each shipment as specified in Section 106.03(b)3. Visibly label all shipments on the membranes or containers with the manufacturer's name, membrane trade name, lot number, and material quantity.

TABLE A
Adhesive-Backed Preformed Membrane Sheet Minimum Requirements

Preformed Membrane Sheets		For Bridge Deck Surfaces		For Surfaces Other Than Bridge Decks	
Property	**Test**	**Rubberized Asphalt Type**	**Modified Asphalt Type**	**Rubberized Asphalt Type**	**Modified Asphalt Type**
Tensile Strength, lbs/in (minimum)(1)(3)	ASTM D882 (2)	50	40	20	20
% Elongation at Break, (min) (3)(4)	ASTM D882 (2)	15	10	25	25
		7(7)			
Pliability	ASTM D146 (5)	No cracks	No cracks	No cracks	No cracks
Thickness, mils (minimum)(6)	ASTM D1000	Polyethylene Film Backed—60 Fabric Reinforced Backed—65	70	60	60
Softening Point, F (minimum)	ASTM D36	190	210	190	210

Permeance, perms (maximum)	ASTM E96, Method B	0.1	0.1	0.1	0.1
Puncture Resistance, lbs. (min)	ASTM E154	25	25	40	40

Notes:
(1) Breaking factor in machine direction.
(2) Method A, 1-inch wide strip with 4-inch minimum initial separation and 4-inch gage length at 2 inches per minute. Average 5 samples.
(3) At 73.4F ± 3.6F.
(4) Machine direction.
(5) 180-degree bend over a 1-inch mandrel at -15F.
(6) Total thickness of preformed membrane sheet and polyethylene film or fabric reinforcement.
(7) When fiberglass is used as the reinforcing layer.

680.3 CONSTRUCTION—

(a) Limitation of Operations. Apply waterproofing only if protective covering or asphalt overlay can also be placed within a time that ensures that the membrane will not be damaged by personnel, equipment, exposure to weathering, or from any other cause.

Do not install any part of a waterproofing system in wet, humid, or foggy weather conditions, or if the ambient or concrete surface temperature is below 50F, unless recommended by the manufacturer and authorized in writing by the Representative. Apply the primer and waterproofing membrane only when the concrete surfaces are completely dry.

(b) Surface Preparation. Prepare the surface to be waterproofed to a condition free from holes or projections that might puncture or otherwise damage the membrane. Round (outside) or chamfer (inside) all sharp corners to be covered.

Thoroughly clean all concrete surfaces that are to be waterproofed. Remove any excess laitance, oil, concrete curing compounds, previous membrane treatments, and other foreign materials. Remove all dirt, dust, loose or unsound concrete, and other extraneous material.

Use a scratch coat of asphalt as a leveling course on decks that have been milled and lack a surface that is acceptable to receive a membrane system. Asphalt paving less than one year old does not require a primer or surface conditioner to achieve proper membrane adhesion.

(c) Applying Conditioners and Primers. Thoroughly mix and continuously agitate all primers and conditioners during application according to the manufacturer's instructions. Uniformly apply primer or conditioner to the entire area to be sealed, at the rate stated in the manufacturer's instructions, by squeegee, brush, or roller. Do not apply the primer by spraying. Apply a second coat of primer to any areas of concrete that appear dry. Brush out primer that tends to puddle in low spots to allow complete drying. Cure the primer according to the manufacturer's instructions. Do not let primed areas stand uncovered overnight.

After the primer has dried to a tack free condition, use squeegees or brooms to break any bubbles in the primer. Unless otherwise directed, do not repair the areas where bubbles were broken. If membrane sheets are not placed over primer or conditioner within the time recommended by the manufacturer, recoat the surfaces at no additional cost to the Department.

Before applying the primer or conditioner on a bridge deck, place an oil resistant protective film, held with an adhesive or tape, to any deck areas that will later be covered by expansion dams or headers. Place membrane seal and asphalt concrete across the protective film. If directed, cut the protective film and the preformed sheet at or near the expansion joint.

(d) Adhesive-Backed Preformed Membrane Waterproofing Systems.

1. Installation on Bridge Decks. Before installing any membrane waterproofing systems, drill drain holes, install the drain pipes and galvanized screens as shown on the Standard Drawings.

Apply the preformed membrane sheets, adhesive side down, to the primed or conditioned surfaces either by hand methods or by mechanical applicators. Start placing the membrane sheets at the low side of the deck and work using a shingle overlap toward the high side of the deck so that a shingled effect is achieved in the direction that the water

will drain.

Use either of the two acceptable methods indicated if working from a curb line or barrier railing.

METHOD ONE: As shown on the Standard Drawings and as follows:

Install a 3/4-inch by 3/4-inch cant strip made of wood, metal, plastic, mastic, or other approved joint sealing material at a 90 degree angle between the curb face or barrier railing and the deck. Next, install a 12-inch wide curb strip with the top edge of the strip kept a minimum of 1/2 inch below the wearing surface of the asphalt overlay. Put the 12-inch wide curb strip into positive contact with the curb face, cant strip and bridge deck. Seal the curb strip at the top edge with a two-part urethane liquid membrane or mastic. Overlap the curb strip that extends onto the deck with the next full width membrane sheet by butting the sheet against the curb face at the gutter line. Lay subsequent membrane sheets longitudinally with 3-inch minimum side laps and 6-inch minimum end laps. Install sheets across the deck until the high side curb line is reached. Install a curb strip along the high side curb line as indicated for the low side curb line.

METHOD TWO: Apply a bead of two-part urethane liquid membrane or mastic, as recommended by the manufacturer, between the low side curb face or barrier railing and the deck, extending from the gutter line 2 inches to 3 inches onto the deck. Butt the edge of the membrane firmly against the curb face at the gutter line and embed into the liquid membrane or mastic. Seal the top edge of the membrane at the curb face with a 2-inch bead of liquid membrane or mastic. Lay subsequent membrane sheets longitudinally and side lap with the adjacent sheets not less than 3 inches and end lap by not less than 6 inches. Install sheets across the deck until the high side curb line is reached. Terminate the membrane sheet against the high side curb face. Place a bead of liquid membrane or mastic between the high side curb face and deck. Butt the membrane against the curb face along the gutter line and embed into the bead of liquid membrane or mastic. Seal the top edge of the membrane along the gutter line with a 2-inch bead of liquid membrane or mastic.

After placement, roll the membrane sheets with hand rollers or other apparatus as necessary to develop a firm and uniform bond with the primed or conditioned concrete surfaces. Seal with mastic any laps that were not thoroughly sealed by rolling.

Use procedures that minimize wrinkles and air bubbles. Patch any tears, cuts, or narrow overlaps, using a satisfactory adhesive and by placing sections of membrane sheet over the defective area in a manner that the patch extends at least 6 inches in every direction beyond the edges of the defect. Vent bubbles of 1-inch diameter and larger by piercing with a suitable instrument at a nearly horizontal angle and expel the trapped air. Coat vented bubbles with mastic sealer.

Lay the asphalt overlay the same day as the membrane. If overnight delay is unavoidable, keep the construction traffic off the membrane and make a careful inspection for punctures before placing the asphalt overlay. Provide the asphalt overlay at a mix temperature between 300F and 340F. Rubber tired pavers and trucks may be driven on the membrane provided care is taken to prevent sudden starts and stops. Do not allow trucks to turn their front wheels while standing still.

2. Installation of Other Surfaces. Install as shown on the Standard Drawings, and as specified in Section 680.3(b) and as follows:

On vertical surfaces, place preformed membrane material with each successive horizontal sheet lapped top over bottom to the preceding by a minimum of 3 inches. Lap horizontal splices by a minimum of 6 inches. Seal the exposed edges of membrane sheets after the membrane is placed with a troweled bead of a manufacturer's recommended mastic, or two-part urethane liquid membrane, or with sealing tape.

Provide watertight construction by flashing all projecting pipes, conduits, sleeves, or other facilities passing through the preformed membrane waterproofing with prefabricated or field fabricated boots, fitted coverings, or other approved devices as necessary.

Install protective covers after the application of waterproofing membrane. Apply bonding material, of a type recommended by the waterproofing manufacturer to the surface of the membrane and adjacent concrete surface at a rate, approximately 0.05 gallon per square yard, sufficient to hold the protective covering in position until the backfill is placed. Allow the bonding material to dry until tacky. Place the sheets of protective board or roofing material on the bonding material with edges or ends of the boards either loosely butt-jointed or overlapped.

(e) Nonstandard Applications. For areas not covered in this specification regarding special application techniques of the waterproofing materials, or regarding special application restrictions, follow the manufacturer's recommendations.

(f) Defective Work. Before placing backfill, structural backfill, subbase, or asphalt material, repair or replace damaged membranes or protective coverings according to the manufacturer's recommendations at no additional expense to the Department.

680.4 MEASUREMENT AND PAYMENT—

(a) Membrane Waterproofing Systems Installed on Bridge Deck. Square Yard

(b) Membrane Waterproofing Systems Installed on Other Surfaces. Square Yard

SECTION 681—SLABJACKING

681.1 DESCRIPTION—This work is filling voids beneath existing rigid base courses or pavements and pressure jacking the pavement or base course to grade.

681.2 MATERIALS—Use either cement or high density polyurethane grout to jack the slab.

(a) Cement Grout Stabilization. Section 679.2(a) modified as follows:

6. Mix Design.

One part cement (by volume)
Three parts pozzolan (by volume)
Admixtures—if required and accepted
Water—an amount such that the time of efflux is within 16 seconds to 26 seconds (ASTM C 939). A more fluid mix with an efflux time of 10 seconds to 15 seconds may be used for the initial injection in each hole.
Use a stiffer mix, if the above mix fails to raise the pavement slab.

(b) High Density Polyurethane Grout Stabilization. Section 679.2(c)

681.3 CONSTRUCTION—

(a) General. Section 679.3(a) – except Section 679.3(a)2 and 679.3(a)4

1. Field QC Plan. Section 679.3(a)1 modified as follows:

- Provide existing roadway profiles of the areas indicated on the contract documents, showing existing depressions and proposed grade line to be obtained.

2. Roadway Profile Report. Before acceptance of work, provide to the Representative surveyed profile drawings for the areas that were stabilized. Include the existing profile grade, proposed profile grade and profile grade accomplished by the operation. The Representative may require additional injection based on the results indicated by the profile grade report.

(b) Cement Grout Stabilization.

1. Equipment.

1.a Grout Plant. Section 679.3(b)1.a

1.b Water Tanker. Section 679.3(b)1.b

1.c Drill. Section 679.3(b)1.c

1.d Miscellaneous. Section 679.3(b)1.e

2. Procedure.

2.a Drilling Holes. Section 679.3(b)2.a, except penetration of the stabilized base may not be necessary.

2.b Mixing. Section 679.3(b)2.b

2.c Jacking. Connect an expanding rubber packer to the discharge hose on the grout pump and lower into the holes. Do not extend the discharge end of the packer below the lower surface of the concrete pavement. If jacking continuously reinforced concrete pavement, pump in a pattern and in the amount required to raise the pavement to within 0.02 foot, plus or minus, from a string line grade, or as directed. If jacking jointed slabs of concrete pavement and bridge end slabs, pump in a pattern and in the amount required to raise the pavement to within 0.03 foot, plus or minus, from a string line grade, or as directed.

Continuous pressures to 200 pounds per square inch will be allowed. Pressure to 300 pounds per square inch will be allowed only for short periods as directed, except in the event the pavement is bonded to the subgrade, brief pressure rises to 600 pounds per square inch will be allowed.

2.d Overjacking. Bring pavement, raised above the tolerances listed above, to grade by grinding. If the overjacking is greater than 0.10 foot, satisfactorily remove and replace the pavement in as specified in Section 516 at no additional cost to the Department.

2.e Opening to Traffic. Section 679.3(b)2.d

(c) High Density Polyurethane Grout Stabilization

1. Equipment

1.a Pump Unit. Section 679.3(d)1.a

1.b Drill. Section 679.3(d)1.b

1.c Pavement Plugs. Section 679.3(d)1.c

1.d Miscellaneous. Section 679.3(d)1.e

2. Procedure

2.a Drilling Holes. Section 679.3(d)2.a

2.b Jacking. Inject the high density polyurethane material under the slab. Control the amount of rise by regulating the rate of injection of the material. When the nozzle is removed from the hole, remove any excess material from the area. If jacking continuously reinforced concrete pavement, pump in a pattern and in the amount required to raise the pavement to within 0.02 foot, plus or minus, from a string line grade, or as directed. If jacking jointed slabs of concrete pavement and bridge end slabs, pump in a pattern and in the amount required to raise the pavement to within 0.03 foot, plus or minus, from a string line grade, or as directed.

2.c Overjacking. Section 681.3(b)2.d

2.d Opening to Traffic. Section 679.3(d)2.d

681.4 MEASUREMENT AND PAYMENT—

(a) Cement Grout Stabilization.

1. Holes Drilled. Section 679.4(a)2

2. Grout Material. Section 679.4(a)3

(b) High Density Polyurethane Grout Stabilization.

1. Holes Drilled. Section 679.4(c)2

2. Polyurethane. Section 679.4(c)3

SECTION 686—CONSTRUCTION SURVEYING

686.1 DESCRIPTION—This work is construction surveying for roadways, roadway appurtenances, and structures. This work is to preserve vertical and horizontal controls and stationing throughout the construction phase up to and including final inspection and to provide the Department inspection force with surveying control points to ensure quality of construction activities.

Construction surveying is classified into six types as follows:

(a) Construction Surveying, Type A. Surveying for new construction based on precise horizontal and vertical geometry established from surveys and 1 inch equal to 25 feet scale or 1 inch equal to 50 feet scale topographic mapping referenced to the National Spatial Reference System (NSRS)/ Pennsylvania Coordinate System.

(b) Construction Surveying, Type B. Surveying for reconstruction with the alignment based on, or related to, as-built plan horizontal and vertical geometry or horizontal and vertical geometry produced on the existing roadway with minimal realignment. The planimetric features and cross sections may have been developed from mapping or electronic surveying.

(c) Construction Surveying, Type B Modified. Surveying for reconstruction. The alignment may be based on various alignment data such as:

- As-built plan horizontal geometry
- Horizontal geometry produced on the existing roadway
- Random traverse baseline
- Flat chain alignment along the center of the existing roadway
- A combination of two or more items above

The vertical reference may be based on:

- Plan profile or finish grade only
- Cross sections related to the existing roadway section
- Produced base line grades
- Templates based on the existing roadway cross sections

(d) Construction Surveying, Type C. Surveying for general maintenance construction based on existing roadway alignment with no horizontal or vertical geometry. The drawings or detail sketches are developed using flat chain stations or segments/offsets for location reference. Grade and elevations relate to the existing roadway, unless otherwise indicated.

(e) Construction Surveying, Type D. Surveying for the construction or replacement of a bridge, culvert, arch, or special structure. The horizontal alignment is based on Third Order, Class I surveys, closure 1:10,000. Reference all work points shown on the structure stakeout plan.

(f) Construction Surveying, Type D Modified. Surveying for the minor or major rehabilitation of a bridge, arch, or culvert. Bridge rehabilitation may involve repair or replacement of part of the substructure or all or part of the superstructure. Rehabilitation of an arch or culvert may involve the repair or extension or both of the existing structure.

686.2 MATERIAL—

(a) Tack. Standard Engineer's tack.

(b) Stake. Planed hardwood, 18 inches.

(c) Hub. Planed hardwood, 18 inches.

(d) Nail. Metal, 10-pennyweight.

(e) Guard Stake. Stake, 18 inches, with space to identify the point guarded.

(f) Grade Point. Hub with Engineer's tack; or 60-pennyweight spike.

(g) Reference for Bridge. Hub with Engineer's tack, or iron pin with work center punch.

(h) Paint. Latex. Yellow, orange, or white.

(i) Flat. Planed hardwood, 36 inches.

(j) PK Nail. Hardened masonry nail.

(k) Flagging. Vinyl material.

(l) Benchmark Discs. Furnished by the Department.

(m) Survey Grade Global Navigation Satellite System (GNSS) Inspection Unit(s). Include all necessary components, communication devices, integrated antennae and receiver, controller or data collector or both, cables, software, operating manuals, attachments, and fastening hardware to meet the minimum requirements described below:

- Equipment must be operational and free from damage, unit(s) of the same manufacturer, and compatible with those used by the Contractor. The positional accuracies of the unit(s) must be demonstrated to the Representative by field staking to existing horizontal and vertical control points in the construction area.

- Be not more than 5 years old from the date of manufacturing to the time of delivery to the job site. Provide a dated copy of the manufacturer’s receipt(s) for the purchase, lease, or rental of the units.

- Include the same versions of GNSS planning software, data collection software, navigation software, stakeout software, and post-processing software. Provide the most current version of properly licensed software (including firmware) available from the manufacturer at the time of delivery of the GNSS units.

- Enabled for both standard USB cable and Bluetooth wireless technology for data transfer.

- Ability to import, export, and display point and alignment data in XML format.

- Internal or modular, rechargeable battery system capable of operating a minimum of 8 hours (may include interchangeable batteries), including the battery charger.

- Hard or soft-shell carry case and all appropriate operation manuals.

- Equipped to receive and utilize Real Time Kinematics (RTK) correctional data (current version of Radio Technical Commission for Maritime Services (RTCM) format, Compact Measurement Record (CMR)) through integrated communications with a GNSS base receiver which includes all necessary

communication devices, repeaters and systems to meet the minimum required accuracy and not exceed a 1 second latency at the rover. The RTK data must be available at all locations across the entire contract site during all hours of construction and inspection operations.

- Capability to localize both the horizontal and vertical control to local project monumentation, while utilizing RTK corrections from a reference network.
- Able to display the number of satellites tracked at any one time, and indicate the accuracy quality of each measurement relative to the strength of signals, and the Geometric Dilution of Precision (GDOP).
- Include dual frequency receivers.
- Minimum Required Kinematic Accuracy relative to primary project control: Horizontal: 0.033 feet ± 1.0 parts per million; Vertical: 0.065 feet ± 1.0 parts per million.
- The data controller must allow the user to program and store multiple configurations (also known as user preferences) before the actual field measurements. Configurations must be capable of being stored and recalled in the field
- One fixed height rover rod 2 meters in length, one attachable bipod which is compatible with the rover rod, and one topo shoe for each unit provided.
- A GNSS base unit with fixed height tripod to operate as an RTK base station must include all necessary cables, hardware, and fasteners.
- Must possess FCC license and maintain copy of license with equipment.

(n) Surveying Equipment.

- All surveying instruments and accessories must be Survey Grade
- All automatic and digital levels must be Survey Grade
- Provide proof all instruments are "Cleaned, Calibrated, and Certified" no more than 1 year from the certificate date

686.3 CONSTRUCTION—

(a) General. The Department will provide all pertinent survey information at the preconstruction conference. Do not begin construction surveying until on or after the Notice to Proceed. Upon completion of the survey work, return all survey information to the Representative.

The centerline, base lines, side road alignments, channel alignments, plan base lines, and interchange alignments will be established during project design. If there is an extensive time lapse between the design phase and the beginning of work, the Representative will refurbish the alignment by marking and placing new guard stakes at the pre-established control points.

Verify the alignment, grades, elevations, and dimensions indicated.

Document all design errors. Immediately notify the Representative of all errors, omissions, or discrepancies upon discovery.

Give the Representative written notice at least 3 weeks before removal of any existing benchmark disc(s), . Return the old disc(s) to the Representative.

Place the new benchmark disc(s) as directed, at a point that can be occupied by a survey level rod. Provide a written statement of completion to the Representative. The Representative will establish the new elevation on the new disc(s) and stamp the disc(s) accordingly.

Provide all construction surveying services, material, and equipment needed to stake, mark, reference, and monitor the project. Provide the Representative with all assistance requested for verification of lines, grades, widths, elevations, and measurements or for QA verification. Record geometric or coordinate ties on all lines produced.

All survey activities will be performed according to Publication 122M.

Employ a Professional Land Surveyor or Professional Engineer, registered in the State, qualified in the use of highway and bridge plans; cross sections and specifications; and procedures for establishing line and grade, structure locations, and dimensions, as required. Assume full responsibility for dimensions and elevations taken from control stakes and for the setting of structure location and line and grade stakes. Provide documentation for all types of construction surveying including:

- Name and address of Professional Land Surveyor or Professional Engineer in Responsible Charge
- Copy of current State of Pennsylvania issued license number and a copy of the Professional Seal
- Resume of route surveying experience
- The Professional Land Surveyor or Professional Engineer in Responsible Charge shall be present periodically throughout the construction phases checking the ongoing surveying activities and be available to address all concerns raised by the Department

For Type A, Type B, Type B Modified, Type D, and Type D Modified construction surveying, provide a surveyor or engineer to work under the direction of the registered Professional Land Surveyor or Professional Engineer. This individual shall have as a minimum: highway surveying knowledge, skills, and abilities equivalent to those of the State's Surveyor Technician Supervisor Job Classification or have experience in the prerequisite work elements of the National Institute for Certification in Engineering Technologies (NICET) Transportation Engineering Technician/Highway Surveys Level III Technician.

References to "minor structure work" or "minor roadway work" refer to structure or roadway work representing 20% or less of the total contract price.

For all projects, including those with unsuitable and borrow excavation material, the Department will provide all cross sections needed to compute quantities for payment.

1. Automated Machine Guidance (AMG). Should the Contractor elect to use this technology, submit an AMG QC Plan to Department as specified in Section 106.03(b) at least 1 week before the preconstruction conference. As a minimum, the AMG QC Plan must demonstrate the grading control equipment meets the performance requirements within acceptable tolerances. Also, the AMG QC Plan must provide a methodology the Representative can utilize to make checks for location, grade, flowline, and position according to the contract and as specified in Section 686.3(b) 1.

The Representative may perform spot checks of the machine control grading results, surveying calculations, records, field procedures, and actual staking. Provide base stations to be set up to facilitate inspection as directed. If the Representative determines the work is not being performed in a manner to ensure accurate results, the Representative may order such work to be redone, to the requirements of the contract documents, at no additional cost to the Department. Checks performed by the Representative do not relieve the Contractor of responsibility for the accuracy of work performed.

2. Department Provided Information and Electronic Files. The Representative will set the initial horizontal and vertical control points in the field for the project as indicated in the contract documents.

Computer Aided Design Drafting (CADD) files will include the following as applicable:

- files representing the design surfaces
- files containing all horizontal and vertical alignment information
- documentation file describing all the profiles
- primary design file
- cross section files
- all reference files

No guarantee is made the data systems used by the Department will be directly compatible with the systems the Contractor uses. The Department will develop and make available electronic data to the Contractor for review as part of the contract bid documents as specified in Section 102.06(e). Ensure the electronic data will function in the Contractor's machine control grading system before the bid.

3. Survey Control Report. Develop and submit a Contractor Survey Control Report for all contracts, which includes a contract pay item for construction surveying and if AMG is utilized by the Contractor. Survey control includes all statewide or local, primary and secondary, and horizontal and vertical controls used for the geospatial positioning of work items. Upon completion of initial survey reconnaissance control verification and 5 working days before the scheduled beginning of primary field operations, submit the Contractor Survey Control Report FormS-686 AMG-1 signed and sealed by a Professional Land Surveyor registered in the State.

Include the following required control information (tabular form is acceptable) as part of the Contractor Survey Control Report Form S-686-AMG-1:

- All contract control shown in the contract documents or in the Contractor Survey Control Report
- Submit all contract control points and benchmarks:
  - Indicate which control points and benchmarks were recovered in the field and their condition.
  - Contract coordinate or elevation
  - Field determined coordinate or elevation
  - Contractor adjusted coordinate or elevation, if necessary
  - Control points and benchmarks intended to be used for construction purposes
  - Site Calibration method utilized and a report of the following:
    - A scaled CADD drawing, sketch, or diagram showing project location and control points used to determine the site calibration. The project location must be fully contained in the site calibration control points.
    - A detailed software report of the site calibration
    - Report all survey control points within tolerance used in the site calibration. Horizontal allowable error ± 0.04 feet, Vertical allowable error ± 0.08 feet
    - Report checks of all recovered original survey control points not used in the site calibration
- Adjustment method used to balance or adjust the control (e.g. Compass Rule for Baseline, Calibration Report for GNSS, etc.). Attach a copy of the localization or site calibration necessary for Survey Grade GNSS Inspection and Automated Machine Guidance along with all other miscellaneous adjustments.
- Control Network diagram (drawn to legible scale) with roadways indicated
- Indicate the Pennsylvania Coordinate System Zone utilized, Horizontal Datum, Vertical Datum, Geoid, and Combined factor used to account for the ellipsoidal reduction factor and the grid scale factor
- Indicate if additional (new) control is anticipated and where they would be set
- If a GNSS base station(s) is used on a project either for inspection or stakeout, provide the determined coordinate and elevation value of the station and the datum differential from existing control provided by the Department

Do not begin primary field operations until the Contractor Survey Control Report is accepted by the Representative. Upon acceptance of the Contractor Survey Control Report, submit a signed and sealed copy to the Representative through the PennDOT Project Collaboration Center (PPCC).

Provide all revisions or additions to contract control for stakeout or layout of proposed work items in writing to the Representative before beginning that revised portion of stakeout or layout work.

Notify the District Chief of Surveys of all project control meetings.

(b) Construction Surveying, Type A. Establish the centerline, baselines, side road alignments, channel alignments, plan base lines, and interchange alignments on the ground at major control points. The maximum interval between referenced major control points may not exceed 1,000 feet. Reference all major control points and establish vertical benchmarks at appropriate locations.

Provide construction stakeout of the project using the horizontal and vertical control established by the Department.

Provide relocation and preservation of all horizontal references of major control points and vertical benchmarks established by the Department.

Provide the Representative with a comprehensive stakeout schedule for development of the project listing areas or grading sections by plan designation or station location.

Check the cross section (original ground and template intersection) on each side of the grade point(s) at each station for accuracy and acceptance. In case of cross sectional or template discrepancy, forward documentation to the Representative before continuing earth disturbance.

If the finished grade is 5 feet or more vertically above or below existing grade, place an offset grade point with a guard stake at right angles to the centerline or base line controlling the grade point(s) or at 90 degrees from the tangent to the curve at each 100-foot station. Offset grade points from the intersection of the cross section template and original ground. Mark guard stakes according to the rounding, station, offset right or left of centerline/base line, and offset from the intersection of the template and original ground. If finished grade is constructed using grading equipment controlled by AMG Systems, the longitudinal interval for setting finished grade points may be increased to not more than 500 feet for tangent sections only, provided the requirements as specified in Section 686.3(b)1 are met.

Establish a finished grade control line offset parallel to the centerline or base line, by setting grade points at 50-foot intervals. Establish grade points at 25-foot intervals for arcs/curves equal to or greater than 16 degrees. Provide control points and conventional grade stakes at critical points such as, but not limited to Point of Curve (PC)'s, Point of Tangent (PT)'s, superelevation points, and other critical points required for the construction of drainage and roadway structures.

Furnish the Representative with grade sheets for all grade points and finish grade points. Show the grade point elevation, finish grade elevation, and offset right or left of the grade point or finish grade point from the centerline or base line on Form D-413.

Stake the plan alignments and grade points for temporary construction easements and temporary roadways or crossovers.

Stake legal right-of-way lines and temporary easement lines, if required.

Provide the Representative with all coordinate networks used in staking the project, including coordinate geometry, horizontal geometry, and referenced network points.

1. Automated Machine Guidance (AMG) Include with the AMG QC Plan the equipment type, control software manufacturer and version, grading plans, quality processes, tolerance requirements, and the proposed location of the local GNSS base station used for broadcasting differential correction data to rover units to the Department as specified in Section 106.03(b).

Provide the Representative with a survey grade GNSS inspection unit(s) for use during the duration of the contract. Maintain the unit(s) until 30 days after physical work has been satisfactorily completed. After the 30 days, unit(s) will be returned. Maintain unit(s) in good working condition and provide replacement due to breakdown, damage, or theft within 3 working days. Ensure all GPS units are fully operational.

Review and apply data the Department has provided to perform AMG machine control grading.

Bear all costs, including but not limited to the cost of actual reconstruction of work that may be incurred due to errors in application of AMG machine control grading techniques. Correction of grade elevation errors and associated quantity adjustments resulting from the Contractor's activities are at no additional cost to the Department.

Convert the Department's electronic data into a format compatible with the machine control system. Manipulation of the Department's electronic data is undertaken at the Contractor's own risk. Check and recalibrate, if necessary, the GNSS machine control system at the beginning of each work day.

Download data to the inspection units for use by the Representative and include horizontal and vertical alignments, project control network points, and 3D models.

Utilize the Department provided survey control network as the spatial reference datum network from which RTK base corrections are derived. Select communication technique(s) and devices to be used to ensure consistent and reliable delivery of RTK correctional data from GNSS units.

Meet the same accuracy requirements as conventional grading construction. This may require supplemental technologies to meet final grade accuracy if using AMG.

Establish secondary control points at appropriate intervals and at locations along the length of the project and outside the project limits and where work is performed beyond the project limits as required at intervals not to exceed 1000 feet. Determine the horizontal position of these points using static or RTK GPS sessions or by traverse connection from the original baseline control points. Establish the elevation of these control points using differential leveling from the project benchmarks forming closed loops. Be responsible for all errors. Correct all deficiencies to the satisfaction of the Representative at no additional cost to the Department.

Preserve all reference points and monuments established by the Representative within the project limits. Reestablish reference points that have not been preserved at no additional cost to the Department. Provide a revised survey control report to the Department for all reestablished reference points.

Provide controls points and conventional grade stakes at critical points such as, but not limited to, PC's, PT's, superelevation points, and other critical points required for the construction of drainage and roadway structures.

Provide electronic construction data for the machine-controlled data surface model compatible with MicroStation.

Mount the base station semi-permanently in a stable and secure location where it will not be disturbed by construction activities or be easily damaged by vandalism. Select a location where the base station will be capable of providing radio signal coverage over the entire contract area. If the base station cannot broadcast a signal covering the entire site, provide adequate repeater radios or other communications. Do not relocate a GNSS unit installed as a base station for inspection operations without approval.

At a minimum, set grade points at right angles to the centerline on tangents and radial offsets on curves at 500 foot intervals the entire length of mainline. In addition, set a minimum of two grade points on each ramp, on each intersecting roadway, and on projects less than 1,000 feet in length. Tabulate and provide offsets and elevations of all grade points using Form D-413 to the Representative. Accompany rough grade and fine grade stakes with a guard stake for easy identification.

Provide other points as directed for verification of accuracy by the Department. Within 100 feet horizontally or longitudinally or both from all tie-ins to existing pavement or structures, set grade points at 25-foot intervals as specified in Section 686.3(b).

Provide the same project specific control network to the Department as that used during construction. The Department will review the network and monitor the project.

Test the finished surface at all hinge points or centerline or both, edge of lane, and edge of shoulders on the cross section at all critical locations and as established in the AMG QC Plan. All locations are required to be within ± 1/2 inch.

Upon successful quality control testing, notify the Representative the finished surface is ready for acceptance. At a minimum, the Representative will witness grade testing of the finished surface, at all hinge points or centerline or both, edge of lane, and edge of shoulders on the cross section at random locations every 500 feet according to PTM No. 1 for acceptance. Test results will be documented on Form S-686-AMG-2.

If more than 10% of all acceptance tests are determined to exceed ± 1/2 inch in any phase of the project, the Representative may require setting grade points at 50-foot intervals in tangent and at 25-foot intervals for arcs/curves equal to or greater than 16 degrees as specified in Section 686.3(b).

1.a Survey Grade GNSS Inspection Unit Training. For all survey grade GNSS inspection units, provide Department staff or their representatives or both with a minimum of two separate 8 hour minimum training sessions on the use and operation of the unit(s) during the first year of the contract. Provide the first session within 1 week of delivery of the unit(s) to the site. Provide the second session upon the request of the Department. Provide one additional 8 hour minimum training session during each additional contract year the unit(s) are in service.

Submit qualifications of the training facilitator and proposed training location to the Representative for approval. All training must be from a manufacturer-verified trainer who is approved.

(c) Construction Surveying, Type B. Provide this type of surveying for roadway construction with minor structure work. Construction surveying required for the minor structure work, if any, is incidental. Perform incidental surveying as specified for the applicable type.

Establish the centerline, baselines, side road alignments, and channel alignments on the ground at major control points. The maximum interval between referenced major control points may not exceed 1,000 feet. Reference all major control points and establish vertical benchmarks at appropriate locations.

Provide construction stakeout of the project, using the horizontal and vertical control established by the Department.

Provide relocation and preservation of all horizontal references of major control points and vertical benchmarks established by the Department.

Establish all base lines, grade lines, parallel lines, traverse lines, and reference lines deemed necessary by the Engineer to control construction operations.

Stake the plan alignment and grade for temporary roadways and crossovers.

Stake legal right-of-way lines and temporary easement lines as required to construct the project. Stake the lines based on plan data.

Provide the Representative with all coordinate networks used in staking the project, including coordinate geometry, horizontal geometry, and reference network points.

(d) Construction Surveying, Type B Modified. Provide this type of surveying for roadway construction with minor structure work. Construction surveying required for the minor structure work, if any, is incidental. Perform incidental surveying as specified for the applicable type.

Establish the centerline and baselines on the ground at major control points. Establish vertical benchmarks at appropriate locations. Establish legal right-of-way lines or temporary easement lines, as required, at project locations controlled by flat chain stations. If curved alignments or complex configurations are beyond the scope of the flat chain survey, the Department will stake the right of way.

Provide construction stakeout of the project, using the alignment established by the Department.

Provide the relocation and preservation of all major control point or vertical benchmark.

Place and maintain all grade points, guard stakes, nails, hubs, or paint marks necessary to control construction of the project.

Stake plan alignment and grade for temporary roadways and crossovers.

Stake legal right-of-way lines or temporary easement lines if controlled by horizontal geometry. Stake the lines based on plan data.

(e) Construction Surveying, Type C. Establish the limits of work by marking the beginning and ending station, or the beginning and ending segments and offsets. Establish the limits of work only once during the life of the Contract.

For Group Contracts, establish the limits of work using State Route and segment markers.

Place additional stakes or marks as necessary to control construction operations.

(f) Construction Surveying, Type D. Provide this type of surveying for structure construction with minor roadway work. Construction required for the minor roadway work, if any, is incidental. Perform incidental surveying as specified for the applicable type.

Establish all centerline, base lines, and structure control points on the ground.

Provide the construction stakeout of bridges, arches, culverts, and other special structures, as required to facilitate and control the work, using the horizontal and vertical control established by the Department.

Review the structure stakeout plan sheet designating work points to be referenced with the Representative before performing the field stakeout.

If beam seat layout is required, submit a report verifying staked points. Include the contract coordinates and elevations, field staked coordinates and elevations, and computed residuals.

Obtain approval for all variances and exceptions to the field stakeout plan before performing the work.

Reference all designated work points. Reference each work point on a direct line through all adjacent work point(s). Establish three reference points for the work point at each corner of abutments and at each end of wingwalls. Establish three reference points for work points on proprietary or other walls. For land piers, establish three reference points, on each side of the substructure, for work points on the centerline of bearing. The distance between a work point and its first reference point is to be less than 100 feet, with the exception of centerline pier reference.

Establish a Third Order, Class I traverse network, at each structure site, coordinating abutment and pier reference. Show the precision ratio and comparisons of longitudinal distances.

Before structure construction activities, furnish the Representative with a field stakeout sketch (a sketch will not be required for single span bridge, culverts, and arches), based on the structure plan stakeout, showing only centerline/base line stations, span lengths, reference angles, and reference lengths. Show two described vertical benchmarks.

Before structure construction activities, furnish the Representative with a sketch showing a triangulation network or traverse network at each structure site (a sketch will not be required for single span bridge, culverts, and arches). For water-bound piers, include base line control showing length of sides “a” and “b” and interior angles A and B.

Include the date, structure description, Contractor's name, and person responsible for the stakeout, on field stakeout sketches, signed and sealed by a Professional Land Surveyor or Professional Engineer registered in Pennsylvania.

(g) Construction Surveying, Type D Modified. Provide this type of surveying for structure construction/rehabilitation with minor roadway work. Construction surveying required for the minor roadway work, if any, is incidental. Perform incidental surveying as specified for the applicable type.

Establish all centerline, base lines, and structure control points on the ground.

Provide the construction stakeout of the structure rehabilitation, using the horizontal and vertical control established by the Department.

Review the structure stakeout plan sheet designating the work points to be referenced with the Representative, before performing the field stakeout.

Reference all designated work points. Reference each work point on a direct line through all adjacent work point(s). Establish three reference points for the work point at each corner of abutments and at each end of wingwalls. For land piers, establish three reference points, on each side of the substructure, for work points on the centerline of bearing or as indicated on the structure plan stakeout. The distance between a work point and its first reference point is to be less than 100 feet, with the exception of pier reference. For water-bound piers, use base line reference.

Before structure construction activities, furnish the Representative with a field stakeout sketch, based on the structure plan stakeout, showing reference points, lengths, vertical control, and pertinent plan data.

Before structure construction activities, furnish the Representative with a separate sketch showing a triangulation network or traverse network, or methodology for a mathematical check of the survey produced, signed and sealed by a Professional Land Surveyor or Professional Engineer registered in Pennsylvania.

(h) Highway Joint Locations. As specified in Section 515.3, locate all transverse joint locations and report them to the Representative. To utilize GPS in locating joints, perform a site calibration and complete Form S-686AMG-1. If no contract control exists, establish a horizontal control network referenced to the Pennsylvania Coordinate System. Submit all documentation, reports, and field notes to the Representative. If utilizing a total station to locate joints, a closed loop traverse is required with a precision closure of 1: 15,000.

(i) Right of Way Monumentation. If called for either by a recorded right-of-way plan or signed and sealed construction plan, right-of-way monuments are to consist of No. 5 rebar, 24-inches in length, with either aluminum or plastic caps inscribed with "PennDOT R/W". For monuments in asphalt surfaces, use a railroad spike, or any heavy duty, hardened, steel survey nail no less than 3 1/2-inches in length. For monuments in concrete or bedrock, set an engraved or drilled hole with a cross-cut, well-dressed, and unmistakable surveyed mark.

Perform all work under the supervision of a Professional Land Surveyor, registered in the Commonwealth of Pennsylvania. After monuments are set, submit a survey report signed and sealed by a licensed Professional Land Surveyor, registered in the Commonwealth of Pennsylvania, to the District Chief of Surveys for review and approval. In the survey report, include a scaled CADD drawing, sketch, or diagram of all set monuments, noting the materials used, date set, the horizontal coordinates for each monument, and the centerline stations and offsets. Use the same coordinate base and datum on the CADD drawing as used on the said right-of-way or construction plan. Use positional accuracy according to Publication 122M. Include photographs in the survey report of all set monuments. Index and label the photographs. Publication 122M explains the overall objective for the setting of the right-of-way monuments. If the monuments cannot be set as indicated or according to Publication 122M, consult with the District Chief of Surveys before proceeding.

686.4 MEASUREMENT AND PAYMENT—

(a) Construction Surveying. Lump Sum

For the type indicated.

The Department will pay for this item as specified in Section 110.05, in four payments, according to the following schedule:

- When work representing 10% of the total contract price is completed, excluding the bid price for this item, the Department will pay 25% of the amount bid for this item.
- When work representing 30% of the total contract price is completed, excluding the bid price for this item, the Department will pay 25% of the amount bid for this item.
- When work representing 90% of the total contract price is completed, excluding the bid price for this item, the Department will pay 20% of the amount bid for this item.
- Upon completion of the project, the Department will pay the remaining 30% of the amount bid for this item.

Required system checks, training, maintenance, calibration, electronic file data preparation, and one survey-grade GNSS inspection unit are incidental to this item

(b) Unidentified Work. The Department will pay for unidentified work as follows:

1. Negotiated Price. At an agreed upon price. The Department and the Contractor will agree upon this price before performing the work.

2. Force Account Basis. Section 110.03(d)

(c) Additional Survey Grade GNSS Inspection Units as requested by the Department. Each

(d) Right-of-Way Monuments. Each

SECTION 688—MICROCOMPUTER SYSTEM

688.1 DESCRIPTION—This work is furnishing, setting up, and maintaining a microcomputer of the type specified, and a battery backup system if indicated, for the exclusive use of Department personnel.

688.2 MATERIAL—

(a) General. Provide all material necessary for setup and operation of a microcomputer system, including all cords and cabling. Upon delivery to the field office, ensure that all hardware and software are compatible and operational.

(b) Microcomputer. The Type A microcomputer is a desktop or tower model. The Type C microcomputer is a laptop computer, with an attached 15.6-inch widescreen WXGA+LCD Panel screen having a minimum native resolution of 1366 x 768. The minimum hardware specifications for each type microcomputer systems are as indicated in Table A and as follows:

1. Monitor. For both the Type A and Type C microcomputer systems, provide an external 22-inch minimum, widescreen LCD monitor with WXGA video support having at a minimum native resolution of 1920 x 1080, with 1000: 1 Contrast Ratio with VGA, DVI, and HDMI connectors.

2. Surge Protector. Provide a surge protector for each computer (Type A and/or Type C), with a minimum of six AC outlets and one telephone outlet, with a 6 foot minimum length cord, having a line voltage regulator/conditioner that protects against chronic high voltage, voltage spikes, and radio frequency interference.

3. Input Devices. Provide a Windows compatible, 104 key, full size Multimedia function keyboard, USB with a 6 foot minimum length cord. Provide a Microsoft compatible 3 button optical scrolling mouse, USB with a 6 foot minimum length cord. Provide both devices for Type A and/or Type C computers (one each).

4. Docking Station. Docking Station. Provide a compatible docking station for all Type C microcomputers with a minimum of 4 USB 2 Ports, 2 USB 3 Ports, along with DVI, HDMI, Ethernet connectivity, and audio in/out ports.

5. Miscellaneous.

- Provide two Lithium-Ion batteries, with 3 hours minimum per battery, AC adapter, automobile adapter, with a Type C microcomputer.
- Provide a carrying case large enough to carry the Type C microcomputer, spare battery pack, external pointing device (mouse), AC adapter, automobile adapter.

(c) Software. All system software must be installed on the C: drive partition.

- Provide MS Windows 7 Professional 64 bit operating system, with Service Pack 1, to include all Windows and Microsoft updates. Set up this operating system as a new installation, not as an upgrade from a previously installed, older version of Windows.
- Provide MS Office – 2013 Professional 32-Bit, with all Microsoft Office updates.
- Provide Acrobat Reader 11 (XI) or newer with the most current version.
- Provide WinZip version 15.5 (or newer).
- Provide sun Microsystems Java with most current version with all updates.

- Provide Adobe Flash Player with most current version with all updates.
- Provide antivirus software that meets the Department's current standard, with updates for the duration of the project.
- Provide the Inspector-In-Charge with all OEM software CD's/licenses, manuals, and documentation, to be maintained in the Department's Project Field Office for the duration of the project.
- Provide the Internet Explorer browser that meets the Department's current standard for ECMS.

(d) Battery Backup System. For the Type A microcomputer, provide a UPS (uninterrupted power supply) battery backup system meeting the following minimum requirements:

- Load Wattage (minimum) — 500
- Full Load maximum time — 9 minutes
- Number AC Outlets Regulated — 4
- Number AC Outlets w/battery backup — 2
- Number AC Outlets with noise isolation and spike protection — 4
- Indicator Lights — Line and Battery Power
- Circuit Protection
  - Line — Breaker
  - Battery (internal) — Fuse
- Alarm (audible tone during battery operation with defeat switch)

TABLE A
Minimum Specifications

System Type	Type A	Type C
Central Processing Unit (Min)	Intel Core i7	Inter Core i7
CPU Speed (Min)	3.4 GHz, Intel vPro	3.00 GHz Intel vPro
Random Accessible Memory (RAM) (Min)	8GB RAM	8 GB RAM
Internal SATA Hard Drive (Min)	500GB, SATA 6.0Gb/s	250 GB, SATA 6.0Gb/s
Internal DVD Burner (Min)	24X DVDRW, SATA	8X CD/DVD Burner
USB 3 Button Optical Mouse	Yes	Yes
Internal Pointing Device (Touchpad)	—	Yes
USB 2.0 Ports (Min)	6 (2 front, 4 rear)	4
External USB 2.0 4-Port Hub (Min)	—	Yes
Network Port	Yes	Yes
Type II PCMCIA Slots	—	1

(e) Maintenance Agreement. Furnish a maintenance agreement, which provides for on site repair service within 24 hours of notification. If the system can not be repaired, provide a replacement within 48 hours of notification.

(f) Compatibility. All references to compatibility require that compatibility be demonstrated in the Inspector's Field Office.

688.3 CONSTRUCTION—Furnish microcomputer(s) for Department use no later than 5 working days after the Notice to Proceed date or 5 days before the scheduled start of work. Provide the type of microcomputer specified and install in the Inspector's Field Office. Maintain the system from installation until 30 days after physical work including work on punch list items identified during the final inspection, has been satisfactorily completed unless released earlier

by the Representative. The Representative may direct that the system be maintained for more than 30 days after physical work has been satisfactorily completed, as necessary, to allow time for Department personnel to process outstanding project records, due to the Contractor's failure to submit, complete, and/or correct required certificates or documents, as established during the final inspection. Remove and properly dispose of all dispensable items for the life of the project and upon release by the Representative.

688.4 MEASUREMENT AND PAYMENT—Lump Sum

For the type indicated.

Paid in three payments, in accordance with the following schedule:

- Whenever all the requirements specified of Section 688.2(a) have been met and compatibility satisfactorily demonstrated to the Representative, 80% of the amount bid for this item will be paid.
- Whenever work is performed equal to 40% of the original contract amount, excluding the bid price for this item, 10% of the amount bid for this item will be paid.
- Whenever work is performed equal to 80% of the original contract amount, excluding the bid price for this item, the remaining 10% of the amount bid for this item will be paid.

(a) Price Adjustments. Adjustments to the lump sum prices for the indicated type microcomputer system, as applicable, will be made as follows:

1. Time Extensions and Reductions. In the event the time for completion of all work on the project is extended or reduced, as specified in Section 108.06, to be more than A percent or less than B percent of the original contract time, where A and B are as specified in Table B, an appropriate adjustment (payment to the Contractor or rebate to the Department) will be made to the lump sum prices bid for the indicated microcomputer systems, as applicable, for that portion of adjusted contract time in excess of A percent of (payment) or less than B percent of (rebate) the original contract time, at the following daily rate:

$$\text{Daily Price Adjustment Rate} = \frac{75\% \times \text{Contract Lump Sum Price}}{\text{Original Contract Time in Days}}$$

TABLE B
Contract Time

Original Contract Time in Days		**Percent**	
From More Than	**To and Including**	**A**	**B**
0	100	130	70
100	300	120	80
300	500	115	85
500	1000	112	88
1000		110	90

2. Systems Maintained More than 30 Days After Physical Work Completion. In the event the Representative directs that the microcomputer systems be maintained for more than 30 days after the date of physical work completion, as specified in Section 688.3, an appropriate adjustment (payment to the Contractor) will be made to the lump sum prices bid for the indicated microcomputer systems, as applicable, for the days in excess of 30 until released by the Representative, at the Daily Price Adjustment Rate specified in Section 688.4(a)1.

No adjustment will be made if the Representative directs that the microcomputer systems be maintained for more than 30 days after the date of physical work completion due to the Contractor's failure to submit, complete, and/or correct required certificates or documents, as established during the final inspection.

SECTION 689—CONSTRUCTION SCHEDULING

689.1 DESCRIPTION—This work is the preparation, maintenance, and revision of the construction project schedule using a Narrative, Critical Path Method (CPM), or Resource Loaded CPM Schedule, as indicated, to monitor progress of project operations. For Design/Build or Partial Design/Build projects, include in the construction schedule design activities associated with the Design/Build elements of the project as well as the review and approval durations as indicated in the contract provisions.

Definitions are as follows:

- Controlling Activities. Those activities that control the total length of the project time by forming a chain that makes up the largest sum of activity durations. In the CPM Schedule these activities are also identified as Critical Path Activities.

- Float. The length of time that the start or finish of an activity can be delayed without affecting the Required Completion Date of the project. Float is a shared commodity.

- Redundant Relationship. A relationship representing a link between activities that is also represented in a parallel path or relationship. Redundant relationships can be removed without impacting the logic or calculations of the schedule and may add unnecessary complexity to the schedule and hinder review and analysis.

- Resource. The labor and equipment required by an activity and needed to perform the work of the project.

689.2 MATERIAL—The Department's software standard for scheduling and project management is Asta Powerproject produced by Elecosoft.

The Contractor may use a commercial scheduling software package to produce the schedule and reports according to the requirements of this specification. The Contractor may elect to submit the Narrative Schedule or related reports to the Representative in electronic format. In all cases, the CPM Schedule must be developed in Asta Powerproject (.pp) or a compatible format (.mpp, .xml, .xer, .p3b, .dir, and .stx). Verify the compatibility of the other software packages with the Department's version of Asta Powerproject. The CPM Schedule must be submitted to the Representative in an Asta Powerproject (.pp) electronic format. If the CPM Schedule is developed in an Asta Powerproject compatible format, convert the native CPM Schedule format to an Asta Powerproject (.pp) file format using the PennDOT Construction template before submitting to the Representative. Ensure the converted file is a one to one comparison between the native format and the Asta Powerproject file before submittal.

Upload and submit the Asta Powerproject (.pp) schedule through the PennDOT Project Collaboration Center (PPCC). Uploading the schedule into PPCC will allow all authorized parties to view the current baseline schedule. The Department will then review the submitted schedule and will either accept, Accept as Noted, Revise and Resubmit, or reject the schedule. Once the schedule is accepted by the Department, the Asta Powerproject (.pp) file will be the governing schedule on record. After the schedule is accepted, the Department will download the accepted schedule from PPCC and upload it to the Asta Web Portal. Any subsequent changes to the baseline schedule through the submission of any updates, revisions or recovery schedules will also be uploaded to the project within PPCC in the same way in order to maintain a record of schedule versions.

689.3 CONSTRUCTION—As specified in Section 108.03(b), Construction Project Scheduling, and as follows:

(a) Narrative Schedule. Base the initial Narrative Schedule on the anticipated Notice to Proceed Date in the proposal. Submit the Narrative Schedule within 15 calendar days after the actual Notice to Proceed Date. The District Executive may withhold current estimate payments until the Narrative Schedule is submitted and accepted.

If the actual Notice to Proceed is issued after the anticipated Notice to Proceed Date in the proposal, submit a Narrative Schedule based on the actual Notice to Proceed Date within 15 calendar days after the acceptance of the Narrative Schedule based on the anticipated Notice to Proceed Date. The Narrative Schedule based on the actual Notice to Proceed Date will not be considered without prior acceptance of the Narrative Schedule based on the anticipated Notice to Proceed Date in the proposal.

The Representative will review and respond to the detailed Narrative Schedule and supporting documentation

within 14 calendar days of receipt.

Include, as a minimum, the following in the initial Narrative Schedule and in all Schedule revisions:

- Activity description;
- Activity duration, in working days; and
- Start and finish calendar dates of activities.

In addition, submit a workday calendar showing work days and non-work days, number of shifts per day, and number of hours per shift.

Provide enough activities to demonstrate the necessary interdependencies. Use the above information to complete a narrative description of the construction schedule.

If the Narrative Schedule is not received within 15 calendar days after the actual Notice to Proceed Date, the Contractor will be required to attend a scheduling workshop in order to prepare an acceptable Narrative Schedule. The District Executive may elect not to release current estimate payments until the Narrative Schedule is submitted and accepted.

(b) CPM Schedule. As specified in Section 108.03(b), Construction Project Scheduling and as follows:

1. 60 Calendar Day Work Plan. At the Preconstruction Conference, submit a .pdf of the 60 Calendar Day Work Plan from Asta Powerproject that includes a breakdown of activities. Provide a generalized project schedule for the balance of the work, to meet the Required Completion Date and specified Milestone Date(s).

In lieu of the 60 Calendar Day Work Plan, the Contractor may submit the CPM Schedule specified in Section 689.3(b)3 within 30 calendar days after the contract execution. Maintain and submit, on a bi-weekly basis, a 60 Calendar Day Work Plan until the CPM Schedule is accepted.

2. Bid Preparation Schedule. Submit the schedule used to prepare the contract bid within 30 calendar days after contract execution. At a minimum, this schedule should include the scheduling concepts and logic that were used in sequencing work activities to prepare the contract bid, a workday calendar that identifies work days and non-work days, the number of shifts per day, and the number of hours per shift.

In lieu of the Bid Preparation Schedule, the Contractor may submit the CPM Schedule specified in Section 689.3(b)3 within 30 calendar days after the Notice to Proceed. The District Executive, after consultation with the Contractor, may withhold current estimate payments until the Bid Preparation Schedule or CPM Schedule is submitted and accepted.

3. CPM Schedule. Base the initial CPM Schedule on the anticipated Notice to Proceed Date in the proposal. Submit the CPM Schedule through PPCC in an Asta Powerproject (.pp) file format using the PennDOT Construction template as defined in Publication 615 within 30 calendar days after the actual Notice to Proceed Date. Also, submit the schedule as a portable document format (PDF) through PPCC. The PDF must be generated from Asta Powerproject as an 11-inch by 17-inch page size, with no more than 25 activities per sheet. Ensure the PDF text is large enough to read.

If the actual Notice to Proceed is issued after the anticipated Notice to Proceed Date in the proposal, submit a CPM Schedule based on the actual Notice to Proceed Date within 15 calendar days after acceptance of the CPM Schedule based on the anticipated Notice to Proceed Date. The CPM Schedule based on the actual Notice to Proceed Date will not be considered without prior acceptance of the CPM Schedule based on the anticipated Notice to Proceed Date in the proposal.

Include, at a minimum, the following information for each activity in the initial baseline schedule submission and all subsequent submissions:

- Activity ID
- Activity description
- Activity duration, in working days
- Early start date
- Early finish date
- Late start date
- Late finish date
- Total float

- Predecessor
- Successor
- Calendar
- Resource Allocation (if applicable)
- Resource Effort (if applicable)

The Representative will review and respond to the detailed CPM Schedule within 14 calendar days of receipt.

If the Department does not accept the schedule, revise the schedule and re-submit within 10 days of receiving the Department's comments. If the CPM Schedule is not received within 30 calendar days of the actual Notice to Proceed Date, the Contractor will be required to attend a scheduling workshop in order to prepare an acceptable CPM Schedule. The District Executive, after consultation with the Contractor may withhold current estimate payments until the CPM Schedule is submitted and accepted.

A standardized list of activities must be utilized in all CPM and CPM Resource Loaded schedules. These activities must be used verbatim if they are applicable to the project. The description of these activities cannot be modified. The following is a list of standardized activities that must be included where applicable:

- Project Award
- Notice to Proceed (Anticipated, unless issued after the Anticipated then use Actual)
- Physical Work Start
- Implement Detour
- Remove Detour
- Open to Traffic
- Physical Work Complete
- Project Completion

Use a unique activity ID to describe each activity throughout the duration of the project. Limit activities with duration times in excess of 15 working days to a minimum. Provide enough activities to demonstrate the necessary interdependencies. Limit the fineness of detail, where possible, to a minimum, 5-day activity duration. All activities, with the exception of the single start activity and the single finish activity must have at least one predecessor and one successor. The number of redundant relationships is not to exceed 5% of the total number of relationships in the schedule.

Submit the CPM Schedule with the following format:

- Make all relationships finish to start relationships.
- Identify a single start activity and a single finish activity for the entire schedule.
- Imposed start date set to anticipated Notice to Proceed (or actual if applicable.)
- Incorporate lag/lead times as a separate activity.
- Incorporate the standardized activities verbatim (if applicable to the project.)
- 'Start on' or 'Start on or After' Constraint on Notice to Proceed.
- 'Finish on' or 'Finish on or Before' Constraint on Project Completion.
- Interim Milestone included in the contract should use soft constraints (i.e. 'Start on or After' or 'Finish on or Before') and utilize a 7 day no holiday calendar.

(c) CPM Schedule with Updates. As specified in Section 689.3(b) and as follows.

Submit schedule updates at the frequency specified in Section 108.03(b) using the accepted baseline schedule as the basis for the update. Ensure updates are prepared in the proper format and include the content as described. Failure to submit acceptable schedule updates will impact contractor evaluations.

Activity IDs or descriptions must remain constant throughout the project. Major changes to activities will be addressed by eliminating the existing activity and substituting a new activity with a unique ID and Description.

Progress the schedule through the end of the established progress period with actual start and finish dates and remaining duration (or overall percent complete). Perform a 'reschedule' of the Asta Powerproject (.pp) file with the options set as follows:

- straighten the progress period to 'Progress Entry Period'
- set progress entry period to Default (progress date agreed upon with District)

Include with updates:

- Electronic schedule in Asta Powerproject (.pp) file format for review.
- A narrative report including:
  - The reason for the update.
  - Progressed Activities
- Logic changes (including relationship type and imposed date(s))
- Calendar changes (including activity association and/or work day(s))
- Duration changes
- Critical Path changes
- Any schedule concerns.
- A PDF of the updated schedule showing the following information (In the PennDOT Construction Template the Construction Update view includes all of these columns):
  - Unique Task ID
  - Activity description
  - Activity duration, in working days
  - Original Baseline Duration
  - Early start date
  - Early finish date
  - Late start date
  - Late finish date
  - Total float
  - Predecessor (using unique task ID)
  - Successor (using unique task ID)
  - Actual Start date
  - Actual Finish date
  - Remaining Duration (or overall percent complete)
  - Resource Allocation and Effort (if applicable)

- Submit the narrative report, the CPM Schedule update in an Asta Powerproject (.pp) format, and PDF of progressed schedule through PPCC. The PDF must be generated from Asta Powerproject, should be a 11-inch by 17-inch page size, with no more than 25 activities per sheet. Ensure the PDF text is large enough to read.

The Department will review the updated schedule within 14 calendar days of receipt. If an updated schedule is not submitted in the format required, the District Executive, after consultation with the Contractor, may withhold current estimate payments until acceptable monthly updates as specified herein are received.

(d) Resource Loaded CPM Schedule. As specified in Section 689.3(b) and Section 689.3(c) and as follows:

The resources allocated to meet the Required Completion Date and any specified Milestone Dates. Also include, at a minimum, the following information for each summary activity in the initial schedule submission and all subsequent submissions:

- Business Partner Identification Number (ID)
- Proposed Equipment Name
- Proposed Equipment Number (example: Backhoe 1 and 2)
- Activity Resource
- Activity Resource Duration in working days
- Labor

In addition submit a spreadsheet in an electronic format or a PDF similar to Table A or use Allocation Groups within Asta Powerproject. Have it display labor and equipment that will be on the project site 80% of the time for the following:

- Business Partner ID(s)
- Labor Crews with crew designation, number of personnel per crew, and activity resource

- Proposed Equipment Name and Proposed Equipment Number (example: Backhoe 1 and 2) and activity resource

Table A

		Workforce					Equipment					
Crew	Crew Designation											
(Firm Name) Business Partner 1 Crew A	1-A											
(Firm Name) Business Partner 2 Crew 1	2-1											

689.4 MEASUREMENT AND PAYMENT—Lump Sum

(a) Narrative Schedule. Paid, as specified in Section 110.05, in three payments, as follows:

- The first payment, equal to 50% of the amount bid for this item, will be paid upon submission of the Narrative Schedule, as specified in Section 689.3(a), in the form required by this specification.

- The second payment, equal to 25% of the amount bid for this item, will be paid whenever work representing 40% of the total contract price is completed, excluding the bid price for this item.

- The third payment, equal to 25% of the amount bid for this item, will be paid whenever work representing 80% of the total contract price is completed, excluding the bid price for this item.

(b) CPM Schedule. Paid, as specified in Section 110.05, in four payments, as follows:

- The first payment, equal to 20% of the amount bid for this item, will be paid upon submission of an acceptable 60−Calendar Day Work Plan, as specified in Section 689.3(b)1, in the form required by this specification, or upon submission of an acceptable CPM Schedule, as specified in Section 689.3(b)3, in the form required by this specification.

- The second payment, equal to 30% of the amount bid for this item, will be paid upon submission of an acceptable CPM Schedule, as specified in Section 689.3(b)3, in the form required by this specification.

- The third payment, equal to 25% of the amount bid for this item, will be paid whenever work representing 40% of the total contract price is completed, excluding the bid price for this item.

- The fourth payment, equal to 25% of the amount bid for this item, will be paid whenever work representing 80% of the total contract price is completed, excluding the bid price for this item.

(c) Resource Loaded CPM Schedule. Paid, as specified in Section 110.05, in four payments, as follows:

- The first payment, equal to 20% of the amount bid for this item, will be paid upon submission of an acceptable 60−Calendar Day Work Plan, as specified in Section 689.3(b)1, in the form required by this specification, or upon submission of an acceptable CPM Schedule, as specified in Section 689.3(b)3, in the form required by this specification.

- The second payment, equal to 30% of the amount bid for this item, will be paid upon submission of an acceptable CPM Schedule, as specified in Section 689.3(b)3, in the form required by this specification.

- The third payment, equal to 25% of the amount bid for this item, will be paid whenever work representing 40% of the total contract price is completed, excluding the bid price for this item.

- The fourth payment, equal to 25% of the amount bid for this item, will be paid whenever work representing 80% of the total contract price is completed, excluding the bid price for this item.

SECTION 690–PARTNERING

690.1 DESCRIPTION—This work is to outline a structured process designed to develop a collaborative environment for the project so that communication, coordination, and cooperation are the norm. This Collaborative Partnering approach will aid issue resolution and will lessen impacts on project budget, schedule and quality.

Participation in the formal Partnering process defined here will not void any contract part. All rights and remedies defined by the final contract will be preserved.

Definitions are as follows:

- Project Team. The group of people and organizations who are executing a construction project and who have influence on the outcome. The Project Team is comprised of the Department, the Department's Consultants, the Contractor, the Designer, the subcontractor(s), and other stakeholders including Government agencies, property owners, utility owners, materials suppliers, concessionaires, and third parties affected by the construction project.

- Partnering. An effort by the Project Team to develop joint goals and to establish a cooperative atmosphere regarding execution of the construction project, regardless of delivery method.

- Project Team Leaders. Project Managers from both the Department and Contractor who are accountable for the day-to-day operations of the project and are responsible for leading the Partnering effort. They will also oversee coordinating Partnering meeting times, selecting meeting locations, and other logistics.

Construction partnering facilitation is classified into three types as follows:

(a) Internal Facilitation. Shall be co-facilitated by the Department Manager and the Contractor's Project Manager. At the pre-construction meeting, these individuals shall address the partnering practices and values that apply to all projects and are integral to the success of the project. If this facilitation type is selected as specified in Section 690.3(a), Sections 690.3(b) through 690.3(g) are not required.

(b) Semi-Formal Facilitation. The Department Manager and Contractor Project Manager shall meet to discuss and prepare for the partnering workshop. They will determine the dates, locations, required attendees, and a professional, third party facilitator (optional) for the partnering workshop. For the workshop, they will also be responsible for preparing presentations, giving an overview of the project, deciding which portions of the workshop they would like to facilitate, having a list of potential/actual project issues, and if desired, developing a mission statement for the project. Shall have, at a minimum, half day for a facilitated partnering workshop.

(c) Formal Facilitation. The Department Manager and Contractor Project Manager shall meet to discuss and prepare for the partnering workshop. They will determine the dates, locations, required attendees, and a professional facilitator (required) for the partnering workshop. They will be responsible for preparing presentations, giving an overview of the project, deciding which portions of the workshop they would like to facilitate, having a list of potential/actual project issues, and developing a mission statement. This information shall be reviewed with the third party facilitator so that they can assist in developing an overall agenda for the workshop. Shall have, at a minimum, one full day for a professional facilitated partnering workshop.

690.2 MATERIAL—When required, provide a Professional Partnering Facilitator or Consultant and partnering workshop location. Also, furnish adequate material for presentations, evaluations, and workshops.

690.3 CONSTRUCTION—

(a) Project Facilitation. After the project has been awarded but not later than the preconstruction conference, use Form CS-9, Project Facilitation Type Score Sheet, to determine what recommended facilitation type is best for the project. The recommended facilitation type may be moved up or down one facilitation level if agreed upon by both the Department and the Contractor.

(b) Kick-off Partnering Workshop. Hold the Kick-off Partnering Workshop within 30 days of the Notice to Proceed, but not later than 10 days after work has started. Prior to the Kick-off Partnering Workshop, the Project Team Leaders will meet to discuss and prepare for the partnering workshop. At a minimum, they will present an overview of the project, decide which portions of the workshop they would like to facilitate, have a list of potential/actual project issues, develop an agenda for the Kick-off Partnering Workshop, and develop a mission statement for the project. This meeting will also involve selecting potential dates and locations for the workshop and a facilitator, if required/desired. Once these are selected, a list of attendees will be developed, making sure that the Kick-off Partnering Workshop date(s) work for the key participants. The Project Team Leaders will also discuss their objectives for the partnering on the project. This information should be used for designing the workshop to meet the objectives. The Project Team Leaders will also prepare presentations.

At a minimum, the Partnering Workshop agenda should be developed using the following points of interest:

- Discuss and define partnering values for the team
- Establish project specific goals and potential action items to accomplish the goals
- Exchange organizational charts representing the project personnel
- Develop a project specific organizational/communication plan
- Discuss roles and responsibilities as necessary
- Discuss the team's commitment to resolve claims at the lowest possible level
- Develop the Escalation Plan for escalating unresolved issues for resolution (Form CS-8)
- Identify regular scheduled meetings to promote communications
- Overview of project phasing, including MPT and high level scope of work within each phase
- Identify potential Value Engineering Proposals
- Discuss and develop Potential Risk and Mitigation Strategies ("Rocks in the Road")
- Develop action items

Encourage all subcontractors, material suppliers and other entities within contractual control to participate in the Partnering process as necessary. Make this a specific contractual condition for all subcontractors, material suppliers, and other entities working on this project. The designer for this project and any other consultants engaged in this project will participate in the Partnering process as defined here.

(c) Partnering Charter. At the end of the partnering workshop, the participants shall sign a partnering charter (agreement). This charter includes all the principles and commitments made during the partnering session, the project goals and the identified values for the team, the partnering follow-up plan, and the partnering dispute resolution plan. The minimum goals of the Partnering Charter are:

1. Safe Project Completion
2. Quality Project Completion
3. Timely Project Completion
4. Effective Use of Budget Funds

(d) Facilitator/Partnering Session Evaluation. At the end of the partnering workshop, the participants will fill out an evaluation form for the facilitator and partnering workshop. Use Form CS-10 (Partnering Workshop and Facilitator Evaluation) if another partnering workshop evaluation form is not provided by the facilitator or the Project Team Leaders. Evaluations will be submitted to the Assistant Construction Engineer/Manager or a designee appointed by the Assistant Construction Engineer/Manager.

(e) Partnering Meetings. A follow-up partnering plan should be created at the end of the kick-off partnering workshop. Consider holding joint partnering meetings with the Project Team at all milestones, when there is a significant change of personnel on the project, when lingering unresolved issues are present, when the project enters a new phase of work, and at the beginning of each season for multi-year projects. For internally facilitated projects, joint partnering meetings can be held on an as needed basis. These meetings should discuss the schedule and how the team is going to accomplish it, unresolved or outstanding issues, new issues which need resolution, and any action items and deadlines.

(f) Partnering Evaluations. Department, Contractor, major subcontractors, and major stakeholders will participate in partnering evaluation surveys to measure progress on mutual goals and short-term key issues as they

arise. The frequency of the partnering evaluation surveys may be determined by the Project Team Leaders. Use Form CS-11 (Project Partnering Survey) if another partnering evaluation survey form is not provided by the facilitator or the Project Team Leaders. The partnering evaluations will be collected by the Project Team Leaders and the results will be shared with the project team. The results will be presented in a graphical format so trends can be easily identified. Negative responses in any survey should be identified quickly so that they can be investigated and corrective action can occur.

1. Facilitator evaluations. Facilitator evaluations must be completed by the Department, Contractor, and major stakeholders at the end of the kick-off partnering workshop and at the project close-out partnering workshop. The Representative will provide the evaluation forms to the project team and collect the results. The evaluation results will be made available upon request.

(g) Project Close-out Partnering Workshops. Conduct a project close-out workshop to discuss the project's successes and challenges. Document the lessons learned as a condition of final project acceptance.

(h) Partnering Dispute Resolution Plan. Complete Form CS-8 (Issue Escalation Matrix) as required in Section 108.03(a). Use Form CS-8, Issue Escalation Matrix, to escalate and resolve issues at the appropriate hierarchy level. It is the Department's expectation that issues not effectively settled at the field level will elevate in accordance with the Issue Escalation Matrix. The goal is to maintain project momentum while a decision is reached by the next tier of project management, who can rely on a broader project perspective.

690.4 MEASUREMENT AND PAYMENT—DOLLAR

(a) Facilitation Costs. The Department agrees to reimburse 50% of the invoice costs for the following:

- Facilitator workshop and session costs.
- Monthly partnering evaluation survey service cost.
- Cost for partnering skills development trainer and training site cost.

Payment amount will be based on invoice prices without any markup costs.

SECTION 692—SHOULDER RELIEF JOINT

692.1 DESCRIPTION—This work is construction of a shoulder relief joint on a prepared surface.

692.2 MATERIAL—

- Superpave Asphalt Mixture Design, Asphalt Base Course—Section 504.2
- Asphalt Cement, PG 64S-22—Section 702

692.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Base Course. Construct Superpave Asphalt Mixture Design, Asphalt Base Course as specified in Section 313.3.

692.4 MEASUREMENT AND PAYMENT—Linear Foot
Measured transversely.

SECTION 695 – DETECTABLE WARNING SURFACE

695.1 DESCRIPTION – This work is furnishing all material, equipment, tools, and labor required for the placement and installation of detectable warning surfaces on cement concrete sidewalk curb ramps and other designated surfaces in order to provide a tactile warning for pedestrians with visual impairments under the provisions of the Americans with Disabilities Act (ADA).

695.2 MATERIAL –

(a) Detectable Warning Surface (DWS). Provide a DWS product from a manufacturer listed in Bulletin 15 and meeting the requirements of the Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG). Provide certification as specified in Section 106.03(b)3 that the DWS meets the following PROWAG criteria:

- **General**. Detectable warning surface with the surface comprised of truncated domes. Dome size and spacing as specified and as shown on the Standard Drawings.
- **Surface**. Slip resistant.
- **Contrast**. Provide a DWS color, as approved by the Representative, that contrasts visually with adjacent walking surfaces either light-on-dark or dark-on-light.

(b) Other Material.

- **Class A Cement Concrete** – Section 704
- **Subbase –** Section 350
- **Joint Sealant Material** – Section 705.4(a), (b), or (c)

695.3 CONSTRUCTION –

(a) General. Provide a copy of the DWS manufacturer's written installation instructions.

(b) New Construction. Coordinate this work with the requirements for new Cement Concrete Sidewalks, Section 676. Follow DWS manufacturer's instructions for a cast-in-place installation at the locations indicated and in accordance with the requirements as shown on the Standard Drawings for the designated curb ramp type or other designated surface.

(c) Alteration or Retrofit Construction. Saw cut and remove the entire depth of existing concrete from the area where the DWS will be placed. Replace any removed or disturbed aggregate subbase and compact before placing new concrete.

Place new cement concrete and follow the DWS manufacturer's installation instructions for a cast-in-place installation.

Fill any saw cut gaps with approved joint sealant material. Fill any gaps around the DWS edge installation with the joint material if necessary.

(d) Protection. Protect the new sidewalk and DWS surface from pedestrian traffic until the adjoining cement concrete surfaces have properly cured and work is complete at the curb ramp location. Clean the DWS surface using a method recommended by the manufacturer.

695.4 MEASUREMENT AND PAYMENT – Square Foot

SECTION 696—TEMPORARY IMPACT ATTENUATING DEVICES

696.1 DESCRIPTION—This work is the furnishing, placing, and removing of temporary impact attenuating devices for maintenance and protection of traffic during construction, as indicated.

696.2 MATERIAL—

- Temporary impact attenuating devices from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

696.3 CONSTRUCTION—

(a) General. Submit shop drawings as specified in Section 105.02(d).

(b) Installation. Install according to manufacturer's specifications and installation instructions, or as indicated.

696.4 MEASUREMENT AND PAYMENT—

(a) Temporary Impact Attenuating Device. Each

(b) Repair of Impact Attenuating Device. The Department will pay for repair of Temporary Impact Attenuating Devices as specified in Section 110.03(d) Force-Account Work, if money has not been secured through other sources for the same purpose.

SECTION 697—RESET TEMPORARY IMPACT ATTENUATING DEVICES

697.1 DESCRIPTION—This work is the resetting of a temporary impact attenuating device from one construction area to another within the project limits, as indicated.

697.2 MATERIAL—Section 696.2

697.3 CONSTRUCTION—Section 696.3 and as follows:

Reset temporary impact attenuating device if construction operations require a change in the protection of traffic, or as directed. Store or transport the attenuating devices as required.

697.4 MEASUREMENT AND PAYMENT—Each

SECTION 700
MATERIAL

SECTION 701—CEMENT

701.1 GENERAL—Obtain cement from a producer listed in Bulletin 15 and from silos set aside for Department use. Do not use retrieved or reclaimed cement. Do not use cement with a material temperature exceeding 150F at the time of delivery to the plant.

(a) QC. Section 106.03(a)2

(b) Certification.

1. General. Conduct a Monthly Mill Test according to ASTM C150 or ASTM C595. Submit a copy of the Monthly Mill Test Form TR-7011 or Form TR-7015 for blended cement) to the LTS for verification of compliance with Department specifications:

- Base the Monthly Mill Test on actual or historical statistical process controls.
- Specify the type of material and cross-reference the test to the bill of lading.
- Ensure that a responsible company official sign the Monthly Mill Test.
- Submit split sample with corresponding test results monthly.

2. Levels of Certification. Section 106.03(b)3.e

(c) Handling and Transportation. Section 106.06 and as follows:

For each shipment to the project, furnish two copies of the vendor's bill of lading. Include one copy with the shipment to the project; the vendor shall retain the other copy. Use a form acceptable to the LTs that contains the following information:

- Statement that material has been tested and conforms to Department specifications.
- Type of material
- Silo number
- Company lot identification
- Date of shipment
- Producer's name and location
- Consignee's name and location
- Temperature of cement
- Trailer number
- Quantity (tons)

- Alkali content (%)—determined according to AASHTO T 105.

Ship bulk cement in clean, acceptable, metal, rubber, or plastic waterproof containers or compartments. Ship bagged cement 94 pounds net per bag) in suitable paper bags with the brand, type, and manufacturer's name printed on them. Protect cement bags from the weather. Reject cement bags with net weight more than 3% below that specified.

(d) Storage. Section 106.05 and as follows:

- Provide storage capacity sufficient to maintain the paving schedule.
- Store bulk cement in acceptable silos.
- Store bagged cement in enclosed buildings.
- Store bagged cement in stacks not exceeding eight bags in height and cover.

(e) Chemical and Physical Requirements and Testing. AASHTO M 85 and AASHTO M 240, except sample according to PTM No. 509.

(f) Limited Number of Sources. Obtain cement for each project from a single source, unless otherwise allowed by the Representative in writing. If using more than one source, separate cement of different types and from different sources. Use each type and source in continuous, segregated portions of the project. If possible, limit cement used in an individual structure to a single type and source. If this is not possible, use one type and source for footers, piers, and abutments, and one type and source for superstructures.

SECTION 702—ASPHALT MATERIAL

702.1 GENERAL—Obtain asphalt material conforming to the requirements of Bulletin 25 from a producer listed in Bulletin 15.

(a) QC. Prepare a QC Plan as specified in Section 106.03(a)2. Submit the QC Plan to the LTS for review annually at the beginning of each calendar year before shipping material to the project or by March 31, whichever is earlier. Prepare a QC Plan according to AASHTO R 26 and Bulletin 25 for Performance Graded Asphalt Binder (PGAB). Prepare a QC Plan according to AASHTO R 77 and Bulletin 25 for emulsified asphalt.

(b) Certification.

1. General.

- Obtain a verification sample from each batch and test according to Bulletin 25. A batch is a tank completely filled, partially filled, or refilled with a blend of residual and new material. Test one-third of each sample and forward the test results along with the second one-third of each sample to the LTS. Retain the remaining one-third of each sample and submit the retained sample to the LTS whenever LTS releases a failed sample test result for the second one-third of each sample or whenever LTS requests the retained sample. The LTS will evaluate QC based on verification samples.

- Provide Form CS-4171, Certificate of Compliance, signed by a responsible company official that lists the type of material, tank number, and company lot number for cross-referencing to the bill of lading.

- The Department's QA Teams will periodically review the QC Plan, inspect production and testing facilities, and take QA samples of material either at the plant or at the point where the material will be incorporated into the project.

2. Levels of Certification. Section 106.03.(b)3.e

(c) Handling and Transportation. Section 106.06 and as follows:

For each shipment to the project or asphalt mixture producer, submit one copy of the vendor's bill of lading on a form acceptable to the LTS that contains the following information:

- Statement that the material has been tested and conforms to Bulletin 25.
- Statement that the shipment container was free of contamination before loading.
- Class or grade of material.
- Tank number.
- Company batch number.
- Date of shipment.
- Producer's name and location.
- Consignee's name and location (Asphalt Mixture Producer or Plant, Department Maintenance District or County, or Contractor).

- For cutback asphalts and emulsified asphalts, minimum and maximum mix or application temperature requirements, handling and storage requirements for proper usage, and percent asphalt residue by weight.

- For the specific emulsified asphalt grades requiring the compatibility or stone coating test according to Bulletin 25, a statement that the material is compatible with the job aggregate. Perform the compatibility or stone coating test according to AASHTO T 59, Section 17 (Coating Ability and Water Resistance).

- For non-polymer-modified PGAB, a temperature-viscosity chart for each lot or batch of material to be shipped based on the rotational viscosities in either Pascal-seconds (Pa-s) or centipoises at 275F and 329F. Instead of plotted data, provide minimum and maximum laboratory mixing and compaction temperatures based on the mixing temperature range and compaction temperature range according to AASHTO T 312.

- For polymer-modified PGAB, any specific handling and storage requirements and minimum and maximum laboratory mixing and compaction temperatures as recommended by the PGAB supplier.

- Specific gravity at a temperature of 60F.

- Quantity of material.

SECTION 703—AGGREGATE

703.1 FINE AGGREGATE—

(a) General. Fine aggregate is natural or manufactured sand consisting of hard, durable, and uncoated inert particles reasonably free from clay, silt, vegetation, and other deleterious substances such as reactive chert, gypsum, iron sulfide, amorphous silica, and hydrated iron oxide. Substances present in amounts large enough to cause inconsistent performance in asphalt concrete or plastic or hardened portland cement concrete are considered deleterious. Spent foundry sand may be used as fine aggregate in asphalt concrete and flowable fill.

Obtain fine aggregate with physical properties according to Table A from a source listed in Bulletin 14 or approved by the LTS before use.

1. Natural Sand. Natural sand is fine aggregate resulting from glacial or water action. Fine aggregate produced simultaneously with gravel coarse aggregate may contain crushed particles.

2. Manufactured Sand. Manufactured sand is fine aggregate from the controlled mechanical breakdown of rock, air-cooled blast furnace slag, or air-cooled steel slag into sound, approximately cubical particles.

Fine aggregate manufactured from limestone may not be used in concrete wearing surfaces.

Fine aggregate manufactured from steel slag may not be used in cement concrete or mortar mixtures. Steel slag fine aggregate may only be used in asphalt wearing courses with the approval of the LTS; however, do not use steel slag fine aggregate in conjunction with steel slag coarse aggregate. Provide steel slag fine aggregate that is uniform in density and quality. If steel slag was manufactured after January 1, 2007, traceability of material must be established. If traceability cannot be established, perform chemical testing according to DEP General Permit WMGR144 and submit the test results to the LTS. Cure steel slag fine aggregate according to the following procedure:

- After gradation preparation, place steel slag fine aggregate, whether reclaimed from an old stockpile or processed directly from the steel-making process, in a controlled stockpile. Limit the stockpile size to a maximum of 30,000 tons. Completely soak the steel slag fine aggregate with water before or during stockpiling. Submit the method of constructing and controlling the stockpile to the Representative for review.

- Maintain the stockpile in a uniform moist condition for a period of not less than 6 months. After the minimum cure period, the Representative will sample and test the stockpile for expansive characteristics according to PTM No. 130. The Representative will approve the stockpile for use if the average total volumetric expansion according to PTM No. 130 is less than 0.50%.

- If the stockpile fails expansion criterion, continue curing the stockpile for a minimum of 2 additional months. The Representative will resample and retest the stockpile after the required additional cure period.

The LTS will evaluate the quality of fine aggregates by conducting petrographic analysis according to PTM No. 518 and other tests necessary to demonstrate that required construction of acceptable durability can be achieved.

(b) Production Testing.

1. Personnel and Equipment. Provide and assign to the work a PennDOT Certified Aggregate Technician who will test fine aggregate at the source according to the requirements listed in Bulletin 14.

Provide equipment for acceptance testing and for developing and maintaining a QC program to ensure compliance with specification requirements during production according to Bulletin 14.

2. Testing and Documentation. Perform tests as required by Bulletin 14. Evaluate the test results to ensure the quality requirements are met.

Document the results of tests made during production and make them available to the Department upon request.

(c) Grading and Quality Requirements.

1. Gradation. Table A lists the extreme limits for determining the suitability of supply sources.

Control the grading of Type A Fine Aggregate so the fineness modulus of at least nine out of ten consecutive test samples from a single source delivered to a project or plant varies less than ± 0.20 from the average fineness modulus of the consecutive test samples. Determine the fineness modulus according to PTM No. 501.

For asphalt mixtures:

- If directed, vary the gradations within the limits according to Table A.
- A blend of fine aggregates may be used if the proposed gradation limits for blending are approved by the District Executive in writing.
- If filler is required, provide fine aggregate conforming to the gradation according to Table A and use cement, cement dust, fly ash, or fines from the crushing of stone, gravel, or slag reasonably free of clay.

2. Material Finer than the 75 µm (No. 200) Sieve. Determine the loss by washing according to PTM No.100.

3. Minimum Strength Ratio. Determine the organic impurities in fine aggregate (Type A and Type C only) according to AASHTO T 21. If the color value result is greater than Organic Plate No. 3, determine the minimum strength ratio according to AASHTO T 71 and use fine aggregate meeting the strength ratio according to Table A.

4. Soundness Test. Determine the percentage loss after five cycles of immersion and drying using a sodium sulfate solution according to PTM No. 510.

5. Specific Gravity and Absorption. AASHTO T 84.

TABLE A
Fine Aggregate
Grading and Quality Requirements

	Cement Concrete Sand	**Asphalt Concrete Sand Type B**			**Mortar Sand**
Sieve Size	**Type A**	**#1**	**#3**	**Filler**	**Type C**
9.5 mm (3/8-inch)	100	100	100	—	—
4.75 mm (No. 4)	95-100	95-100	80-100	—	100
2.36 mm (No. 8)	70-100	70-100	65-100	—	95-100
1.18 mm (No. 16)	45-85	40-80	40-80	—	—
600 µm (No. 30)	25-65	20-65	20-65	100	—
300 µm (No. 50)	10-30	7-40	7-40	95-100	—
150 µm (No. 100)	0-10	2-20	2-20	90-100	0-25
75 µm (No. 200)	—	0-10	0-10	70-100	0-10
Material Finer Than 75 µm (No. 200) Sieve Max. Percent Passing	3	—	—	—	—
Strength Ratio Min. Percent	95	—	—	—	95
Soundness Test Max. Loss Percent	10	15	15	—	10
Fineness Modulus	2.30-3.15	—	—	—	1.6-2.5

703.2 COARSE AGGREGATE—

(a) General. Coarse aggregate consists of hard, tough, durable, and uncoated inert particles reasonably free from

clay, silt, vegetation, and other deleterious substances such as reactive chert, gypsum, iron sulfide, amorphous silica, and hydrated iron oxide. Substances present in amounts large enough to cause inconsistent performance in asphalt concrete or plastic or hardened portland cement concrete are considered deleterious.

The LTS will evaluate the quality of coarse aggregates by conducting petrographic analysis according to PTM No. 518 and other tests necessary to demonstrate required construction of acceptable durability can be achieved.

Furnish coarse aggregate crushed and prepared from one of the materials described below with physical properties conforming to Tables B, C, and D. Obtain coarse aggregate from a source listed in Bulletin 14 or approved by the LTS before use.

1. Stone. Durable stone free from slate texture or cleavage planes.

2. Gravel. Durable gravel particles. For use in cement concrete, wash thoroughly during production. For use in all asphalt wearing courses, unless otherwise specified, a minimum of 85% crushed particles with at least two faces resulting from fracture is required. For use as No. Open Graded Subbase (OGS), a minimum of 75% crushed particles with at least three faces resulting from fracture is required. For all Type A use, the maximum allowable absorption determined according to AASHTO T 85 is 3.0%; however, this restriction does not apply to dredged river gravel used in portland cement concrete. For all Type B use, the maximum allowable absorption determined according to AASHTO T 85 is 3.5%.

3. Blast Furnace Slag. By-product of a pig-iron making process. Tough, hard, and durable pieces of air-cooled blast furnace slag. If blast furnace slag was manufactured after January 1, 2007, traceability of material must be established. If traceability cannot be established, perform chemical testing according to DEP General Permit WMGR144 and submit the test results to the LTS. Blast furnace slag is excluded from the abrasion requirements. The density (unit weight) of blast furnace slag cannot be less than 70 pounds per cubic foot. If there is more than 5% contamination of steel slag in a stockpile, the stockpile is considered steel slag. Limit the stockpile size to a maximum of 30,000 tons.

4. Steel Slag. By-product of a steel making process. Tough, hard, and durable pieces of steel slag reasonably uniform in density and quality. If steel slag was manufactured after January 1, 2007, traceability of material must be established. If traceability cannot be established, perform chemical testing according to DEP General Permit WMGR144 and submit the test results to the LTS. After crushing, grading, and forming a stockpile, take a sample from the stockpile and submit it to the LTS for testing of expansive characteristics. The LTS will accept the stockpile for use if the total expansion determined according to PTM No. 130 is less than 0.50%. Once a stockpile is accepted, do not add to it if it is for Department use. Limit the stockpile size to a maximum of 30,000 tons. If the stockpile fails expansion requirements, cure the aggregate stockpile as follows:

- Rework the stockpile and soak the aggregate completely with water.
- Submit the proposed method of constructing and controlling the stockpile during the cure period for review and acceptance.
- Maintain the aggregate in a uniformly moist condition in the stockpile for a period of at least 6 months. Take a sample after this curing period and submit it to the LTS for testing according to PTM No. 130.
- The Representative will accept the stockpile for use if the total expansion is less than 0.50%. If the stockpile still fails the expansion requirement, continue curing for at least 2 additional months before resampling and retesting.

Aggregate manufactured from steel slag is not acceptable for pipe or structure backfill, in cement concrete, or as subbase. Aggregate manufactured from steel slag may be used for selected granular material, shoulders, selected material surfacing, and in asphalt surface courses.

5. Granulated Slag. By-product of an iron-making process. Granulated blast furnace slag is the granular glassy material formed if molten slag from iron-making is rapidly quenched by immersion in water and contains not more than 3% total iron reported as Fe_2O_3. If granular slag was manufactured after January 1, 2007, traceability of material must be established. If traceability cannot be established, perform chemical testing according to DEP

General Permit WMGR144 and submit the test results to the LTS. Limit the stockpile size to a maximum of 30,000 tons.

Provide material containing not more than 20% by mass (weight) of substances that are not granulated slag. Use material with a dry rodded density (unit weight) determined according to AASHTO T 19 of not more than 80 pounds per cubic foot. Provide uniform material having a maximum size of 50 mm (2 inches) and not more than 20% passing the 150 µm (No. 100) sieve. Granulated slag may only be used for subbase material as specified in Section 350.

6. Lightweight Aggregate. Acceptable types of lightweight aggregate are as follows:

- Aggregate prepared by expanding, pelletizing, or sintering products such as blast-furnace slag, diatomite, fly ash, clay, shale, or slate.

- Aggregate prepared by processing natural materials such as pumice, scoria, or tuff.

Furnish lightweight aggregate conforming to AASHTO M 195, the soundness and abrasion limits for Type A aggregate according to Table B, and the following durability requirements.

• Aggregate Absorption Factor (PTM No. 526)	Max. %	2.5
• Freeze-Thaw Resistance of Concrete, Decrease of Dynamic Modulus at 300 Cycles (AASHTO T 161, Procedure B, except after 14 days of moist cure, dry the beams 3 inches by 4 inches by 16 inches at 72F ± 3F and approximately 50% relative humidity for 14 days. Then soak the beams in water for 3 days before starting the freezing and thawing test.)	Max. %	60
• Freeze-Thaw Resistance of Aggregate (PTM No. 525)	Max. %	25

TABLE B
Coarse Aggregate
Quality Requirements(7)

	Type A	Type B	Type C	Type S
Soundness, Max. %	10	12	20	16
Abrasion, Max. %	45	45	55	55
Freeze-Thaw Loss, Max %	—	—	—	7.0(6)
Thin and Elongated Pieces, Max. %	15	20	—	—
Material Finer Than 75 µm (No. 200) Sieve, Max. %	—(1)	—(1)	10	10
Crushed Fragments, Min. %	55(2)	55(2)	50	50
Compact Bulk Density (Unit Weight), lbs./cu. ft.	70	70	70	70
Deleterious Shale, Max. %	2	2	10	10
Clay Lumps, Max. %	0.25	0.25	3	3
Friable Particles, Max. % (excluding shale)	1.0	1.0	—	—
Coal or Coke, Max. %	1	1	5	5
Glassy Particles, Max. %	4 or 10(3)	4 or 10(3)	—	—
Iron, Max. %	3(5)	3(5)	3(5)	3(5)
Absorption, Max. %	3.0(4)	3.5(4)	—	2(4)
Total of Deleterious Shale, Clay Lumps, Friable Particles, Coal, or Coke Allowed, Max. %	2	2	15	15

Notes:
(1) Section 703.2(c)4.
(2) Section 703.2(c)5.
(3) Section 703.2(c)9.
(4) Gravel only for Types A and B. as specified in Section 703.2(c)2. All natural aggregates for Type S.
(5) Section 703.2(c)10..
(6) Natural coarse aggregates with an absorption less than 2% are considered freeze thaw resistant and not subject to testing according to AASHTO T 103, Procedure A. Natural aggregates with an absorption exceeding 2% shall be considered freeze thaw resistant if either their sodium sulfate soundness level is less than 16% or their AASHTO T 103 freeze thaw loss after 25 cycles (coarse fraction) does not exceed 7.0%. Type S 2A aggregate may be supplied where Type 2A aggregate for purposes other than subbase is specified at no additional cost to the Department.
(7) Test methods to determine the quality requirements of Table B as specified in Section 703.2 (c).

7. Recycled Concrete. Salvaged and crushed concrete pavements and concrete highway structures from Department, county, or municipal projects for use as 2A aggregate, shall not be used in subbase.

(b) Production Testing.

1. Personnel and Equipment. Provide and assign a PennDOT Certified Aggregate Technician to test coarse aggregate at the source according to Bulletin 14.

Provide equipment for acceptance testing and for developing and maintaining a QC program to ensure compliance with specification requirements during production according to Bulletin 14.

2. Testing and Documentation. Perform tests as required by Bulletin 14. Evaluate the test results to ensure the quality requirements are met.

Document the results of tests made during production and make them available to the Department upon request.

(c) Quality Requirements. The following notes are applicable to Table B.

1. Soundness. Determine the percentage loss after five cycles of immersion and drying using a sodium sulfate solution according to PTM No. 510. The LTS may accept aggregate failing the test if it can be demonstrated in writing the aggregate has a satisfactory service record in both pavements and structures. Acceptable aggregate produced from recycled concrete need not conform to soundness requirements since cementitious material cannot be evaluated with this test.

2. Abrasion. Determine the percentage of loss according to AASHTO T 96.

3. Thin and Elongated Particles. ASTM D4791, Method B, using the material retained on the 4.75 mm (No. 4) sieve. Measure the ratio of 5:1, comparing the length to the thickness of the aggregate particles. Calculate the percentage of flat and elongate particles by mass.

TABLE C
Size and Grading Requirements for Coarse Aggregates
(Based on Laboratory Sieve Tests, Square Openings)

AASHTO Number	Total Percent Passing														
	100 mm (4")	90 mm (3 1/2")	63 mm (2 1/2")	50 mm (2")	37.5 mm (1 1/2")	25.0 mm (1")	19.0 mm (3/4")	12.5 mm (1/2")	9.5 mm (3/8")	4.75 mm (No. 4)	2.36 mm (No. 8)	1.18 mm (No. 16)	300 µm (No. 50)	150 µm (No. 100)	75 µm (No. 200) ***
1	100	90-100	25-60		0-15		0-5								
3			100	90-100	35-70	0-15		0-5							
467				100	95-100		35-70		10-30	0-5					
5					100	90-100	20-55	0-10	0-5						
57					100	95-100		25-60		0-10	0-5				
67						100	90-100		20-55	0-10	0-5				
7							100	90-100	40-70	0-15	0-5				
8								100	85-100	10-30	0-10	0-5			
89								100	90-100	20-55	5-30	0-10	0-5		
9									100	85-100	10-40	0-10	0-5		
10									100	85-100				10-30	
2A**				100			52-100		36-70	24-50	16-38*	10-30			
OGS**				100			52-100		36-65	8-40		0-12			

* Applies only for asphalt mixtures.
** PennDOT Number – Only Type C and Type S will be listed in Bulletin 14.
*** For 75 µm (No. 200), see Table D.

Note A: A combination of No. 7 and No. 5 may be substituted for No. 57, if no more than 50% or less than 30% of the combination is No. 7 size.

Note B: Provide No. OGS material that has a minimum average coefficient of uniformity of 4.0. The average coefficient of uniformity is defined as the average of the sublots within each lot. Determine the coefficient of uniformity according to PTM No. 149 each time the gradation is determined. The required minimum coefficient of uniformity for individual samples is 3.5. If the coefficient of uniformity of any sample falls below 3.5, reject the lot. Do not use the coefficient of uniformity in the multiple deficiency formula.

4. Material Finer than the 75 µm (No. 200) Sieve. Determine the loss by washing according to PTM No. 100 and Table D.

This test is not required for aggregate processed through a mechanical dryer for use in asphalt concrete; however, the aggregate is required to be clean and free of fines that would adversely affect the coating of the aggregate with asphalt material.

This test is not required for AASHTO No. 10 aggregates.

TABLE D
Material Passing the 75 µm (No. 200) Sieve —
(Based on Laboratory Sieve Tests, Square Openings)

Section	Specification	% Maximum
350	Subbase (No. 2A)	10
350	Subbase (No. OGS)	5
470	Bit. Seal Coat	1.0
471	Bit. Seal Coat w/ Precoat. Aggr.	2.0
480	Bit. Surf. Treatment	1.0
704	Cement Concrete	1
—	All other uses	2

5. Crushed Fragments. ASTM D5821

6. Deleterious Shale. Determine the percentage of deleterious shale by four cycles of wetting and drying according to PTM No. 519. The LTS will use petrographic analysis to confirm the results.

7. Friable Particles. Percent loss according to PTM No. 620.

8. Coal or Coke. Determine the percentage of mass (weight) by visual identification and hand separation. If required, the LTS will use petrographic analysis to confirm the results.

9. Glassy Particles. Determine the percentage of mass (weight) by visual identification and hand separation. Pieces of slag containing more than 50% glass are considered to be glassy particles. Waste glass is also considered to be glassy particles. For coarse aggregate used in cement concrete, the maximum percentage of glassy particles allowed is 4%. For other uses, the maximum percentage of glassy particles allowed is 10%. Coarse aggregate containing glassy particles consisting of waste glass may not be used in cement concrete or asphalt wearing courses.

10. Metallic Iron. The LTS will use petrographic analysis to determine the content of metallic iron. Pieces of slag containing metallic iron are considered to be metallic iron. This requirement is waived if aggregate with metallic iron is used in asphalt mixtures or subbase. PTM No. 518.

11. Clay Lumps. Determine the percentage of mass (weight) by visual identification and hand separation. If required, the LTS will use petrographic analysis to confirm the results.

12. Specific Gravity and Absorption. AASHTO T 85.

13. Bulk Density (Unit Weight) and Voids. AASHTO T 19.

(d) Testing and Acceptance. Section 703.5(b)

703.3 SELECT GRANULAR MATERIAL (2RC)—

(a) General. Select granular material consists of durable bank or crushed gravel, stone, or slag mixed or blended with suitable filler materials to provide a uniform mixture. Obtain select granular material from a source listed in Bulletin 14. Stockpile, sample, and test material before it is used to ensure reasonable uniformity and acceptability. Use material free from vegetable or organic matter, lumps, or an excessive quantity of clay or other objectionable or foreign substances and not more than 10% deleterious shale by mass (weight).

(b) Gradation. Conforming to the following gradation, determined according to PTM No. 616:

- Passing 50 mm (2-inch) sieve—100%
- Passing 4.75 mm (No. 4) sieve—15% to 60%
- Passing 150 µm (No. 100) sieve—0% to 30%

703.4 ANTI-SKID MATERIAL—

(a) General. For use on ice or snow-covered pavement surfaces, furnish anti-skid material conforming to Table E from a producer or agent listed in Bulletin 14. Do not use material containing metal, glass, or substances harmful to automotive equipment and vehicles. Use material reasonably free of deleterious substances or foreign materials including, but not limited to, dirt, shale, slate, incinerated asphalt coal mine waste, and within the maximum limits of the individual deleterious and total deleterious materials according to Table B, Type C.

(b) Description.

1. Type AS1. Either natural sand, manufactured sand (except slag aggregates), or a combination of the two conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 110 pounds per cubic foot determined according to AASHTO T 19.
- Crushed Fragments. If natural sand is furnished, not less than 35% of the fragments retained on the 2.36 mm (No. 8) sieve are required to be crushed fragments, determined according to ASTM D5821.
- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

2. Type AS2 and AS3. Crushed stone or crushed gravel conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 105 pounds per cubic foot determined according to AASHTO T 19.
- Los Angeles Abrasion. Abrasion loss not exceeding 55%, determined according to AASHTO T 96, Gradation D.
- Crushed Fragments. If crushed gravel is furnished, not less than 60% of the fragments retained on the 4.75 mm (No. 4) sieve are required to be crushed, one face, determined according to ASTM D5821.
- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by weight of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

3. Type AS4. Crushed slag conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 105 pounds per cubic foot determined according to AASHTO T 19.
- Los Angeles Abrasion. Abrasion loss not exceeding 55%, determined according to AASHTO T

96, Gradation D.

- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

(c) Gradations. According to Table E.

TABLE E
Anti-Skid Gradation

Anti-Skid Type	Maximum Percent Passing Sieve								
	31.5 mm (1 1/4")	19.0 mm (3/4")	12.5 mm (1/2")	9.5 mm (3/8")	4.75 mm (No. 4)	2.36 mm (No. 8)	300 µm (No. 50)	150 µm (No. 100)	75 µm (No. 200)*
Type AS1				100	60-100	0-80		0-8	0-5
Type AS2				100	35-80	0-45		0-6	0-3**
Type AS3			100	90-100		0-30		0-8	
Type AS4				100		0-30		0-8	0-5

* Determined by PTM No. 100.
** If the total percent passing the 2.36 mm (No.8) sieve is less than 25%, the total percent passing the 75 µm (N0. 200) sieve is allowed to be 0-5.

(d) Testing. If shipping, test material for moisture content according to PTM No. 513. A minimum of two tests per day is required. If conditions exist that would cause a change in moisture content, conduct additional tests. A Department representative will verify the test results.

Document tests at the end of delivery quantity at the end of the day and determine the average moisture content. The Department will adjust the delivery quantity by deducting the average moisture content from the aggregate quantity shipped. Payment is based on the calculated oven dry mass (weight).

703.5 ACCEPTANCE OF CONSTRUCTION AGGREGATES—

(a) General. The following describes the certification acceptance of construction aggregates. Accept AASHTO No. 1 Coarse Aggregate as specified in Section 850.2(a)1.

(b) Testing and Acceptance. Certify each day's shipment of aggregate as specified in Section 106.03(b)3.

1. QC. Section 106.03(b)2 and as follows:

- Submit for annual review a QC Plan conforming to the minimum Department requirements for aggregate suppliers.

- Establish and positively identify aggregate stockpiles that have been tested according to the approved QC Plan and conform to Department Specifications. Material may be added to or shipped from stockpiles at the producer's discretion.

2. Source Verification Samples. Under the direction and supervision of the Representative, obtain a verification sample (n=3) from each stockpile to be tested. Obtain the sample from the stockpile according to AASHTO R 90 or from a mini-stockpile. If the mini-stockpile method is chosen, obtain the sample according to the following procedure:

- Place approximately 10 tons of aggregate into a mini-stockpile on a suitable surface. Use a loader to strike off the top of the mini-stockpile.

- Obtain sufficient material for sampling from random locations on the mini-stockpile using a square faced shovel.

If project verification samples or lot acceptance samples in Section 703.5(b)3 result in a Percent Within Limits

(PWL) < 90, the Representative will direct additional source verification sampling of the stockpile(s) from which the failing material was shipped. In such instances, do not ship additional materials from the stockpile(s) until test results from source verification samples have PWL ≥ 90.

Immediately deliver the source verification sample to the Representative for testing using the equipment provided as specified in Sections 703.1(b) and 703.2(b). The Representative will test all three increments according to Tables A, B, C, and D, as applicable. If the test results verify the material conforms to the specifications, use the material under certification, unless project verification samples require lot acceptance.

If the material does not conform to the specifications, the Representative will determine the PWL as specified in Section 106.03(a)3. If source verification results indicate a PWL < 90, the Representative will reject the stockpile.

If a stockpile is rejected, increase QC testing according to the reviewed QC Plan. Construct another stockpile of the aggregate to be tested consisting of 300 tons to 500 tons of material or the remainder of the quantity identified for Department projects, whichever is less. The Representative will accept the material under certification if test results verify the material from the new stockpile conforms to the specifications, unless project verification samples require lot acceptance.

3. Project Verification Samples. Under the direction and supervision of the Inspector, obtain verification samples (n=3) according to Table F for aggregates used for subbase applications under the roadway and shoulders as specified in Section 350. At the preconstruction conference provide the Representative estimated aggregate quantities for subbase applications under the roadway and shoulders. Other aggregate types or applications may be sampled for project verification if the Representative determines the material is visually suspect. Obtain samples at the point of placement (loose aggregate sample on grade before trimming and compaction) and not from project stockpiles unless directed:

TABLE F
Verification Samples

Aggregate Quantities	Number of Samples (n=3)
1,000 tons or more, but less than 2,000 tons	1
2,000 tons or more, but less than 10,000 tons	2
10,000 tons or more, up to 25,000 tons	3
Each additional increment of 25,000 tons	1

The Inspector will select sample locations according to PTM No. 1.

Under the direction and supervision of the Inspector, immediately deliver the sample(s) to the test site at either the producers' location or the project site. The Inspector will test the sample(s) using the equipment provided as specified in Sections 703.1(b) and 703.2(b). The Inspector will test all three increments for compliance with Tables C and D, plus the Crushed Fragments Test of Table B if applicable. The Inspector will provide the test results within 5 days from the date of sampling. The Department will continue to accept material under certification if test results verify the material conforms to the specifications.

If the material does not conform to the specifications, the Inspector will determine the average PWL of the material as specified in Section 106.03(a)3. If results indicate a PWL < 90 for the material, the Department will discontinue certification acceptance and begin project lot acceptance of the aggregate. Discontinue all operations using that size of aggregate until the Representative determines new lot sample locations according to PTM No. 1 and authorizes operations to continue. Conduct lot acceptance testing at the point of placement according to the following procedure:

- Under the direction and supervision of the Inspector, use a PennDOT Certified Aggregate Technician to obtain an acceptance sample (n=3) at the point of placement (loose aggregate sample on grade before trimming and compaction) for each 7,500 tons of material placed. The lot size of 7,500 tons will be divided into three equal sublots.

    - The Inspector will select sample locations according to PTM No. 1. The Inspector will take possession of the sample and immediately transport the sample from the sampling point to the testing site. The Inspector will test all three sample increments for compliance as specified in Section 703.2(c), Tables C and D plus the Crushed Fragments Test of Table B. Aggregates other than gravel will use 100 as the PWL for the Crushed Fragments Test according to Table

B. The Inspector will provide the test results within 5 days of sampling. Failure to provide test results within the targeted timeframe will not form a basis to dismiss the test results, and the test results will govern in all cases.

- If less than 7,500 tons remain for the project, the remaining quantity will be considered a lot. Divide the remaining approximated quantity into three equal sublots so three increments are obtained.

- If a change in aggregate sources is made before three increments are obtained for a lot, obtain additional increments from remaining materials on the project to provide one full acceptance sample (n=3) from the first source.

- The Inspector will document the placement location(s) by station of material placed to clearly delineate the location of all material within the lot.

- The Department will continue project lot acceptance testing until five consecutive lots are accepted at ≥ 90 PWL. Once five consecutive lots are accepted at ≥ 90 PWL, acceptance may again be by producer certification and verification testing will begin again at the frequency according to Table F for the remaining project quantity. The Contractor will be charged $600 for each lot of material placed, for the project lot acceptance testing performed by the Inspector.

- For all test values, the Department will determine the lot PWL as specified in Section 106.03(a)3. If results indicate a PWL ≥ 90, the lot is accepted at full payment. If results indicate a PWL <90 for the material, the Department will determine the Degree of Non-Conformance (DNC) for the lot according to the following:

  - Lot average values for all sieve sizes which do not conform to the specified limits will be used to calculate the DNC. For each sieve where the average does not conform to specifications, the difference between the average test value and the closest specified limit will be computed (upper limit for average values where the upper limit has been exceeded or lower limit for average values where the lower limit was not reached). Each difference will be multiplied by the factor according to Table G.

  - Crushed fragment average test results which do not conform to the specified limits will also be included in the DNC. The DNC will include the difference between the lower specified limit and the lot average crushed fragment test results.

  - The Department will determine the total DNC for the lot by summing of all the non-conformances for each sieve size and crushed fragments after each has been multiplied by applicable factors according to Table G and Table H. The total DNC will be used to adjust the payment represented by the non-conforming lot according to Table I.

TABLE G
Multiplication Factors for DNC

Sieve Size	Multiplication Factor
4 inch to No. 4 inclusive	1.0
No. 5 to No. 80 inclusive	1.5
No. 100	2.0
No. 200 (Table D)	Table H
Crush Count	1.0

TABLE H
No. 200 Sieve Upper Limit and Multiplication Factor

% Maximum	Upper Limit To Calculate DNC	Multiplication Factor
10	10.49	2.5
5	5.49	2.5
2	2.49	2.5
1	1.49	2.5
2.0	2.05	5
1.0	1.05	5

TABLE I
DNC Pay Reduction Percent

Total Sum of DNC	Percent of Contract Unit Price Reduction
0.5 to 3.0	2%
3.1 to 5.0	4%
5.1 to 8.0	7%
8.1 to 12.0	11%
Greater than 12.0	**
**If the sum of the DNC is greater than 12.0, the Representative will direct the material represented by the lot (n=3) be removed and replaced at no additional cost to the Department or left in place and final payment for the material will be at 70% of the contract unit price. Pending the decision by the Representative, do not place additional materials on or incorporated with the non-conforming material.	

4. QA Samples. CMD QA samples (n=3) may be taken at the source of supply or at the point of placement on the project. Submit samples to the LTS for testing. If results for any type of material indicate a PWL of less than 90, the District will immediately obtain an additional verification sample (n=3) at the appropriate site (project or source). The Department will test all three sample increments at either the producer's location or at the project site and determine the PWL for the material. If results indicate a PWL for the material of less than 90, obtain source verification samples and project verification samples as specified in Section 703.5(b)2 and Section 703.5(b)3.

(c) Weighing Responsibilities. Prepare weight slips and certifications attesting to the accuracy of the weights recorded and ensuring conformance as specified in Section 107.23(b). Designate a licensed weigh person(s) to act as the Contractor's agent. Ensure scales are calibrated annually by an independent agency acceptable to the Department. A Department Inspector may provide random checking.

Weigh empty trucks used to haul material measured by mass (weight) daily unless otherwise directed. If the invoice mass (weight) exceeds the net mass (net weight) determined by a Department mobile weigh team by more than 3%, the Department will consider the deviation to be excessive. Take immediate corrective action upon notification of an excessive deviation. Within 30 days of notification, provide the District Executive with a written description of corrective actions and safeguards and the time they were implemented.

703.6 CERTIFICATION OF AGGREGATES AT ASPHALT AND CEMENT CONCRETE PLANTS—

(a) Certification. Certify aggregate at asphalt and cement concrete plants yearly for quality requirements as specified in Section 106.03(b)3 using Form CS-4171 or another acceptable form.

SECTION 704—CEMENT CONCRETE

704.1 GENERAL—

(a) Description. Furnish the indicated class of cement concrete according to the requirements of Table A. Cement concrete is a mixture of portland cement, fine aggregate, coarse aggregate, water and air-entraining admixture, with or without water reducing admixture, retarding admixture, or supplementary cementitious material (SCM)

The methods of producing concrete referred to in these Specifications are defined as follows:

1. Plant Mixed Cement Concrete. Concrete proportioned and mixed in either a stationary, commercial, and central plant or a stationary plant located near the project. Concrete is delivered to the work site by truck, agitator truck, or mixer truck.

2. Truck Mixed Cement Concrete. Concrete prepared by dry batching in a proportioning plant and placing the dry ingredients in a truck mixer. Measured water is then added to the truck drum from the plant water system and the concrete is mixed in the truck at the plant. Mixing is not allowed en-route to or at the work site.

3. Volumetric Mixed Cement Concrete. Concrete proportioned and mixed in a truck-mounted mobile mixer. The unit is capable of proportioning concrete ingredients from self-contained bins and mixing the materials with measured water in a self-contained mixer. The concrete is mixed and discharged at the work site.

(b) Material.

- Cement—Section 701
- Fine Aggregate, Type A—Section 703.1
- Coarse Aggregate, Type A, maximum size AASHTO No. 467, No. 57, No. 67 or No. 8 (Stone, Gravel, or Slag)—Section 703.2
- Coarse Aggregate, Type A Lightweight, Section 703.2(a) 6
- Water—Section 720.1
- Admixtures—Section 711.3
- Supplementary Cementitious Material (SCM)—Section 724

Table A
Cement Concrete Criteria

Class of Concrete	Use	Cement Factor(2)(4) (lbs./cu. yd.)		Maximum Water Cement Ratio(5) (lbs./lbs.)	Minimum Mix(1,7) Design Compressive Strength (psi) Days				28-Day Structural Design Compressive Strength (psi)
		Min.	Max.		3	7	28(8)	56(8)	
AAAP	Bridge Deck	560	640	0.45	—	3,000	4,000	—	4,000
AAA(3)	Other	634	752	0.43	—	3,600	4,500	—	4,000
AAAP LW	Bridge Deck	600	730	0.45	---	3,000	4,000	---	4,000
AA	Slip Form Paving	587	752	0.47	—	3,000	3,750	—	3,500
AA	Paving	587	752	0.47	—	3,000	3,750	—	3,500
AA	Accelerated(6)	587	800	0.47	—	—	3,750	—	3,500
AA	Structures and Misc.	587	752	0.47	—	3,000	3,750	—	3,500
AA LW		587	752	0.47	---	3,000	3,750	---	3,000
ASC(9)		587	846	0.47	---	---	4,000	---	4000
A		564	752	0.50	—	2,750	3,300	—	3,000
C		394	658	0.66	—	1,500	2,000	—	2,000
HES		752	846	0.40	3,000	—	3,750	—	3,500

(1) Test Procedures: Slump—AASHTO T 119; Compressive Strength—PTM No. 604, or Maturity Meter Method—PTM No. 640. The upper age limit and lower age limit are defined by the values listed for 7-day and 28-day compressive strength.

(2) For use in miscellaneous or structural concrete, if the Fineness Modulus (FM) is between 2.3 and 2.5, increase the minimum cement factor for the class of concrete 47 pounds per cubic yard. This requirement may be waived after adequate strength data is available and analyzed according to the mix-design section in ACI 211.

(3) AAA concrete is not allowed to be used for new bridge decks.

(4) For exception, see Section 704.1(c). Cement factor may be increased to a maximum of 690 pounds per cubic yard with the approval of the DME/DMM.

(5) If a portion of the cement is replaced by SCM, use a water to cement plus SCM ratio by weight. The minimum water cement ratio for AAAP is 0.40 pounds per pounds.

(6) For accelerated cement concrete, submit mix design, as specified, Section 704.1(c), having a minimum target value compressive strength of 1,500 pounds per square inch at 7 hours if tested according to PTM No. 604. (1,500 pounds per square inch at 7 hours is for mix design acceptance only). The required compressive strength for opening to traffic is specified in Section 501.3(q).

(7) Trial Mix Designs for Class AAAP, AAAP LW, ASC and all concrete paving mixtures are required to meet a minimum 28-day compressive strength overdesign requirement of 28-day Minimum Mix Design Compressive Strength plus 500 pounds per square inch.

(8) DME/DMM may accept mix designs based on the 56-day strength based on qualification testing.

(9) For accelerated structural cement concrete, submit mix design, as specified in Section 704.1(c), having a minimum target value compressive strength of 3,500 pounds per square inch at 24 hours and 3,000 pounds per square inch to open to traffic when tested according to PTM No. 604.

1. Density of Material. Except for admixtures, use the following material densities (unit weights) if proportioning cement concrete:

Type of Material	**Density**
Water	62.4 pounds per cubic foot
Cement	94.0 pounds per cubic foot
Fine Aggregate	Based on bulk specific gravity as specified in Section 704.1(b)2
Coarse Aggregate	
Stone or Gravel	Based on bulk specific gravity as specified in Section 704.1(b)2
Slag	Based on field tests as specified in Section 704.1(b)2
Lightweight	Based on bulk specific gravity as specified in Section 704.1(b)2
SCM	Based on the LTS Tests

2. Specific Gravity of Aggregates. For fine and coarse aggregates, use the bulk specific gravity (saturated, surface-dry basis) listed in Bulletin 14.

For lightweight aggregate use the bulk specific gravity value (saturated surface-dry basis) listed in Bulletin 14, or the SSD gravity provided by the lightweight aggregate if purchased. As an alternative, the producer may run the SSD test and absorption with District Materials unit present.

If slag is used, test at the site to determine its loose-struck unit weight, solid volume per cubic yard, and bulk specific gravity factor (saturated surface-dry basis). Establish the concrete proportions based on the bulk specific gravity factor determined by the test. Check the unit weight of the slag daily to maintain the established solid-volume proportions.

3. Adjustment of Weight of Free Water. Adjust the batch weight of the aggregate to compensate for the free water on the aggregate. Base this adjustment on tests of representative samples taken from aggregate stockpiles.

4. Batching. For plant and truck mixed cement concrete, batch by weight. For volumetric mixed cement concrete, batch by volume.

(c) Design Basis.

1. General. Compute and prepare concrete mix designs according to ACI 211. For AAAP, AA Paving, and AA Slip Form Paving mix designs, determine the aggregate gradation for the mix design according to PTM No. 528. This does not apply to AAAP with #8's. Base concrete mix designs on the materials to be used in the work.

Overdesign strengths will be a minimum of 1,000 pounds per square inch except for AAAP, AAAP LW, AA Paving, and ASC which will be 500 pounds per square inch.

Make trial mixtures for each class of concrete and mold and cure test specimens. If the requirements of Table A cannot be achieved, furnish other acceptable materials or make necessary changes in the mixing procedure to conform to the specified requirements. Notify the DME/DMM at least 3 days in advance of preparing trial mixtures.

At the start of construction, mix a full-sized batch using the type of mixer and the mixing procedure planned for the project. Use this batch to provide the basis for final adjustment of the accepted design.

Mixture qualifications testing of Anti-Washout concrete according to PTM No. 641 to determine the maximum loss and required anti-washout admixture dosage may be conducted at an accredited lab or by the ready-mix producer with oversight from a technical representative from the admixture supplier. Trial batching for determination and verification of other design requirements must be performed by the ready-mix producer as specified in Section 704.1(c). Document the test results from the mixture qualification testing on the mix design before submitting for Department review.

2. Cement Factor. For all classes of concrete, use the minimum cement factor (cement, blended cement, or cement and SCM(s) combined) specified in Table A, except as follows:

Portland cement may be replaced with SCM(s) provided the maximum replacement by mass percentages in Table G, Prevention Level Z are not exceeded. The maximum limit of the cement factor may be waived if SCM(s) is/are added to the mix provided the portland cement portion does not exceed the maximum cement factor specified.

For AAAP and AAAP LW cement concrete, replace Type I or Type II portland cement with SCM (silica fume, flyash or slag cement) weighing as much as or more than the portland cement replaced. The percentages of SCM applicable to AAAP concrete are as shown below. Limit SCM to not more than two of the three SCMs listed below in one mix design as long as one of the SCM supplements meets the minimum percentage of replacement.

Cement factor must include at least one of the following as a replacement for a portion of the cement:

Slag Cement (Grade 100 or higher)	25% (min)
Flyash (Type C or Type F)	15% (min)
Silica Fume	5%-10%

3. Air Content. Design cement concrete to have an air content of 6.0% in the plastic state. Design AAAP and AA(pave) concrete mixes to have an air content of 7.0% in the plastic state. Obtain the air content through the addition of a solution of an air-entraining admixture as specified in Section 704.1(e)4. Use the quantity of air-entraining admixture necessary to maintain the plastic concrete air content, determined according to AASHTO T 152 (DO NOT APPLY AN AGGREGATE CORRECTION FACTOR) for stone and gravel and AASHTO T 196 (DO NOT APPLY AN AGGREGATE CORRECTION FACTOR for slag or lightweight coarse aggregate, within a tolerance of ± 1.5% during the work. The plastic concrete air content includes entrapped and entrained air.

If the hardened concrete exhibits deficiencies or the Representative suspects the hardened concrete to have deficiencies, and, if directed, determine the percent of entrained air in the hardened concrete according to PTM No. 623. Voids greater than 0.2 mils and less than 40 mils in their smallest dimension are considered entrained air. Voids 40 mils or more in diameter are considered entrapped air. The entrained air in the hardened concrete must be between 3.5% and 7.5%, inclusive. For AAAP and AA(pave) mixes, the entrained air in the hardened concrete must be between 4.5% and 8.5% inclusive.

4. Mix Design Acceptance. Submit a copy of each completed mix design to the Representative before its use in the work. The Department reserves the right to review all design through plant production before its use in Department work at no additional cost to the Department. The concrete design submitted for review is required to comply with the specified concrete class requirements, supported by slump, air content, and compressive strength test data according to ACI 211.

The Department will accept concrete designs based on the 7-day strength tests (Class High Early Strength (HES) may be accepted based on 3-day strength tests); however, conduct 28-day tests to show the potential of the design mix. The Department may also accept designs based on the 28-day tests.

Design AAAP cement concrete mixtures to achieve slow strength gain. Adjust component proportions with an objective of attaining a 28-day to 7-day compressive strength ratio during mix design greater than or equal to 1.20. A PennDOT inspector will witness the compressive strength tests. The 1.20 ratio is for mix design purposes only and not to be utilized as an acceptance factor during production. In no case will the Department accept any mixture during design which fails to meet a minimum 28-day to 7-day compressive strength ratio of 1.20.

Additional criteria for mix design acceptance of AAAP concrete are as follows:

The producer is required to complete the following tests before mix design submittal and approval.

- **Permeability** – Design the concrete mixture to meet a target permeability of 2,000 coulombs after a 56-day curing period according to with AASHTO T 277 or AASHTO T 358, not to exceed 2,800 coulombs.
- **Shrinkage (Microstrain)** – The 28-day shrinkage according to ASTM C157 is not to exceed 500 microstrain unless approved up to 550 microstrains by the DME/DMM. Wet cure specimens in the lab for 14 days before beginning the 28-day shrinkage testing (42 total days).

If permeability and shrinkage testing have been met for AAAP with #57's, these tests are not required for AAAP with #8's, provided the aggregates are from the same source.

A higher-class concrete may be used in place of an indicated lower-class concrete if the higher-class concrete conforms to all the requirements of the indicated lower class, and if approved by the Department.

5. Lightweight Cement Concrete (AAAP LW and AA LW). Compute and prepare concrete mix designs according to ACI 211.2. Design lightweight cement concrete to have a range of Equilibrium Density of 110 pounds per cubic feet to 117 pounds per cubic feet with a target of 115 pounds per cubic feet, when tested according to ASTM C567

Supply the following information to the District Materials Unit at least two weeks before conducting trial mixes:

- Approximate absolute volume of coarse aggregate (cubic feet)
- Suggested coarse aggregate factor (CAF) (pounds per cubic yard)
- Oven-dry loose weight of coarse aggregate (pounds per cubic feet)
- Specific gravity factor
- Percent absorption

Store and use lightweight aggregates in a stable, uniform, saturated condition to ensure the aggregate, if batched, is at a moisture greater than saturated surface dry (SSD). Use the same source of aggregates and mix design throughout the entire project.

Plastic density can be used for field acceptance once a correlation between plastic density and equilibrium density is established. Equilibrium density as measured according to ASTM C567.

Entrained air content can be determined by the unit weight method according to ASTM C138. Once established, a correlation between air content as tested according to ASTM C 173 and the unit weight method can be made.

6. Sulfate Resistance Concrete. Design sulfate resistant concrete according to ACI 201.2.

(d) Testing and Acceptance.

1. QC Plan. Prepare a QC Plan as specified in Section 106.03 and submit it for review before the start of the project and at least annually thereafter. Include in the QC Plan testing frequencies and action points to initiate corrective measures. Do not start work until the Department has reviewed the QC Plan. Furnish a copy of the QC Plan to be maintained in the Department's project field office.

1.a Field Operation QC Plan. Prepare a field operation QC Plan for the Representative's review, as outlined on Form CS-704, to evaluate concrete field operation. Submit the field operation QC Plan at the Pre-construction conference or at least 2 weeks before the first concrete pour. Describe the construction equipment, personnel, and methods necessary to construct and test concrete courses for all structural elements. Include testing frequencies and action points to initiate corrective measures. Do not establish action points at either the upper or lower specification limits.

2. Concrete Technician. Provide, and assign to the work, a concrete technician properly instructed and trained to develop the concrete design, to control the quality and gradation of aggregates used, to perform required concrete tests, and to control the operations and concrete deliveries so the completed mixture conforms to the specifications at the point of placement.

The Department's concrete plant Inspector will not allow concrete considered unacceptable to be shipped to the project. The Inspector will not assume, by act or by word, any responsibility for batch control adjustments; calculations; or for setting of dials, gauges, scales, or meters. Failure of the Inspector to reject unacceptable concrete will not relieve the Contractor's obligation to provide concrete conforming to the specifications.

2.a Concrete Field Testing Technician. Provide, and assign to the work during placement of material, a PennDOT certified field testing technician, meeting the requirements according to Publication 536, to perform the required acceptance testing. The technician must carry a valid PennDOT certification card during placement of material.

3. Testing Facilities and Equipment. Provide sufficient thermometers, air meters conforming to AASHTO T 196 and T 152, and slump cones conforming to AASHTO T 119 for each separate project operation as needed. In the presence of the Inspector, calibrate all air meters a maximum 2 weeks before beginning concrete placement. Recalibrate all air meters, in the presence of the Inspector, every 2 weeks during concrete placement. Have back-up equipment available to ensure no tests are missed. Provide sufficient 6-inch by 12-inch cylinder molds and tight-fitting domed caps (PTM No. 611) for QC, acceptance, verification, and QA samples. Provide sufficient incidental equipment such as wheelbarrows, shovels, and scoops as needed.

Provide acceptable means to conduct compressive strength testing using a compression machine and capping device conforming to PTM No. 604. Provide a curing tank conforming to PTM No. 611. Provide curing boxes, or other acceptable equipment, conforming to PTM No. 611 and capable of maintaining the air temperature immediately adjacent to the field-cured cylinders in the range of 60F to 80F for the first 24 ± 2 hours. Provide sufficient high-low thermometers or other temperature recording devices to monitor the temperatures next to the test cylinders. If required, cap cylinders at the testing site under the Representative's supervision.

If using the maturity method to estimate concrete compressive strength, provide one or more maturity meters and a sufficient number of temperature sensors conforming to PTM No. 640. Note: Casting concrete cylinders according to PTM 611 is recommended in case maturity meter equipment malfunctions.

Maintain all equipment used for testing in an operable condition. Using an independent agency acceptable to the Department, calibrate scales, balances, and the compression machine at least once per year. Recalibrate the compression machine whenever it is relocated. Maintain accurate records of calibration. If the compression machine is out of tolerance or malfunctions, return it to working order within 24 hours or supply a back-up machine until the problem is corrected.

Provide the necessary facilities for inspection, including a plant office as specified in Section 714.5(a), with the exception of a minimum floor space of 120 square feet.

4. QC Testing. Perform QC testing according to the reviewed QC Plan and as follows:

4.a QC Sampling and Testing of Plastic Concrete. Select an appropriate slump target value and range that will provide a workable mix for the construction element. The Contractor's technician must have a copy of the Department reviewed QC Plan in their possession during testing and must be aware of the target slump for the structural element being placed. Do not exceed the following slump upper limits:

Type of Mix	**Slump Upper Limit**
without water reducing admixtures	5 inches
with water reducing admixtures	6 1/2 inches
with high range water reducing admixtures (superplasticizers)	8 inches
mixes specified in Section 704.1(h) (except tremie concrete as specified in Section 1001.2(j))	2 1/2 inches
AAAP (regardless of admixtures used)	5 1/2 inches
AAAP LW (regardless of admixtures used)	6 inches

Perform plastic concrete slump, air, density (for AAAP LW and AA LW) and temperature tests on the first three consecutive trucks at the beginning of concrete placement operations or after a significant stoppage such as plant or equipment breakdown to determine if material control has been established. Material control is established when all test results of concrete slump, air, and temperature for three consecutive trucks are determined to be within the established action points. Obtain samples of fresh concrete according to PTM No. 601. Perform slump tests according to AASHTO T 119, air content tests according to AASHTO T 152 (DO NOT APPLY AN AGGREGATE CORRECTION FACTOR) or T 196 (DO NOT APPLY AN AGGREGATE CORRECTION FACTOR) (AASHTO T196 for AAAP LW and AA LW), temperature tests according to ASTM C1064, and density testing according to AASHTO T 121(for AAAP LW and AA LW) Report test data to the concrete technician promptly in order to facilitate necessary changes. Continue testing consecutive trucks until material control is established. Once material control is established, the frequency of testing may be reduced to a minimum of one test per 50 cubic yards. Select concrete batches for sampling according to the reviewed QC Plan or as directed by the Inspector. Notify the Inspector if sampling and QC testing are to be performed. The Inspector will witness the sampling and QC testing. If a QC test fails to conform to the specified requirements or exceeds the upper or lower action points included in the reviewed QC Plan, increase the testing frequency to every truck until material control has been reestablished.

Maintain the cement concrete consistency within 1 1/2 inches of the selected target slump value (target range). If the upper slump limit is exceeded on any slump test, the Contractor's technician shall reject the cement concrete. If any slump test result falls outside the target range and has not exceeded the upper limit, immediately perform the air content and temperature tests. If the air content and concrete temperature is within the specified limits, the Contractor may incorporate the material into the work provided a full set of quality control and acceptance cylinders are molded in addition to the cylinders made for the originally selected PTM No. 1 sample location, for compressive strength testing according to PTM No. 611 and PTM No. 604. If one or more truckloads of cement concrete exceeds the slump target range, make additional quality control and acceptance cylinders from each truck. Use the lowest compressive strength cylinders for acceptance of the lot.

Do not incorporate concrete into the work that does not conform to the specified requirements.

4.b QC Compressive Strength Test Cylinders. From the same sample of concrete selected for acceptance testing as specified in Section 704.1(d)5, mold a sufficient number of concrete QC cylinders to be tested for 3-day or 7-day compressive strength, 14-day compressive strength (AAAP), 28-day compressive strength, form removal strength, and loading strengths, as specified.

If using the maturity method to estimate concrete compressive strength, mold two or more cylindrical specimens for temperature history recording and embed a temperature sensor at the vertical and horizontal center of the cylindrical specimen and activate the maturity meter or data acquisition equipment to record the temperature history for the 3-day, 7-day, 14-day (AAAP), 28-day, and, as required, 56-day compressive strength analysis.

Field cure cylinders according to PTM No. 611, Section 11.2, for the specified curing period. After concrete curing is discontinued, QC cylinders may be relocated to a preapproved, acceptable, secure area, to protect them from damage. Provide maintenance and security for the area at no additional cost to the Department. The secure area must be easily accessible for inspection at all times. Continue to provide the same field cure and protection from the elements on all surfaces of the cylinders as that provided for the in-place concrete the cylinders represent until the cylinders are tested for compressive strength. Remove cylinders from molds at the same time formwork is removed.

Perform QC testing for 3-day or 7-day compressive strength, 14-day compressive strength (AAAP), 28-day compressive strength, and form removal and loading strengths according to PTM No. 611. If using the maturity method to estimate concrete compressive strength, perform QC testing using the procedure to estimate in place strength according to PTM No. 640. Do not use the maturity method for determining acceptance strength, typically at 28 days. Notify the Inspector when QC testing is to be performed. The Inspector will witness the QC testing.

Unless otherwise directed, use QC test results for 3-day or 7-day compressive strength and form removal and loading compressive strength to determine whether to place additional concrete in areas that will be impacted by the lot of concrete represented by the QC cylinders. Acceptable QC compressive strength test results do not relieve the Contractor's responsibility for providing concrete conforming to the 28-day minimum mix design compressive strength acceptance requirements as specified in Section 704.1(d)5.

For AAAP and Prevention Level Z mixes, in addition to the samples required above, mold two concrete cylinders and cure them under QC conditions for 56 days. After 56 days test the two cylinders for compressive strength and report the compressive strengths.

4.b.1 3-Day or 7-Day or 14-Day (AAAP) QC Compressive Strength. If the average 3-day (HES concrete only) or average 7-day QC compressive strength test result is greater than or equal to the minimum mix design compressive strength requirement specified in Table A, the Contractor may discontinue the field cure on the lot of concrete represented by the QC cylinders unless otherwise directed. If the average 14-day (AAAP) QC compressive strength test result is greater than or equal to 3,500 pounds per square inch, the Contractor may discontinue the field cure on the lot of concrete represented by the QC cylinders, unless otherwise directed.

If the average 3-day (HES concrete only) or average 7-day QC compressive strength test result is less than the minimum mix design compressive strength requirement specified in Table A, continue the field cure on the lot of concrete represented by the QC cylinders until the specified 28-day minimum mix design compressive strength is obtained, or for a maximum of 28 days. If the average14-day (AAAP) QC compressive strength test result is less than 3,500 pounds per square inch, continue the field cure on the lot of concrete represented by the QC cylinders, until the specified 28-day minimum mix design compressive strength is obtained, or for a maximum of 28 days.

4.b.2 28-Day QC Compressive Strength. If the average 28-day QC compressive strength test result is greater than or equal to the 28-day minimum mix design compressive strength specified in Table A, acceptance of the concrete lot will be based on the compressive strength testing of acceptance cylinders as specified in Section 704.1(d)5.

If the average 28-day QC compressive strength test result is less than the 28-day minimum mix design compressive strength specified in Table A, but greater than or equal to the 28-day structural design compressive strength specified in Table A, acceptance of the concrete lot will be based on the compressive strength testing of acceptance cylinders as specified in Section 704.1(d)5, and as follows:

- Perform an investigation of procedures for material sampling, testing, and concrete cylinder molding and curing, and evaluate the concrete mix design and specification compliance to determine possible causes for the QC test result not meeting the specified minimum mix design compressive strength.

- Implement corrective actions as required.

- Submit an investigation report to the District Executive within 10 working days for review and approval.

If the average 28-day QC compressive strength test result is less than the 28-day structural design compressive strength specified in Table A, acceptance of the concrete lot will be based on compressive strength testing

of cores obtained from the lot of concrete represented by the QC cylinders as specified in Section 110.10(d).

5. Acceptance Testing. Determine the lot size, or portion thereof for partial lots, for material acceptance according to Table B. Establish new lots daily for each class of concrete. Lots must be specific to a particular structural element, except for incidental concrete items. The Contractor may use a lot combining structural elements if allowed in writing before concrete placement and if the following conditions are met:

- The total volume is 100 cubic yards or less.
- The combined structural elements are constructed using the same mix design concrete.
- The combined structural elements are cured using identical curing methods and conditions.

Cylinders (and cores if necessary) for this lot will represent all the combined elements.

TABLE B
Lot Size for Concrete Acceptance

Construction Area	Lot Size
Structural Concrete	100 cu. yd.
Pavement Concrete	500 cu. yd.
Pavement Patching Concrete	200 cu. yd.
Incidental Concrete	100 cu. yd.

The Representative will select sample locations for acceptance testing according to PTM No. 1 (n=1). Perform sampling and testing for acceptance in the presence of the Representative. Obtain samples of fresh concrete at the point of placement according to PTM No. 601. Perform concrete temperature tests. Perform air content tests according to AASHTO T 196 or T 152. Reject all concrete not conforming to the specification requirements at the point of placement.

If the results of plastic concrete testing conform to the specification requirements, mold a sufficient number of acceptance cylinders according to PTM No. 611 from the same sample of concrete taken for slump, air content, and temperature determination. Standard cure acceptance cylinders according to PTM No. 611, Section 11.1, for 28 days and 56 days (AAAP and Prevention Level Z) at an acceptable location. Conduct 28-day and 56-day (AAAP and Prevention Level Z mixtures only) compressive strength testing of two acceptance cylinders according to PTM No. 604. If for any reason two testable acceptance cylinders are not available for compressive strength testing, obtain two cores of the representative concrete within 3 working days as directed, and at no additional cost to the Department. Conduct 28-day compressive strength testing of the cores according to PTM No. 604.

The Department will accept the lot of concrete if the average 28-day acceptance cylinder compressive strength test result is greater than or equal to the 28-day minimum mix design compressive strength specified in Table A and if the average 28-day QC compressive strength requirements specified in Section 704.1(d)4.b have been met.

If the average 28-day acceptance cylinder compressive strength test result is less than the 28-day minimum mix design compressive strength specified in Table A, acceptance of the concrete lot will be based on the procedures as specified in Section 110.10.

6. Verification Testing. The Representative will perform verification testing on the initial acceptance sample for each type of concrete specified in Table B and a minimum of one verification test for every ten acceptance samples thereafter. Verification testing will consist of testing for temperature, air content, and compressive strength. Verification tests will be performed on concrete from the same sample used for acceptance testing.

The Representative will obtain the temperature of the sample concurrently with the acceptance sample. Immediately after an acceptable air content test result for acceptance is obtained, the Representative will test the sample for air content according to AASHTO T 196 or T 152 using the same air meter.

The Representative will mold two verification cylinders according to PTM No. 611. Standard cure the verification cylinders along with the acceptance cylinders according to PTM No. 611, Section 11.1, for 28 days. Conduct 28-day compressive strength testing of the verification cylinders according to PTM No. 604 in the presence of the Representative. Conduct the testing at the same time the acceptance cylinders are tested and using the same equipment.

Verification test results will be compared to the associated acceptance test results and will not be used to determine acceptance of the lot. If there is a difference in test results of more than 5F for temperature, 1.0% for air

content, or 500 pounds per square inch for compressive strength, the Representative will immediately review the testing procedures, equipment, and personnel used in the acceptance testing and implement corrective measures to ensure the tests are performed within the prescribed tolerances. The Representative will record the acceptance test results, the verification test results and applicable corrective measures in the Concrete Inspector's Daily Record Book, Form CS-472.

7. QA Testing. The CMD QA personnel will obtain QA samples as part of the operation review process according to the QA Manual, Publication 25.

QA personnel will select concrete to be sampled. Obtain samples of fresh concrete at the point of placement according to PTM No. 601. Perform concrete temperature tests adjacent to those conducted by QA personnel. Perform air content tests according to AASHTO T 196 or T 152 with the air meter used for acceptance testing and the backup air meter. Immediately report all test results to the QA personnel. Reject all concrete not conforming to the specification requirements at the point of placement.

QA personnel will immediately perform an independent assurance evaluation of the temperature and air content test results. If the difference in test results is more than 5F for temperature or 1.0% for air content, the Representative will immediately review the testing procedures, equipment, and personnel used in the acceptance testing and implement corrective measures to ensure the tests are performed within the prescribed tolerances.

Mold five QA cylinders from the selected sample according to PTM No. 611. Field cure the QA cylinders according to PTM No. 611, Section 11.2, for the specified curing period for the structural element the cylinders represent. After curing of the in-place concrete is discontinued, QA cylinders may be relocated to a pre-approved, acceptable, secure area, to protect them from damage. Provide maintenance and security for the area at no additional cost to the Department. The secure area must be easily accessible for inspection at all times. Continue to provide the same field cure and protection from the elements on all surfaces of the cylinders as that provided for the in-place concrete the cylinders represent until the cylinders are tested for 28-day compressive strength.

Conduct 28-day compressive strength testing on two QA cylinders according to PTM No. 604 using the same equipment used for acceptance and verification testing.

The Representative will forward the remaining three QA cylinders to the LTS for 28-day compressive strength testing according to PTM No. 604 and hardened air content testing according to PTM No. 623. Furnish packaging material and package cylinders under the direction and supervision of the Representative. Place the cylinders in individual containers cushioned with suitable material to prevent damage during shipment. The total weight of each container, cylinder and cushioning material must not exceed 50 pounds.

QA personnel will perform an independent assurance evaluation of the 28-day compressive strength test results. If the difference between the test results of the cylinders tested at the project site and the cylinders tested at the LTS is more than 500 pounds per square inch, the Representative will immediately review the testing procedures, equipment, and personnel used in the acceptance testing and implement corrective measures to ensure the tests are performed within the prescribed tolerances.

(e) Measurement of Material.

1. Cement. AASHTO M 157 and as follows:

For plant and truck mixed concrete, measure by weight. The Contractor may measure the weight of the cement separately in an enclosed compartment in the aggregate hopper. The Contractor may measure the weight of the cement and discharge it simultaneously with the aggregates, except as specified in Section 106.05(c).

For volumetric mixed concrete, measure by volume.

2. Aggregates. AASHTO M 157 and as follows:

For plant or truck mixed concrete, measure by weight unless otherwise allowed. Base measurements on the material weight-volume relationship, as specified in Section 704.1(b)1.

For volumetric mixed concrete, measure by volume.

3. Water. AASHTO M 157 except as follows:

Use water-measuring systems capable of discharging the total quantity of measured water into the plant or truck mixer drum in a time not greater than one-fourth of the specified mixing time. For truck mixed concrete, do not add water from the truck water system. Add water only from the plant water measuring system.

4. Admixtures. Incorporate the air-entraining admixture solution into the batch with the mixing water using a suitable visual measuring device. If another type of admixture is used with an air-entraining admixture, add it in

solution to another portion of the mix water, as directed, by an additional suitable visual measuring device, except high range water reducing and anti-washout admixtures will be added according to the manufacturer's recommendations.

Equip the measuring device with interlocks to prevent discharging during the charge cycle and to prevent charging during the discharging cycle. Provide a means to calibrate the measuring device to within ±3%.

Dispense the air-entraining admixture solution into the batch from a bulk supply tank. For paving, and if directed, provide a bulk supply tank containing sufficient solution for the entire day's concreting operations.

On the dispensing system, provide device(s) capable of detecting and indicating the presence or absence of admixture flow. Agitate admixtures, as required, to insure consistency of the solution.

5. SCM. If the use of SCM is allowed by the specification, add separately and measure cumulatively as specified in Section 704.1(e)1.

(f) Mixing Conditions.

1. During Cool and Cold Weather. If concrete is to be placed at air temperatures below 40F, or if the local weather bureau forecasts air temperatures to descend to 40F or lower at any time during the 24-hour period following concrete placement, use an acceptable method to ensure the aggregate is free of frozen lumps and at a temperature of not less than 40F or more than 100F at the time of charging into the mixer. Heat mixing water, if necessary, but do not exceed 150F. Do not allow water with a temperature above 90F to come in contact with the cement until the cement has been mixed with the aggregates.

2. During Hot Weather. In hot weather, cool the aggregates and the mixing water as necessary to maintain the concrete temperature from 50F to 90F at the time of placement. For bridge deck concrete placement, maintain the concrete temperature from 50F to 80F at the time of placement. For accelerated concrete placement, maintain the concrete temperature from 50F to 100F at the time of placement.

3. Retarding Admixtures. The Contractor may use retarding admixtures, or may be directed to use retarding admixtures, if any of the following conditions are anticipated:

- rapid drying of the concrete as a result of low humidity
- high winds
- high air temperatures

Introduce the retarder into the concrete mixture as specified in Section 704.1(e)4. Adjust the proportions of the design as necessary but do not use the retarder to replace any portion of the specified volume of cement.

Use a retarder available in sufficient quantities to provide the required degree of retardation under the prevailing weather conditions at the time of concrete placement.

(g) Mix Designs Using Potentially Reactive Aggregate.

1. Definition of Terms.

1.a Alkalis. Oxides of sodium and potassium generally derived from Portland cement, but may also be available to concrete from other sources such as; admixtures, de-icing salts, and, in rare instances, aggregates. Alkalis are calculated according to AASHTO M 85.

1.b SCM. A siliceous or siliceous and aluminous material that possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties. The term "SCM," includes flyash, slag cement, silica fume, and metakaolin.

1.c **Lithium Nitrate Admixtures.** A lithium nitrate admixture as listed in Bulletin 15.

1.d Alkali-Aggregate Reaction. A chemical reaction in concrete between alkalis and certain constituents of some aggregates. The products of this reaction, under certain conditions, may cause deleterious expansion within the concrete.

1.e Alkali-Silica Reaction. An alkali-aggregate reaction involving certain siliceous aggregates and some calcareous aggregates containing certain forms of silica.[(1)]

Note (1)—Siliceous substances known to react with alkalis are as follows: opal; chalcedony as a constituent of chert in carbonate rock or sand and gravel particles; tridymite and cristobalite, which are high temperature forms of silica found in andesite or rhyolite; acid glasses containing more than 65% silica; or intermediate glasses containing between 55% and 65% silica. Other siliceous substances that are potentially reactive with alkalis are strained quartz as a constituent of granite or granite gneiss and clay minerals as a constituent of graywackes, argillites, phyllites, and siltstones.

1.e.1. Determining Aggregate Reactivity.

1.e.1.a. Field Performance History. Field performance history according to AASHTO R 80, Section 6.1 of an aggregate may be used to establish the potential to contribute to deleterious ASR with the approval of the DME/DMM.

1.e.1.b Petrographic Examination. Petrography may be used to classify an aggregate as potentially reactive, but expansion testing is required to determine the extent of potential reactivity and the appropriate level of prevention.

1.e.1.c. Expansion Testing. Aggregates will be tested according to ASTM C1293 or AASHTO T 303 and listed in Bulletin 14. ASTM C1293 test results will be used to determine the reactivity level of an aggregate. Unless it is a new source, the AASTHO T 303 results will be used until ASTM C1293 testing is completed by the Department. The reactivity class of the aggregate will be used to determine the required level of prevention. If using aggregates with different reactivity levels, the highest reactivity level will be used for mitigation. If the expansion result for a coarse aggregate size is not listed in Bulletin 14, use of the expansion result from another coarse aggregate size listed in Bulletin 14 from the same source will be acceptable.

Use aggregates deemed potentially reactive only with cements or cement-SCM combinations as specified in Section 704.1(g)3. If one or both of the aggregates (coarse or fine) used in a mix is reactive, mitigation is required as specified in Section 704.1(g)3. This requirement applies to all concrete used in paving or permanent structures on Department projects, including latex modified overlays and precast and prestress concrete products.

For new Type A aggregate sources which do not have LTS expansion listed, LTS will initially perform AASHTO T 303 to determine the reactivity class. Any new source with an expansion that indicates the aggregate is non-reactive (R0) will initially be listed with an expansion of 0.11% (R1) requiring ASR mitigation until ASTM C1293 testing by LTS is completed.

Sources will be tested on a 5-year cycle according to ASTM C1293. Testing will be performed by LTS. If the new test results change the mitigation level of the aggregates, mix designs must be started immediately and all designs must be completed within 90 days of receiving test results.

2. Selecting Preventive Measures for Alkali-Silica Reaction.

2.a Using the Concrete Prism Test (ASTM C1293) to Evaluate Preventive Measures.

2.a.1 Mixture Qualification. The concrete prism test may be used to evaluate the efficacy of SCMs or blended cements or both used with volumetric SCM replacements less than those specified in Section 704.1(g)2.c as a prescriptive remediation method and for all mixtures utilizing remediation with either metakaolin or a lithium nitrate admixture. If lithium nitrate admixtures are used, the admixture must be added to the mix water and necessary corrections made to account for the water in the admixture. If the expansion of concrete prisms is less than 0.04 percent after 2 years, the preventive measure will be deemed effective with the reactive aggregate(s).

For mixtures qualified using the preventive measure, substitutions of the cement (type for type), or SCM(s), type for type will be allowed provided the alkali limits as specified in Section 704.1(g)3 are not exceeded. Substitution of aggregates using the preventive measure is prohibited.

2.b Steps for Selecting Preventive Measures for Alkali Silica Reaction.

2.b.1 Determine the level of prevention by considering the reactivity class of the aggregate(s), classification of the structure type, and the associated risk level.

2.b.1.a Aggregate Reactivity. The degree of alkali silica reactivity of an aggregate will be determined as specified in Section 704.1(g).1.d.1.c and as indicated in Table C.

Table C
Classification of Aggregate Reactivity

Aggregate Reactivity Class	Description of Aggregate Reactivity	1-Year Expansion in ASTM C1293 (percent)	14-d Expansion in AASHTO T 303 (percent)
R0	Non-reactive	≤ 0.04	≤ 0.10
R1	Moderately reactive	>0.04 to ≤ 0.12	>0.10 to ≤ 0.30
R2	Highly Reactive	>0.12 to ≤0.24	>0.30 to ≤0.45
R3	Very Highly Reactive	>0.24	>0.45

2.b.1.b Risk of ASR. Determine the level of ASR risk occurring in a structure by considering the aggregate reactivity class in Table D.

Table D
Level of ASR Risk

Aggregate Reactivity Class	R0	R1	R2	R3
Level of ASR Risk	Risk Level 1	Risk Level 2	Risk Level 3	Risk Level 4

2.b.1.c Level of Prevention. The level of prevention is determined from Table E by determining the risk of ASR from Table D together with the class of structure from Table F.

Table E
Determining the Level of Prevention

Level of ASR Risk	**Classification of Structure**		
	S1	S2	S3
Risk Level 1	V	V	V
Risk Level 2	V	W	X
Risk Level 3	W	X	Y
Risk Level 4	X	Y	Z

Table F
Structure Classification

Structure Class	Consequences	Acceptability of ASR	Structure/Asset Type	Sections
S1	Safety and future maintenance consequences small or negligible	Some deterioration from ASR may be tolerated	Temporary structures. Inside buildings. Structures or assets that will never be exposed to water	620, 621, 624, 627, 628 643, 644, 859, 874, 930, 932, 934, 952, 953, and 1005
S2	Some minor safety, future maintenance consequences if major deterioration were to occur	Moderate risk of ASR acceptable	Sidewalks, curbs and gutters, inlet tops, concrete barrier and parapet. Typically structures with service lives of less than 40 years	303, 501, 505, 506, 516, 518, 523, 524, 525, 528, 540, 545, 605,607, 615, 618, 622, 623, 630, 633, 640, 641, 658, 667, 673, 674, 675, 676, 678, 714, 852, 875, 910, 948, 951, 1001, 1025, 1040, 1042, 1043, 1086, 1201, 1210, 1230, and Miscellaneous Precast Concrete
S3	Significant safety and future maintenance or replacement consequences if major deterioration were to occur	Minimal risk of ASR acceptable	All other structures. Service lives of 40 to 75 years anticipated.	530, 1001, 1006, 1031, 1032, 1040, 1080, 1085, 1107, MSE walls, Concrete Bridge components, and Arch Structures

2.c Minimum Levels of Supplementary Cementitious Materials (SCM) based on Level of Prevention. Utilize a minimum mass replacement level from Table G below.

Table G
Minimum Replacement Level of SCM (percentage by mass of cementitious material [12])

Type of SCM[1]	Alkali Level of SCM (% Na2Oe) [2], [3]	Level V[4]	Level W	Level X	Level Y	Level Z[5], [11]
Class F or C flyash[6]	≤ 3.0	–	15	20	25	35
Class F or C flyash[6]	>3.0 to ≤ 4.5	–	20	25	30	40
Slag Cement	≤ 1.0	–	25	35	50	65
Silica Fume[7], [8], [9], [10]	≤ 1.0	–	1.2 x LBA	1.5 x LBA	1.8 x LBA	2.4 x LBA

Notes:

(1) The SCM may be added directly to the mixture, be a blended cement, or a combination of a blended cement and a SCM.
(2) Where combinations of Class C and Class F are used, the alkalinity of the Class C flyash may exceed 4.5% provided the calculated alkalinity of the combination, based on the mass replacement, does not exceed 4.5%
(3) If two or more SCMs (including SCMs in blended cements) are used in combination, the minimum mass replacement levels given in Table G for the individual SCMs may be reduced provided the sum of the parts of each SCM is greater than or equal to one. For example, if silica fume and slag are used together, the silica fume level may be reduced to one-third of the minimum silica fume level given in the table provided the slag level is at least two-thirds of the minimum slag level required.
(4) No remediation is required at prevention Level V unless otherwise indicated by specification, e.g. Section 530.
(5) The alkali level of the concrete may be limited as specified in Section 704.1(g) 2.c.1
(6) The CaO must be limited to a maximum of 18%.
(7) The SiO must be greater than or equal to 85%
(8) The minimum level of silica fume is calculated based on the alkali (Na2Oe) content of the concrete contributed by the Portland cement and expressed in LBA (lbs./cy) by multiplying the cement content of the concrete in lbs./cy by the alkali content of the cement divided by 100. For example, for a concrete containing 500 lbs./cy with an alkali content of 0.81% Na2Oe, the value of LBA = 500 x 0.81/100 = 4.05 lbs./cy. For this concrete, the minimum replacement level of silica fume for Level Y is 1.8 x 4.05 = 7.3 percent.
(9) Regardless of the calculated value, the minimum level of silica fume should not be less than 7 percent if it is the only method of prevention.
(10) It is impractical to modify a mix design frequently during production based on the actual alkali limit of the cement used, therefore, where silica fume is used as the sole method of prevention, the maximum assumed alkali limit of the cement must be indicated on the mix design.
(11) Additional options for prevention Level Z are specified in Section 704.1(g)2.c.1 and Table H
(12) The use of high levels of SCMs in concrete may increase the risk of problems due to deicer salt scaling if the concrete is not properly proportioned, finished, and cured.

2.c.1 The minimum replacement levels in Table G are appropriate for use with portland cements of moderate to high alkali contents (0.70 to 1.25 percent Na2Oe). Table H provides an alternative approach for utilizing SCMs if the alkali content of the Portland cement is less than or equal to 0.70%.

Table H
Adjusting the Minimum Level of SCM if using low alkali Portland cement

Cement Alkalis (% Na2Oe)	Level of SCM
≤ 0.70	Reduce the minimum amount of SCM given in Table G by one prevention level.(1)
(1) The replacement levels should not be below those given in Table G for prevention Level W regardless of the alkali content of the Portland cement.	

2.c.2 Requirements for Prevention Level Z. Where prevention Level Z is required, use the minimum level of SCM shown in Table G or use the minimum level of SCM and the maximum concrete alkali content indicated in Table I.

Table I
Using SCM and Limiting the Alkali Content of the Concrete

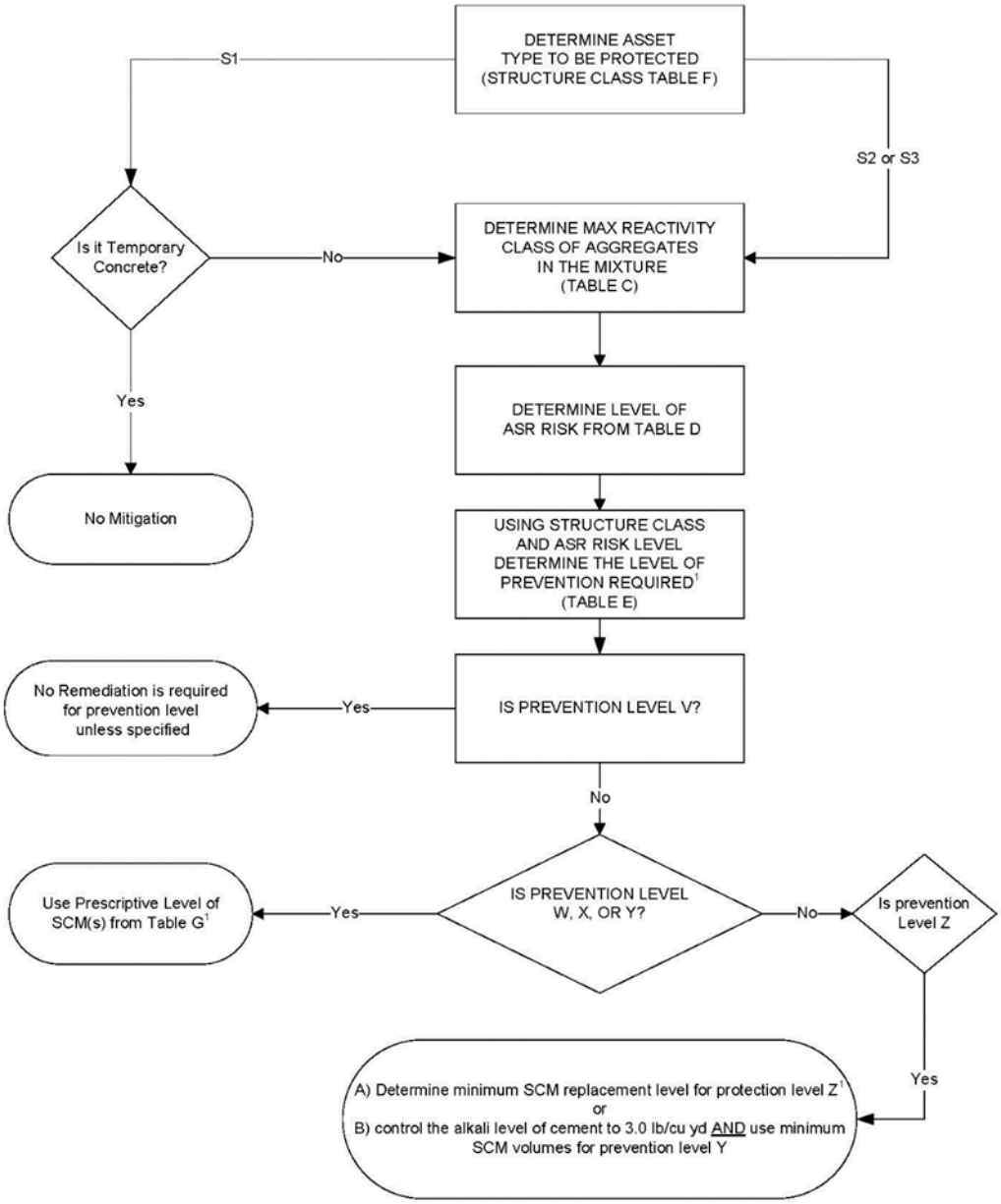
Prevention Level	SCM as sole prevention	Maximum Alkali Content, (lbs./cy) and Minimum SCM Level
Z	Level Z from Table G	Maximum Alkali Level Content: 3.0 AND minimum SCM Level Y from Table G

3. Cement/Cement-SCM Requirements. For use with aggregate deemed potentially reactive as specified in Section 704.1(g), provide Portland cement, blended hydraulic cement, or Portland cement-SCM combinations as specified in Section 704.1(b) and the following:

3.a Portland Cement. Conforming to the optional chemical requirement in AASHTO M 85 for a maximum alkali content of 1.25% Na2Oe if used for ASR prevention.

3.b Blended Hydraulic Cement. Type IS or IP, AASHTO M 240 (ASTM C595). From a manufacturer listed in Bulletin 15.

3.c. ASR Mitigation Flowchart.



Note 1: The prevention level may be reduced by one level if low alkali cement (≤ 0.70) is used.

4. **Admixture Requirements.** Furnish chemical admixtures as specified in Section 711.3.

5. **Exceptions.** If a service record of nonreactivity can be documented, the Department may exempt aggregates

classified through testing as potentially reactive, as specified in Section 704.1(g)2, from the cement/cement-SCM requirements as specified in Section 704.1(g)3.c. The service record must include a minimum of 10 structures, each over 10 years of age and preferably over 15 years of age.

Include the following documentation in the service record:

- A report on the visual examination of each structure for cracking including expansion at joints where applicable.
- Structure type and age.
- Concrete class or mix design proportions if available.
- Cement and alkali content of the cement used during construction.
- Use and type of all SCMs used in the mixture/structure.
- Presence and type of symptoms of distress if found.

Take cores from a representative number of structures and perform petrographic analysis of cores according to ASTM C856 to determine the presence or absence of alkali-silica gel formations and associated microcracking.

Determination of the aggregate classification according to ASTM C295. This analysis must confirm the aggregates from the structures are similar in mineralogical composition to that of the aggregate currently being considered for use.

If field performance history and subsequent testing indicates an aggregate source has begun to form ASR expansion, no exception for use other than the prescriptive methods provided will be accepted.

(h) Extra Cement Concrete. If 25% extra cement is allowed rather than the standard use of an anti-washout admixture (AWA) as specified in Section 1001.3(k)3.a, the extra cement may be replaced with other cementitious material in the same proportions as established in the mix design or as specified in Section 704.1(c). Up to 50% of the water dose for the extra cementitious material, based on the water cement ratio of the mix being utilized, may be added. Add additional admixtures, other than an AWA, as required for performance or to meet other mixture criteria as specified.

704.2 PLANT AND TRUCK MIXED CEMENT CONCRETE—

(a) Batching Plant. Proportion cement, aggregates, water, and admixtures in a plant conforming to AASHTO M 157 for batching plants.

Install a moisture meter to accurately and continuously indicate the variability of the fine aggregate moisture content. If approved, automatic moisture compensating probes for fine and coarse aggregate may be used to control the amount of batched water. Calibrate moisture probes according to the reviewed QC Plan.

Provide scales with graduation increments no greater than 1/1000 of the total scale capacity to measure the weight of aggregates or cement. Increments of less than 5 pounds are not required. Provide scales with capacities approximately equal to the hopper capacity or the central mixer capacity under normal proportioning conditions.

Provide a minimum of ten 50-pound weights at the plant for checking the scale's accuracy. Store the weights in a manner to maintain their weight-calibration accuracy.

Check the accuracy of the bin scales according to PTM No. 410.

Provide the plant with the following equipment for developing the concrete design and to control the quality of aggregates used and the concrete produced:

Number of Each	Equipment
1	Sample splitter for fine aggregate having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of 12 total chutes is required. The minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample and the maximum width of the individual chutes is to be 3/4 inch. Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material.
1	Sample splitter for coarse aggregate having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of eight total chutes is required. The minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample. Include two receptacles to hold the samples following

	splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material.
	Or
1	Adjustable sample splitter for both coarse aggregate and fine aggregate having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of 12 total chutes is required. For coarse aggregate, the minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample. For fine aggregate, the minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample and the maximum width of the individual chutes is to be 3/4 inch. Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material.
1	Mechanical Sieve Shaker (with timer)—PTM No. 616
1 Set Each	Standard Sieves for Fine and Coarse Aggregate—ASTM E 11
1	Oven capable of maintaining a uniform temperature of 230F ± 9F—PTM No. 616
1	Calculating machine
1	Cylindrical Metal Measure 1 cubic foot— AASHTO T 19 and T 121, ASTM C136
1	Air Meter, acceptable type— AASHTO T 196 and T 152
1	Slump Cone— AASHTO T 119
1	Cylinder Compression Machine—PTM No. 604(1)
1	Curing Tank—PTM No. 611(2)
1	Capping Device—PTM No. 604(1)
1	Balance conforming to the requirements of AASHTO M 231 for the class of general purpose scale required, for the principle sample weight of the sample being tested—PTM No. 616.
1	Platform scale conforming to the requirements of AASHTO M 231 for the class of general purpose scale required, for the principle sample weight of the sample being tested—PTM No. 616, and AASHTO T 121 and ASTM C136
Sufficient	6-inch by 12-inch Cylinder Molds—PTM No. 611
	Necessary Incidental Equipment
1	Maturity Meter—PTM No. 640, if used
Sufficient	Temperature Sensors—PTM No. 640 if used

Note (1)—Equipment requirements may be waived if arrangements for testing have been made at the producer's central facility or at a commercial testing laboratory that participates in the AASHTO Accreditation Program in the area of Concrete Testing. Commercial testing laboratories are to conform to ASTM E329 for Concrete Inspection and Testing except for the equipment listed above.

Note (2)—Equipment requirements may be waived if, after 24 hours (±2 hours), specimens made for checking the strength of trial mixes are properly transported to a central facility or commercial testing laboratory for curing according to PTM No. 611.

Provide the plant with proper laboratory equipment, space, and utilities as specified in Section 609.

(b) Mixers and Agitators. AASHTO M 157. If directed, test air content of individual mixed concrete samples taken approximately at the beginning, the midpoint, and the end of the batch. If the air content varies by more than 1.5%, discontinue the use of the mixer or agitator until the condition is corrected.

If mixing in truck mixers at the plant, use inclined-axis, revolving-drum type mixers or horizontal-axis, revolving-drum high-discharge type mixers.

(c) Mixing and Delivery. Maintain concrete temperature after mixing between 50F and 90F for general concrete, and between 50F and 80F for bridge deck concrete. Do not ship concrete exceeding these temperature ranges. Maintain adequate two-way communications between the concrete plant and the work site to provide both uniformity and control of the concrete mixture.

For each truck, furnish a plant delivery slip signed at the plant by the technician or other designated person. Include the following information on the delivery slip:

- Contract number, complete state project number or purchase order number.

- The concrete plant supplier code.
- Method of concrete mixing (i.e., central or truck).
- Class of concrete, JMF number, and trial mix number (i.e., trial #1, 2, etc.).
- Number of cubic yards.
- Time of completion of mixing.
- Truck number.
- Number of mixing revolutions, if applicable.
- Total amount of batch water used in each truck (pounds).
- The total weight in pounds of the total cementitious materials.
- The types of additives used in each truck (i.e., water reducer, AEA, retarder, etc.).

Submit the plant delivery slip and batcher-mixer slip (according to AASHTO M 157) to the Inspector-in-Charge. Do not use any concrete until it is approved for use by the Inspector-in-Charge.

Conform to AASHTO M 157, except as follows:

- If mixing in a plant, mix for not less than 50 seconds or more than 90 seconds for normal strength concrete, and not less than 70 seconds for HES concrete.
- If mixing in the truck drum at the plant, mix for not less than 70 or more than 125 truck-drum revolutions, at a mixing speed of not less than 6 truck-drum revolutions per minute (rpm) nor more than 18 truck-drum rpm. Upon completion of the designated number of mixing revolutions, reduce the truck-drum speed to not less than 2 rpm or more than 6 rpm. Do not exceed a total of 300 truck-drum revolutions.

Deliver the mixed concrete to the work site and discharge within 11/2 hours after completion of mixing. As an alternative, use a set retarding admixture or a workability retention admixture or both, listed in Bulletin 15 and according to manufacturer's dosage recommendations, to extend the initial set time and time for discharge to 2 hours after the completion of mixing. Agitate, but do not mix the concrete en-route to the work site.

- In hot weather, under conditions contributing to quick concrete stiffening, or if the concrete temperature is 80F or above, do not allow the time between completion of mixing and discharge to exceed 1 hour. As an alternative to maintaining the concrete temperature below 80F, use an approved, set retarding admixture to extend the initial set time and enable the mix to remain workable for the full 11/2 hours of allowable mixing time.
- If using mixer or agitator trucks, agitate concrete for at least 20 revolutions immediately before placement. Do not use concrete that has exceeded 45 minutes without agitation.
- If wash water is used to clean the truck drum, completely discharge this wash water before the introduction of the succeeding batch.
- Do not allow concrete to come in contact with aluminum unless the aluminum is coated with an acceptable coating (delivery of concrete in an aluminum truck bed is allowed).

(d) Clean Out Areas. Concrete clean out areas, either contractor designed, or detailed within the contract documents, are incidental.

704.3 VOLUMETRIC MIXED CEMENT CONCRETE

(a) General. Use a plant inspected and listed in Bulletin 42. Make trial mixtures with a calibrated mixing plant. Provide plant equipment, facilities, and a concrete technician(s) as specified in Section 704.1. Do not begin production until the mixing plant and all equipment and facilities necessary for performing the work have been inspected and accepted. Mixing plants may be truck mounted.

(b) Usage. Volumetric mixing plants may be used to produce concrete for endwalls, inlets, manholes, end anchors, sign posts, and similar miscellaneous structures requiring small quantities of concrete. If allowed by the District Executive in writing, volumetric mixing plants may also be used for pavement patching and structures. Approved plants may produce concrete for precast items.

(c) Equipment. Prominently attach a permanent metal plate(s) to the plant plainly marking the gross volume in terms of mixed concrete, the operating speed, the plant auger mixing angle, and the plant weight-calibrated cement constant in terms of a revolution counter or other output indicator, all as rated by the manufacturer.

1. Compartments. Provide separate compartments to carry the ingredients. Cover the aggregate bins and prevent contamination and intermixing of the fine and coarse aggregates during loading and transporting. Keep the cement bins free of moisture and contamination. Provide suitable means to carry water and additives and to incorporate the additives with the mixing water in the mix

2. Feed System. Provide a feeder system mounted under the compartment bins to deliver the ingredients to the mixing unit. Equip each bin with an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from the bin compartment. Do not charge aggregate bins more than 4 hours before mixing.

Set the cement bin feeding mechanism to discharge a given volumetric weight equivalent of cement at a continuous and uniform rate during the concrete mixing operation. Coordinate the coarse and fine aggregate feeding mechanisms with the cement feeding mechanisms to deliver the required proportions.

3. Mixing Unit. Provide an auger-type mixer incorporated in the plant's discharge chute, or another suitable mixing mechanism that produces concrete of uniform consistency and discharges the mix without segregation. Examine the mixing screw daily and clean as necessary to prevent the build-up of mortar or concrete.

4. Dials and Measuring Devices. Equip the plant with accurate revolution-counter indicators that allow the volumetric weight equivalent of cement, fine aggregate, and coarse aggregate discharged to be read during the concrete-mixing operation. Equip the counter with a ticket print-out to record this quantity.

Equip the plant with a water flow meter or gauge to indicate the discharge rate of water (by volume) entering the mix and a water meter to register the total amount of water discharged during the mixing operation. Also, equip the plant with suitable gauges for checking the rate of flow of all additive(s) entering the mix. Coordinate the water and additive flow meters with the cement and aggregate feeding mechanisms. Equip the flow meters with scales appropriate for the type and amount of material being measured. Mount a tachometer indicating the drive shaft speed on the plant.

Place gauges, dials, and other devices that indicate the accuracy of concrete proportioning and mixing in full view so the operator can accurately read or readjust them while concrete is being produced. Provide the operator convenient access to all controls.

(d) Calibration. Use a unit constructed to allow convenient calibration of the gate openings and meters. Conduct a calibration once a year in the presence of Department representatives. Make satisfactory arrangements with the Department at least 1 week in advance of calibration. During the yearly calibration, calibrate the cement meter according to the manufacturer's recommendation and check the aggregate gate settings against the calibration data for the plant. Maintain the calibration data in the plant and submit the data to the District.

After performing the yearly calibration and before starting work, provide a mix design for review and acceptance and run a yield test to verify the design. Adjustments to correct for yield may require recalibration or a design change.

Conduct a recalibration if there is a change in the source of fine or coarse aggregate or cement. Conduct additional calibrations if directed. Provide each plant with data on the accepted recalibration.

If hydraulic drive units are used, perform the following additional calibration procedure: At the beginning of the actual batching operation, check the cement meter against the count and time used for the cement during the calibration

of the individual materials. If a discrepancy occurs, adjust the belt speed of the unit so the actual cement meter count does not vary from the calibrated meter count by more than two counts per 60 seconds.

(e) Mixing and Delivery. Proportion, measure, and batch cement and aggregates by a weight equivalent method. The measuring and batching mechanism is required to produce the specified proportions of each ingredient within the following tolerances:

- Cement, Weight 0 to +4%
- Fine Aggregate, Weight ±2%
- Coarse Aggregate, Weight ±2%
- Admixtures, Weight or Volume ±3%
- Water, Weight or Volume ±2%

The tolerances are based on a volume/weight relationship established during the calibration of the measuring devices.

During mixing, maintain the drive shaft speed, as indicated by the tachometer, within 50 rpm of the operating speed. Set the auger mixer angle in the range determined by the manufacturer. Do not exceed 1/2 hour between the continuous placing of succeeding batches.

1. Testing. Conduct slump and air content tests according to PTM No. 601. Conduct the unit weight test, the concrete uniformity test, and the output meter calibration test according to AASHTO T 121, ASTM C136, AASHTO M 157, and PTM No. 626. If there is any doubt in the uniformity of the concrete, perform further testing as directed.

2. Recording. Provide a batcher mixer slip with each load of ingredients. Include the following information on the batcher mixer slip:

- Aggregate gradation and moisture information.
- Class of concrete and the corresponding dial setting, as determined in the design.
- Water discharge rate limitations.

Use a separate batcher mixer slip for each class of concrete. Deliver the batcher mixer slip to the Inspector-in-Charge at the work site. Do not use the concrete until the Inspector-in-Charge verifies the data noted on the slip complies with the specifications.

(f) Clean Out Areas. Concrete clean out areas, either contractor designed, or detailed within the contract documents, are incidental.

SECTION 705—JOINT MATERIAL

705.1 PREMOLDED EXPANSION JOINT FILLER—From a manufacturer listed in Bulletin 15, provide one of the following cork, sponge rubber, fiber joint fillers, or polypropylene foam conforming to the following requirements:

(a) General. As shown on the Standard Drawings, or as indicated.

If used for transverse joints in reinforced or plain cement concrete pavement, furnish lengths equal to the width of the traffic lane, ramp, or taper with a minimum thickness of 1 inch. Provide a smooth top surface and holes punched for dowel bars to provide a snug fit without loss in thickness of the material.

If used for longitudinal joints in concrete base courses, furnish pieces at least 8 feet in length and join securely.

If used for joints in structures, furnish pieces at least 8 feet in length, or as otherwise indicated, and join securely.

(b) Cork or Preformed Rubber. AASHTO M 153 and as follows:

Joint filler modified to include polyurethane bonded recycled rubber, consisting of preformed strips of a durable composite of ground recycled rubber from automobile tires bonded together with polyurethane adhesive, is allowed.

(c) Fiber. AASHTO M 213, except for the compression test use a specimen at least 4 inches on a side with a minimum area of 16 square inches. For glass fiber tested for compression, the applied force may be less than the minimum 100 pounds per square inch.

(d) Preformed Polypropylene Foam Expansion Joint Filler. ASTM D8139, test the physical properties of a semi-rigid, non-extruding, resilient type, closed-cell polypropylene foam, preformed joint filler.

(e) Certification. Section 106.03(b)3.

705.2 LONGITUDINAL JOINT MATERIAL—From a manufacturer listed in Bulletin 15 and as shown on the Standard Drawings or as indicated. Use tie bars, tiebolts, and key formers conforming to the following requirements:

(a) Tie Bars.

1. Deformed Tie Bars. Section 709.1(a)1, 709.1(b)1, 709.1(d)1, or 709.1(e), and epoxy coated as specified in Section 709.1(c).

2. Deformed Bent Tie Bars. Section 709.1(a)1, 709.1(b)1, 709.1(d)1, or 709.1(e) and epoxy coated as specified in Section 709.1(c).

(b) Tiebolts. Certify as specified in Section 106.03(b)3 and as follows:

- Manufactured from mild steel.
- A 9/16-inch diameter bar with rolled threads or a 5/8-inch diameter bar with cut threads, with a threaded sleeve nut.
- For the nut, steel pipe or hexagonal steel bar (1 1/16 inches diameter by 1 7/8 inches long), or a high strength steel bar (27/32-inch diameter by 2 inches long).
- For the assembled tiebolt, a minimum yielding load of 15,000 pounds is necessary.
- Epoxy coated or galvanized, excluding threads, as specified in Section 709.1(c) or 1105.02(s).

(c) Key Former. Manufactured of a material that does not deform during concrete placement.

705.3 LOAD-TRANSFER UNITS FOR REINFORCED AND PLAIN CEMENT CONCRETE PAVEMENTS—

(a) General. As shown on the Standard Drawings and as follows:

1. Coated Dowel Bars and Supporting Members. Section 709.1(a)2, and either as specified in AASHTO T 253 Section 5, or Structural adequacy testing according to PTM No. 642 showing a maximum Linear Variable Differential Transformers (LVDT) differential deflection (The differential deflection is the absolute difference in deflection between the loaded and unloaded sides of the joint) for dynamic and static loading, for both the approach and leave sides of the joint of not more than 7.5 mils at 1 million cycles and not greater than a 2.5-mil increase in the LVDT differential deflection at 10 million cycles from the corresponding 1 million cycle LVDT deflection.

Provide bars with their free end a true circle and without burrs.

2. Alternate Shaped Coated Dowel Bars. Bars with properties equivalent to conventional, round steel-coated dowel bars may be used if documentation of conformance to applicable requirements of Section 705.3 are accepted by LTS.

3. Bondbreaking Requirements. AASHTO M 254

3.a Type A. Coating material develops sufficiently low bond strength with concrete so a shop applied bond breaker or bond breaker lubricant is not necessary.

3.b Type B. Coating material develops bond strength with concrete so a shop applied bond breaker or bond breaker lubricant is necessary. Shop-applied bondbreakers are to conform to the pull-out load requirements of AASHTO M 254.

(b) Dowel Bar Coating. AASHTO M 254 modified as follows:

Provide fusion-bonded epoxy coating as a Type B coating with a minimum nonabraded thickness of 8 mils. No more than 2 holidays per linear foot average, as detected with a 67.5 V holiday detector, are allowed. Repair areas damaged during shipment, handling, fabrication, or placement. The sum of all damaged areas to be repaired per linear foot may not exceed 2% of the bar surface area per linear foot. Repair all visible signs of rust and all visible defects. Repair is accomplished by means of a mechanical wire brush cleaning, or another acceptable procedure, followed by application of an approved epoxy paint utilizing the paint manufacturer's recommended procedure. Do not cover in excess of 5% of the total bar surface area with patching material.

(c) Mechanically Galvanized Dowel Bars. Provide galvanizing as specified in Section 1105.02(s) (ASTM B695 and B 696). Coating thickness to be not less than 3.4 mils (2.0 ounces per square foot).

(d) Stainless Steel Dowel Bars. If specified, provide stainless steel dowel bars and stainless steel dowel baskets conforming to ASTM A955/A955M as specified in Section 709.1(f) for stainless steel reinforcement

1. Storage. Section 1002.4(i)3.

(e) Uncoated, Corrosion-Resistant Dowel Bars. If specified, provide steel dowel bars conforming to AASHTO M 334 categorized as Level 3 by AASHTO T 374 for uncoated, corrosion-resistant steel reinforcement.

(f) High Performance Dowel Bars. As shown on the Standard Drawings and as follows:

1. Physical Requirements. Provide dowel bars or tubes with a smooth-finished surface meeting the requirements of Table A and as follows:

- Diameter of 1.5 inches or 1.25 inches (+ 0.25 inch, - 0.001 inch) as shown on the Standard Drawing RC-20M or as indicated.
- Length of 18 inches (+/- 1/8 inch)
- Submit structural adequacy testing according to PTM No. 642 showing a maximum Linear Variable Differential Transformers (LVDT) differential deflection (The

differential deflection is the absolute difference in deflection between the loaded and unloaded sides of the joint) for dynamic and static loading, for both the approach and leave sides of the joint of not more than 7.5 mils at 1 million cycles and not greater than a 2.5-mil increase in the LVDT differential deflection at 10 million cycles from the corresponding 1 million cycle LVDT deflection.

Table A – High Performance Dowel Bar Requirements

Dowel Surface Material	Configuration	Solid Bar or Tube Material		Cladding or Coating Material	
		Material	**Minimum Wall Thickness (in.)**	**Material**	**Minimum Wall / Coating Thickness (in.)**
Stainless Steel	**Solid Bar**	Stainless Steel(1)	—	—	—
	Clad Bar	Steel(2)	—	Stainless Steel(1)(4)	0.04
	Clad Tube	Steel(2)	0.12	Stainless Steel(1)(4)	0.04
	Solid Tube	Stainless Steel(1)	0.12	—	—
Zinc Clad	**Clad Bar**	Steel(2)	—	Rolled Zinc Alloy(5)	0.04
	Clad Tube	Steel(2)	0.12	Rolled Zinc Alloy(5)	0.04
Glass Fiber-Reinforced Polymer Coated (GFRP)	**Coated Bar**	Steel(2)	—	GRFP(3)	0.125
Multi-Layer Epoxy Coated	**Coated Bar**	Steel(2)	—	Minimum 2 Coats of Epoxy(6)	0.02

(1) ASTM A955, Grade 60, meeting one of the following UNS Designations: S31603, S31653, S31803.
(2) ASTM A615, Grade 40 or higher.
(3) GFRP coating according to the requirements of Section 3 of AASHTO LRFD Bridge Design Guide Specification for GFRP Reinforced Concrete Bridge Decks and Traffic Railings. Provide clips that firmly hold the GFRP dowel bars in the Load Transfer Unit. Provide clips to positively secure the GFRP dowels to the Load Transfer Unit. Do not weld GFRP dowel bars to Load Transfer Unit.
(4) Press fit the stainless steel tube using an epoxy adhesive between the tube and the carbon steel core.
(5) Rolled zinc alloy (U.N.S. Z41121) sleeve mechanically bonded to a steel bar or tube.
(6) Provide epoxy coated bars with a minimum of two layers of epoxy coating. Provide epoxy coating according to ASTM A934 for the first epoxy coating layer and an abrasion resistant second epoxy layer passing NACE TM0215 using the Smooth Cut Carbide Bit gouge tool. Provide a total non-abraded epoxy coating thickness of 20 mils to 60 mils. Zero holidays are allowed. Weld areas used for dowel basket attachments must be ground for welding, and cleaned, and recoated after welding. Remove and replace dowel bars that have epoxy coating damaged (including the ends of the dowels) during shipment, handling, fabrication, or placement, prior to paving.

2. **Alternate Shaped Coated Dowel Bars.** Bars with properties equivalent to conventional, round steel-coated dowel bars, may be used, when documentation of conformance to applicable requirements of section 705.3(f) are accepted by LTS.

3. Bondbreaking Requirements. AASHTO M 254

3.a. Type A. Coating material develops sufficiently low bond strength with concrete so that a bondbreaker is not necessary.

3.b. Type B. Coating material develops bond strength with concrete so that a bondbreaker is necessary. Shop-applied bondbreakers are to conform to the pull-out load requirements of AASHTO M 254.

(g) Certification. Section 106.03(b)3

705.4 JOINT SEALING MATERIAL—

(a) Silicone Joint Sealing Material. Low modulus, non-sag-silicone, sealing material in a nonacid-curing, one part formulation, which requires tooling, from a manufacturer listed in Bulletin 15. Furnish silicone joint sealing material conforming to the following physical requirements:

• Tensile Stress at 150% elongation, psi, max. (ASTM D412, Die C) 7-day cure at 77F ± 3F and 45% to 55 % relative humidity	45
• Elongation at maximum tensile strength, %, min. (ASTM D412, Die C)	600
• Extrusion rate, grams/minute, min. 0F to 100F (Test for extrusion using an air-powered caulking gun, having a 1/8-inch orifice, at 90 psi)	75
• Specific gravity (ASTM D792, Method A)	1.010 to 1.515
• Durometer hardness, shore "A" (ASTM D2240) 7-day cure at 77F ± 3F and 45 to 55% relative humidity.	10 to 25 @ 0F
• Shelf life, days, min., from date of manufacture.	180
• Ozone and ultraviolet resistance (ASTM C793)	No chalking, cracking, or bond loss after 5000 hours.
• Flow (ASTM C639-TypeII)	Nil
• Bond to cement mortar, psi, min., primed if required. (Mold three cement mortar briquets according to AASHTO T 132 and moisture cure for at least 28 days. Saw briquets in half, clean, and oven dry to a constant weight in an oven at 110 °C ± 5 °C. After cooling, bond halves together with approximately 10 mils of silicone sealant, cure 7 days at 77F ± 3F and 45 to 55% relative humidity, and test using clips conforming to AASHTO T 132. Test specimens in tension at loading rate of 0.3 inch/minute.	50
• Tack free time, minutes, max. (ASTM C679)	90
• Movement capability and adhesion (ASTM C719)	Cyclic movement: +100% / -50% (extension/compression), no adhesive or cohesive failure after 10 cycles @ 0F

(b) Rubberized Joint Sealing Material. From a manufacturer listed in Bulletin 15, use ASTM D6690-Type II for sealing asphalt pavement joints and ASTM D6690-Type IV for all other joint sealing applications.

(c) Rubberized Joint Sealing Material. ASTM D6690-Type I, from a manufacturer listed in Bulletin 15.

(d) Preformed Neoprene Compression Seals and Strip Seals and Lubricant Adhesive.

1. Physical Requirements. ASTM D2628 and ASTM D3542 (Movement Range) for pavement seals, ASTM D 3542 for bridge seals, and as follows:

1.a Seals.

- Free of pin holes and uncured areas and uniform in all dimensions.
- Function properly at temperatures between -20F and +140F.
- Misalign the walls by not more than 1/8 inch if the pavement seal is in a compressed condition.
- Exceed nominal width by not more than 1/16 inch for seals up to 1 1/2 inches; 3/16 inch for seals greater than 1 1/2 inches up to 2 1/2 inches; 1/4 inch for seals greater than 2 1/2 inches up to 4 inches; and 5/16 inch for seals greater than 4 inches. Allow no negative tolerance from nominal width.
- Vary from nominal height by not more than 1/8 inch if pavement seals are used and 1/4 inch if bridge seals are used.
- Allow no tolerance in the movement range for initial qualification samples. Allow up to a -5% tolerance in the movement range for routine production samples.
- Allow no negative tolerance on the movement classification for bridge seals. The movement classification for each bridge seal configuration is determined by rounding the movement range criterion down to the nearest 1/2-inch increment.
- Pavement seals have a minimum seal recovery as follows:

Temperature	Percent Recovery* Plant Verification Samples (PV)	Field Samples (QA, DQA, FV, etc.)
-20F	88	83
14F	95	88
212F	90	85

*based on nominal width

Seal Size	Minimum Movement
1 inch	0.365 inch
1 1/4 inches	0.540 inch

- Pavement seals have a minimum side wall bearing pressure of 4 pounds per square inch at 85% nominal width.

1.b Lubricant Adhesive. ASTM D4070 and as follows:

Of suitable viscosity at installation temperature and compatible with application equipment. Do not use lubricant adhesive more than nine months after date of manufacture.

2. Acceptance. Before using each lot of seal, obtain the eCAMMS generated laboratory test report with the automated statement of approval or rejection. A seal lot is a continuous production not exceeding 10,000 linear feet for pavement seals, and not exceeding 3,000 linear feet for bridge seals.

3. Marking and Shipping.

3.a Seals. Clearly and permanently mark the top of each seal with appropriate line characters of not less than 0.0625 inch in height, in increments not exceeding 4 feet. The line characters must designate the lot or batch number, the cure date code, and the type of seal designation. Mark the top of each pavement seal at 1 foot ±1/8 inch intervals in a manner clear and durable to enable stretch/compression determinations of the seal.

3.b Lubricant Adhesive. Label each container with the code or type designation, plant place, lot number, and manufacture date.

(e) Preformed Closed Cell Polyethylene Joint Filler. ASTM D7174, Type I, and as follows:

Compressibility:

Pressure necessary to compress test specimen by 25%	min. 5 pounds per square inch
Pressure necessary to compress test specimen by 85%	max. 30 pounds per square inch

(f) Preformed Polyurethane Foam Joint Filler. A semi-open, flexible, polyurethane foam that is molded to a cross-sectional shape and easily installed in a pavement joint with parallel sides and is sufficiently self-locking to prevent the material from floating out of the joint. Furnish joint filler from a manufacturer listed in Bulletin 15 and as follows:

1. Dimensions.

- Length—minimum 8-foot lengths
- Width—4 7/16 inches to 4 3/4 inches
- Depth—7 3/4 inches to 13 inches

2. Properties. Determine using a skinless sample.

• Density, lbs/cu. in.	6.0-10.0
• Compressive deflection (ASTM D7174)	
• Pressure (Load) necessary to compress the test specimen 25%	min. 5 psi
• Pressure (Load) necessary to compress the test specimen 65%	max. 30 psi
• Recover, % of original, min. 65% deflection, calculated after 60 seconds of relaxation form deflection return.	95%
• Water absorption, max.	30% vol.

(g) Asphalt Rubber Sealing Compound. ASTM D5078 from a manufacturer listed in Bulletin 15.

(h) Certification. Section 106.03(b)3

705.5 GASKETS AND WATERSTOPS—From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

(a) Shipment and Certification. Label shipments with style or code number, lot or batch number, plant, place, and manufacture date. Certify materials, as specified in Section 106.03(b)3.

(b) Gaskets.

1. Elastomeric. ASTM C443 for rubber gaskets and ASTM C361 for neoprene gaskets.

2. Preformed Flexible Joint Sealant – Butyl Rubber Sealant. ASTM C990, with the following exceptions:

- Flash Point, Cleveland Open Cup (C.O.C.) min., F 350
- Fire Point, C.O.C. min., F 375

3. Resilient Connectors between Inlets/Utility Holes and Pipes.

- Storm Water Systems – ASTM C1478
- Sanitary Sewer Systems – ASTM C923

(c) Waterstops.

1. Metal. ASTM B370. Copper sheets used for waterstops, of a weight indicated and containing a minimum copper mass of 99.5%.

2. Polyvinyl Chloride.

2.a Physical Requirements.

- Manufactured from virgin polyvinyl chloride resin with the addition of only those plasticizers, stabilizers, and other materials necessary to ensure aging stability and in-place durability.
- Not factory scrap or reclaimed polyvinyl chloride.
- Brittleness temperature, ASTM D746 -20F max.
- Modulus of flexure, ASTM D747, lbs/sq. in. 400 min.
- Tensile strength, ASTM D412,
  Die C original, lbs/sq. in. 1,000 min.
  Across job splice, lbs/sq. in. 1,150 min.
- Elongation
  Original, percent 280 min.
  Across job splice, percent 200 min.
- Tear strength, ASTM D624, Die B
  Original, lbs/in. 260 min.
- Oven aging, ASTM D573, 70 hours at 212F

Change in tensile strength, percent change	20 max.
Change in elongation, percent change	20 max.

- 14-Day extraction, 140F/150F

Change in tensile strength, percent change	40 max.
Change in elongation, percent change	40 max.

2.b Marking. Permanently label with the manufacturer's name and style or code number, at intervals not exceeding 3 feet.

2.c Acceptance. Material shipped is subject to inspection at the delivery point. If directed, provide samples, selected at random from the shipment, consisting of one portion 4 feet long and another portion from a job splice consisting of a minimum of 12 inches of splice, within 6 inches of unspliced material on each side. Submit samples to the LTS for material confirmation and compliance.

705.6 MORTAR—Mix mortar in an acceptable type of mixer, unless otherwise allowed. Do not use retempered mortar or mortar mixed for more than 1/2 hour, unless otherwise specified. Certify as specified in Section 106.03(b)3.

(a) For Pipe Joints.

1. Job-Mixed Mortar. Mix one part cement, two parts fine aggregate, and sufficient water to form a plastic composition. Use materials conforming to the following requirements:

- Cement—Section 701
- Fine Aggregate—Section 703.1, Type C
- Water—Section 720.1

(b) For Masonry Joints and Horizontal Joints Between Precast Components in Utility Holes and Inlets. ASTM C270, Type N

705.7 CAULKING COMPOUND—Certify as specified in Section 106.03(b)3. From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

(a) For Caulking Pipe Joints and Horizontal Joints Between Precast Components in Utility holes and Inlets. ASTM D4586

(b) For Other Caulking. ASTM C834 or C920

705.8 JOINT BACKING MATERIAL—Expanded, low-density, polyethylene foam from a manufacturer listed in Bulletin 15 and conforming to ASTM D5249. Certify each shipment as specified in Section 106.03(b)3. If indicated, the foam may be used as a bond breaker between joint filler material and joint sealer.

SECTION 706—CONCRETE BONDING COMPOUND

706.1 Epoxy-Bonding Compound—Provide an epoxy bonding compound conforming to ASTM C 881 and specify Type and Grade as per operation. Obtain compound from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3. Submit a copy of the manufacturer's recommendations for proper application to the Representative. Apply the compound according to the manufacturer's recommendations.

(a) General. If epoxy-bonding compounds are used, the Type and Grade of epoxy must be specified for each specific operation. Use the following classifications in conjunction with Bulletin 15:

1. Application/Operation Specific Types.

- Type I—For use in non-load bearing applications, bonding hardened concrete (28 days or older) to hardened concrete surfaces.
- Type II—For use in non-load bearing applications, bonding freshly mixed concrete to hardened concrete.
- Type III—For use in bonding skid-resistant materials to hardened concrete and as a binder in epoxy mortars or epoxy concretes used on traffic bearing surfaces (or surfaces subject to thermal or mechanical movements).
- Type V—For use in load bearing applications, bonding fresh concrete to hardened concrete.

2. Grades. Flow characteristics.

- Grade 1—Low viscosity
- Grade 2—Medium viscosity
- Grade 3—Non-sagging consistency

3. Classes. Temperature use range.

- Class A—For use below 40F, to the lowest allowable temperature defined by the manufacturer.
- Class B—For use between 40F and 60F
- Class C—For use above 60F, to the highest allowable temperature defined by the manufacturer.

706.2 Other Bonding Compound—Provide a bonding compound with a minimum 14-day bond strength of 1,500 pounds per square inch as tested according to ASTM C 882. Obtain compound from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3. Submit a copy of the manufacturer's recommendations for proper application to the Representative. Apply the compound according to the manufacturer's recommendations.

SECTION 709—REINFORCEMENT STEEL

709.1 REINFORCEMENT BARS—As indicated, from a manufacturer listed in Bulletin 15, and conforming to the following requirements:

(a) Billet-Steel Bars.

1. Deformed. AASHTO M 31 (ASTM A615), Grade 60. Where AASHTO M 31 (ASTM A615), Grade 40 is indicated (non-bridge items only), Grade 60 may be substituted on a bar-to-bar basis at no additional cost to the Department. If using deformed bent tie bars in pavement structures, use only Grade 40.

2. Plain. AASHTO M 227 (ASTM A663) or AASHTO M 255 (ASTM A675), Grades 70, 75, or 80. AASHTO M 31 (ASTM A615), Grades 40 or 60.

(b) Rail-Steel Bars.

1. Deformed. ASTM A996, Grade 60, including supplementary requirements. Do not weld or bend.

2. Plain. ASTM A996, Grades 50 or 60, including supplementary requirements. Do not weld or bend.

(c) Epoxy Coating (Where Indicated).

1. Coating. Coat bars according to ASTM A775, modified as follows:

- Section 5—Materials

  Subsection 5.2. "Maintain the certification for the powder coating material at the applicator's site. Provide only a light colored coating that will reveal rusted or undercoated areas of steel."

  Subsection 5.2.1. Revise as follows: "Provide written certification in accordance with Pennsylvania Department of Transportation Publication 408, Section 709.5 that the powder supplied meets the requirements of Annex A1 of this specification."

- Section 8—Requirements for Coated Steel Reinforcing Bars.

  Subsection 8.1.3. Revise the first sentence as follows: "For acceptance purposes, 90% of all recorded coating thickness measurements shall not be less than the specified minimum thickness or more than the specified maximum thickness."

  Subsection 8.2.1 Add a second sentence as follows: For Department verification purposes, after shipment, a hand held 67.5V, 80 000 ohm, wet-sponge type direct current holiday detector or equivalent method will be used to test plant or project samples consisting of an approximate 4 ft. length of bar cut from a full production bar or cut from a bar shipped to a project.

  Subsection 8.2.2. Add a third sentence as follows: For quality control and quality assurance purposes, the average applies to the full production length of a bar or to a Department verification sample consisting of an approximate 4 ft. length of bar cut from a full production length bar or cut from a bar shipped to a project.

2. Fabrication.

2.a QC. Section 106.03(a)2. Submit a QC Plan to the CMD.

2.b Repair all sheared or cut ends and/or damaged areas with epoxy patching material according to the QC Plan and ASTM D3963, modified as follows:

- Section 3—Coating Repair Materials

  Subsection 3.1. Add the following sentences: "Provide verification that the material has been tested and conforms to Annex 1. Certify each shipment of this material as specified in Pennsylvania Department of Transportation Publication 408, Section 106.03(b)3."

- Section 7—Repairs

  Subsection 7.1.3 Coat sheared/cut ends with approved patch material to have a minimum coating thickness of 7 mils.

  Control repair of damaged epoxy coating and sheared/cut ends according to ASTM A775, Section 11. Furnish patching or repair material that is compatible with the coating as approved and listed in Bulletin 15. Furnish patching or repair material that is inert in concrete. Furnish patching or repair material that can be satisfactorily used at the coating application facility, at the bar fabrication facility or at a project location in the field.

The patching or repair material must be compatible with the coating, inert in concrete, and feasible for repairs at the applicator, fabricator, or in the field. Control repair of damaged epoxy coating and sheared/cut ends according to ASTM A775, Section 11, modified as follows.

- Section 11—Permissible Amount of Damaged Coating and Repair of Damaged Coating

  Subsection 11.2. Furnish patching or repair material that is compatible with the coating as approved and listed in Bulletin 15. Furnish patching or repair material that is inert in concrete. Furnish patching or repair material that can be satisfactorily used at the coating application facility, at the bar fabrication facility, or at a project location in the field.

  Subsection 11.4. Coat sheared/cut ends with approved patch material to have a minimum coating thickness of 7 mils.

Handle and store coated bars at the fabricator's facility according to the requirements of ASTM D3963.

(d) Low-Alloy Steel Bars.

1. Deformed. ASTM A706, Grade 60.

(e) Galvanized Reinforcement Bars. Galvanized reinforcement bars may be substituted for epoxy coated reinforcement bars. Separate bundled pieces before pickling. Galvanize straight bars only in accordance with ASTM A767. Where bent bars are indicated, bending may be performed only after galvanizing is performed. Provide a Class 1 coating weight conforming to the requirements given in Table 1. Ensure that each piece is completely galvanized. During galvanization, use methods that prevent bars from becoming stuck together. Immediately quench the galvanized reinforcement bars in the chromate bath specified in ASTM A767. Repair all sheared or cut ends and/or damaged areas, as defined in ASTM A767, in accordance with ASTM A780. Cracking, flaking, tears, or spikes in the zinc coating at bend areas is considered to be damaged.

Test galvanized reinforcement bars for embrittlement after galvanizing by bend testing samples of the galvanized reinforcement bars in accordance with ASTM A615. Reject any lots found to be embrittled.

(f) Stainless Steel Reinforcement Bars. When indicated or specified, provide hot rolled deformed stainless steel reinforcement bars in accordance with ASTM A955, Grade 60 meeting one of the following UNS Designations:

- S24100, S30400, S31653, or S31803

(g) Uncoated, Corrosion-Resistant Steel Reinforcement Bars. Uncoated, corrosion-resistant steel reinforcement bars may be substituted for epoxy coated reinforcement bars on a bar-to-bar basis. Substitutions other than on a bar-to-bar basis may only be pursued through the Value Engineering (VE) process for substructure units only, which includes the submission of a substructure design utilizing the higher strength available from uncoated, corrosion-

resistant reinforcement bars. The VE must be approved and accepted in writing by the Department before any substructure bar substitutions are allowed. Provide steel reinforcement bars conforming to AASHTO M 334, modified as follows:

- Section 13—Finish
  Subsection 13.2. "Seams and surface irregularities shall not be cause for rejection provided the weight, dimensions, cross-sectional area, and tensile properties are not less than the requirements of this specification. Visible mill scale oxidation or corrosion deposits are cause for rejection."

709.2 BAR MATS—Steel Bars, Section 709.1, assembled into mats, as shown on the Standard Drawings, by rigidly welding or clipping the bars at joints or points of intersection.

(a) Clips. For mechanical assembly, use No. 9 gage steel wire of sufficient ductility to prevent clip fracture in mat fabrication.

For manual assembly, use No. 12 gage spring steel wire of high elastic limit, conforming to the following chemical analysis:

	Percent	
Element	**Min.**	**Max.**
Carbon	0.45	0.70
Manganese	0.90	1.20
Sulfur	0.00	0.045
Phosphorus	0.00	0.045
Silicon	0.08	0.12

(b) Method of Assembly (Using Clips). Hold the bars in close contact by clips designed to exert constant pressure. Assemble at the point of manufacture, using clips of acceptable design, and fasten by mechanical means.

Use double-latching type clips for manual assembly. Use some form of locking device on the clips' free or latching ends so that when the clips are latched in place, no creeping occurs that would allow the bars to be easily moved from their necessary positions.

Provide, approximately, a 1-inch spread of the clips at intersections for necessary leverage to hold bars at right angles. Latch each alternate clip at right angles to the adjacent clips, to ensure maximum rigidity. Use clips of a length so the material is not stressed beyond the elastic limit during the latching process. A minimum length of 3 1/2 inches is necessary for No. 3 to No. 10 bars.

Other types of clips that ensure equal rigidity may be submitted for acceptance.

(c) Acceptance of Design. Submit designs for acceptance, before use.

709.3 STEEL WELDED WIRE FABRIC—ASTM A1064 Grade 70. From a manufacturer listed in Bulletin 15, rigidly welded at joints and points of intersection to form a fabric reinforcement, and as shown on the Standard Drawings.

(a) Epoxy Coating (Where Indicated). ASTM A884, Type 1, Class A.

(b) Galvanized Welded Wire Fabric. Galvanized Welded Wire Fabric may be substituted for Epoxy Coated Welded Wire Fabric. Galvanize in accordance with ASTM A123 with a coating grade consistent with the measured wire diameter of the fabric. Chromate in accordance with ASTM A767, Section 6.8.

709.4 DEFORMED WELDED WIRE FABRIC—ASTM A1064 Grade 75. From a manufacturer listed in Bulletin 15 and as shown on the Standard Drawings.

(a) Epoxy Coating (Where Indicated). Section 709.3(a).

(b) Galvanized Welded Wire Fabric. Galvanized Deformed Wire Fabric may be substituted for Epoxy Coated Deformed Wire Fabric. Galvanize according to ASTM A123 with a coating grade consistent with the measured wire diameter of the fabric. Chromate in accordance with ASTM A767, Section 6.8.

709.5 CERTIFICATION—Certify as specified in Section 106.03(b)3 and conforming to the following requirements.

- Identify the appropriate specification on the certification and include the grade of steel. Forward a copy to the project with the shipment of steel.

- Epoxy coaters or galvanizers of reinforcement steel must complete and maintain the original copy of Form CS-4171C in addition to the original CS-4171 and all component certifications at the epoxy coater's or galvanizer's location for a period of not less than 3 years from the date of the last shipment to a project, distributor, supplier, private label company, fabricator, or precast plant. Make files available for inspection and verification by a Department Representative. Submit a copy of Forms CS-4171 and CS-4171C, with each shipment of epoxy coated or galvanized reinforcement steel to a project, distributor, supplier, private label company, fabricator, or precast plant. Form CS-4171C does not have to be completed if the fabrication of epoxy coated or galvanized reinforcement steel is performed at the same location as listed in Bulletin 15.

- Fabricators of epoxy coated or galvanized reinforcement steel must complete and maintain the original copy of Form CS-4171F in addition to the CS-4171C, when applicable, and all component certifications at the fabricator's location for a period of not less than 3 years from the date of the last shipment to a project, distributor, supplier, private label company, or precast plant. Make files available for inspection and verification by a Department Representative. Submit a copy of Forms CS-4171 and CS-4171F, with each shipment of epoxy coated or galvanized reinforcement steel to a project, distributor, supplier, private label company, or precast plant.

SECTION 711—CONCRETE CURING MATERIAL AND ADMIXTURES

711.1 CURING AND PROTECTING COVERS—

(a) White Polyethylene Sheeting. ASTM C171, except minimum tensile strength requirements are as follows:

Machine Direction	Cross Machine Direction
7.0 lbs/lin. in.	7.0 lbs/lin. in.

(b) White Polyethylene Sheeting—Burlap-Backed.

1. White Polyethylene Sheeting—natural burlap backed. ASTM C171.

2. White Polyethylene Sheeting—synthetic burlap backed. ASTM C171, except weight of synthetic burlap backed white polyethylene sheeting is 8.0 ounces per square yard.

(c) White Polypropylene Sheeting—Polypropylene Fiber Backed.

1. White Polypropylene Sheeting—polypropylene fiber backed, with maximum moisture loss of 113 pounds per 1,000 square feet in 72 hours when testing according to ASTM C156.

2. Daylight reflectance of white polypropylene sheeting is at least 70% when measured according to ASTM E1347.

3. White Polypropylene Sheeting—polypropylene fiber backed, weighing not less than 6.0 ounces per square yard.

4. A white sheeting layer with a nominal thickness of 0.0040 inch and not less than 0.0030 inch.

5. Minimum strength requirements are as follows:

Grab Tensile Strength	Grab Tensile Elongation	Puncture
120 lbs	50%	65 lbs
ASTM D4632	ASTM D4632	ASTM D4833

(d) Burlap. AASHTO M 182, Class 1.

(e) Insulating Mats. Treated new wood fibers, rock wool, or glass fibers, completely enclosed on all sides within weather-proof covers of asphalt-saturated kraft crepe or polyethylene sheeting, and conforming to the following requirements:

- Asphalt-saturated crepe covers manufactured from extra heavy, two-ply, kraft crepe, totaling not less than 30 pounds per 1,000 square feet, on the weather side and of kraft paper or kraft crepe, of not less than 15 pounds per 1,000 square feet, on the reverse side.
- Polyethylene covers manufactured from sheeting of not less than 6 mils normal thickness on the weather side and of not less than 4 mils normal thickness on the reverse side.
- Fiber bonded to the covers of insulating mats over 24 inches in width, to prevent bunching of the mats during storage, shipping, or handling.

(f) Foam Insulation. Molded, extruded, or spray-applied polyurethane or molded or extruded polystyrene, forming closed-cell foam insulation, with the cells uniformly distributed and conforming to the following requirements:

- Water absorption, percent by volume, tested according to ASTM D2842—3.0 max.

- Density, lbs/cu. ft., tested according to ASTM D1622—1.0 - 6.0

(g) Certification. Section 106.03(b)3

711.2 CURING COMPOUNDS—

(a) Liquid Membrane-Forming Curing Compound, Clear or White. ASTM C309, Type 1-D, clear or translucent and containing a red fugitive dye; Type 2, white pigmented.

The rate of application for testing untextured specimens is 200 square foot per gallon.

Type I cement from Lafarge Bath plant in Ontario and Ottawa ASTM graded sand are used in the mortar for testing.

The curing compound must be manufactured to:

- Remain sprayable at temperatures above 40F
- Control sagging, pigmented settling, leveling, and de-emulsification
- Maintain the specified properties for at least 1 year

Settlement of pigment must be a thoroughly wetted, soft, mushy mass allowing the complete and easy vertical penetration of paddle. Settled pigment must be easily predisposed, with minimum resistance to the sideways manual motion of the paddle across the bottom of the container, to form a smooth, uniform product of the proper consistency.

Do not dilute or alter the curing compound after manufacture.

Package the curing compound in clean 275-gallon totes, 55-gallon barrels, or 5-gallon pails, or supply curing compound from a suitable storage tank located at the job site. The containers must comply with 49 CFR 171-180. Provide 275-gallon totes and 55-gallon barrels with removable lids and airtight fasteners. The 5-gallon pails must be round and have standard full open head and bail. Do not use lids with bungholes.

Fill containers in a way that prevents skinning.

Line steel containers and lids with a coating that prevents destructive action by the compound or chemical agents in the air space above the compound. The coating must not come off the container or lid as skins.

Plastic containers and lids must not react with the curing compound.

Label each curing compound container with:

- Manufacturer's name
- ASTM C309 classification
- Lot number
- Volume
- Date of manufacture
- Shelf Life
- Volatile organic compound content
- Warning that curing compound containing pigment must be well stirred before using with no dilution, introduction of air or other foreign substances into the curing compound
- Precautions concerning the handling and application of curing compound
- Statement that the contents fully comply with State air pollution control rules and regulations

Use the curing compound within 12 months from the date of manufacture or before the expiration of the product shelf live, whichever occurs first.

(b) Liquid Membrane-Forming Curing Compound, White, Poly-alpha-methylstyrene (PAMS). ASTM C309, Type 2, Class B as modified below:

- Total Solids (% by weight of compound): to be used as a reference
- % Reflectance in 72 hours (ASTM E1347): 60 minimum
- Loss of Water, pounds per square foot in 72 hours (ASTM C156): 0.082 maximum
- VOC content (pounds per gallon): 2.90 maximum
- Infrared Spectrum, Vehicle: 100% alpha methylstyrene

The rate of application for testing untextured specimens in 200 square feet per gallon.

Type I cement from Lafarge Bath plant in Ontario and Ottawa ASTM graded sand are used in the mortar for testing.

The curing compound must be manufactured to:

- Remain sprayable at temperatures above 40F
- Control sagging, pigmented settling, leveling, and de-emulsification
- Maintain the specified properties for at least 1 year

Settlement of pigment must be a thoroughly wetted, soft, mushy mass allowing the complete and easy vertical penetration of paddle. Settled pigment must be easily predisposed, with minimum resistance to the sideways manual motion of the paddle across the bottom of the container, to form a smooth, uniform product of the proper consistency.

Do not dilute or alter the curing compound after manufacture.

Package the curing compound in clean 275-gallon totes, 55-gallon barrels, or 5-gallon pails, or supply curing compound from a suitable storage tank located at the job site. The containers must comply with 49 CFR 171-180. Provide 275-gallon totes and 55-gallon barrels with removable lids and airtight fasteners. The 5-gallon pails must be round and have standard full open head and bail. Do not use lids with bungholes.

Fill containers in a way that prevents skinning.

Line steel containers and lids with a coating that prevents destructive action by the compound or chemical agents in the air space above the compound. The coating must not come off the container or lid as skins.

Plastic containers and lids must not react with the curing compound.

Label each curing compound container with:

- Manufacturer's name
- ASTM C309 classification
- Lot number
- Volume
- Date of manufacture
- Shelf Life
- Volatile organic compound content
- Warning that curing compound containing pigment must be well stirred before using with no dilution, introduction of air or other foreign substances into the curing compound
- Precautions concerning the handling and application of curing compound
- Statement that the contents fully comply with State air pollution control rules and regulations

Use the curing compound within 12 months from the date of manufacture or before the expiration of the product shelf live, whichever occurs first.

(c) Liquid Membrane-Forming Curing Compound, Black. Emulsified asphalt (Class E-1, Bulletin 25) or cut-back asphalt (Class RC-70, ASTM D2028) both conforming to the performance requirements of ASTM C309 for Type 4.

(d) Bridge Deck Intermediate Curing Compound. A monomolecular film, composed of a film-forming fatty alcohol, capable of retarding moisture evaporation from concrete. Use material from a manufacturer listed in Bulletin 15.

(e) Certification. Section 106.03(b)3, including the date of manufacture and the product shelf life on Form CS-4171.

711.3 CONCRETE ADMIXTURES—Of an approved type, from a manufacturer listed in Bulletin 15, and conforming to the following requirements:

(a) General. If tested by precipitation, the chloride ion content is not to exceed the following:

- 1.0% by weight of the admixture for use in conventional reinforced cement concrete

- 0.1% by weight of the admixture for use in prestressed concrete

(b) Certification. Section 106.03(b)3

(c) Shipment. Ship and deliver in drums, in bulk or in bags. Mark or tag each drum or bag with the batch or lot number and date of manufacture. Forward a bill of lading with each bulk shipment, bearing the same information as necessary for drums. Each shipment will be subject to sampling and testing at any time.

(d) Air Entraining Admixtures. AASHTO M 154

(e) Latex Emulsion Admixture. A nontoxic, film-forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture and homogeneous and uniform in composition. Conform to the prequalification requirements specified in Report FHWA-RD-78-35, "Styrene-Butadiene Latex Modifiers for Bridge Deck Overlay Concrete," April 1978.

(f) Other Admixtures. AASHTO M 194

(g) Fibers for Plastic Shrinkage Cracking. Monofilament or collated fibrillated synthetic fiber, complying with ASTM C1116, 4.1.3-Type III. Provide test report complying with ICC Evaluation services (ICC-ES) AC32 Acceptance Criteria for Concrete with synthetic fibers, Section 3.2.1 from an Independent Certified Laboratory.

Provide a method of adding the fibers to the mix such that the fibers are dispersed during mixing and no clumps of fibers are present at the end of a mix cycle.

(h) Pigment for Internally Colored Concrete. Colored or white pigments in powder or liquid form, complying with ASTM C979.

Provide test report complying with ASTM C979 from an Independent Certified Laboratory. The maximum prescribed dosage rate of the pigment must be less than 10% by weight of the cement. Maintain water/cement ration when using liquid pigments. Demonstrate that the amount of pigment added has little or no effect on the physical properties of the fresh or hardened concrete.

SECTION 713—MASONRY UNITS

713.1 BRICK—

(a) Sewer Brick. ASTM C32, Grade SS; except, with a maximum water absorption of 12.0% for the average of 5 bricks and 15% for individual bricks.

(b) Building Brick. ASTM C62, Grade SW

(c) Certification. Section 106.03(b)3

713.2 PRECAST CONCRETE BLOCKS—As listed in Bulletin 15, conforming to the applicable requirements of ASTM C 90, and as follows:

(a) General. Machine made blocks with a minimum compressive strength of 2,500 pounds per square inch, when tested according to ASTM C140.
Do not use liquid membrane-forming compounds for curing.
Certify each shipment of precast concrete blocks as specified in Section 106.03(b)3.

(b) Material.

- Cement—Section 701
- Fine Aggregate, Type A—Section 703.1*
- Coarse Aggregate, Type A—Section 703.2*
- Water—Section 720.1
- Pozzolan—Section 724

* The gradation of aggregates does not apply.

(c) Acceptance. Prepare a QC Plan, as specified in Section 106.03(a)2.a, and submit it for review at the start of the project. Provide two samples for each lot number, or as directed. A lot may represent each day's production. Acceptance will be based on the results of compression tests made on these samples and on inspection of the finished product to determine conformance with specifications and lack of defects.

(d) Rejection. Blocks exhibiting any of the following conditions will be considered defective and will not be accepted:

- Defects that indicate imperfect proportioning, mixing, and molding;
- Surface defects, such as honeycombing or open texture; or
- Areas damaged beyond satisfactory repair.

SECTION 714—PRECAST CONCRETE PRODUCTS

714.1 GENERAL REQUIREMENTS—As shown on the Standard Drawings, as indicated and as follows:

(a) Description. Precast concrete units are those cast in other than their permanent location by a manufacturer listed in Bulletin 15.

(b) Shop Drawings. As accepted. Standard precast elements may be fabricated as shown on the Standard Drawings without submitting shop drawings to the Bureau of Project Delivery for acceptance, unless otherwise indicated. For deviations or modifications of the standards, submit shop drawings for acceptance.

714.2 PRECAST CONCRETE UNITS—Approved plants may fabricate any of the following items:

- Concrete barrier: median barrier, single face, temporary, permanent, structure mounted, etc.
- Manholes
- Inlet Boxes
- Concrete Top Units for Inlet Boxes
- Junction boxes
- Endwalls
- Sound barrier posts and panels
- Non-structural precast architectural products such as balustrade, rails, pylons, etc.
- Other precast products, as approved by the Chief Structural Materials Engineer.

714.3 MATERIAL—

- Storage of Material—Section 106.05
- Cement Concrete—Section 704, except Sections 704.1(d)4., 704.1(d)5., 704.1(d)6., and 704.1(d)7. Requirements for remediation of a potential alkali-silica reaction do not apply for cement concrete used in the fabrication of precast concrete barrier that is to be used in temporary installations only, as specified in Section 627, and as specified in Section 714.6(d).
- Coarse Aggregate, Type A, No. 8, No. 57, or No. 67—Section 703.2
- Fine Aggregate, Type A—Section 703.1
- Concrete Curing Material—Sections 711.1 and 711.2(a).
- Reinforcement Steel—Section 709. Epoxy coated or galvanized reinforcement bars or epoxy coated or galvanized welded wire fabric are not required for the fabrication of precast concrete barrier that is to be used in temporary installations only, as specified in Section 627, and as specified in Section 714.6(d).
- Steel Anchor Bolts—Section 1105.2(c)

- Metal Units—Sections 605.2(a) and (b)
- Manhole Steps—Section 605.2(c)
- Protective Coating (Boiled Linseed Oil)—Section 503.2

714.4 PLANT ACCEPTANCE—

(a) General. Do not begin fabrication before the Chief Structural Materials Engineer's inspection and acceptance of the plant. Provide a permanent building offered for the Department's acceptance.

Material, equipment, test procedures, methods of fabrication, handling, storage, and transportation are subject to inspection. Precast facilities fabricating solely non-structural precast architectural products need only to be certified under Architectural Precast Association (APA) plant certification program.

Register and certify the plant under either the Prestressed Concrete Institute (PCI) or National Precast Concrete Association (NPCA) plant certification program. Submit an annual endorsed copy to the Chief Structural Materials Engineer for continued qualification.

(b) QC.

1. General. Establish a level of QC based on uniform production practices. Submit the plant's QC Plan and mix design(s) to the Chief Structural Materials Engineer, Bridge Design & Technology Division, Structural Materials Section, for review and approval. Include with the QC Plan a company organizational chart indicating a separate chain of command from the QC Manager to the Owner/Plant Manager independent of the Production Manager. Resubmit the QC Plan, mix design, and organizational chart, ifrequired by the Chief Structural Materials Engineer, due to changes in processes, materials, or personnel.

2. QC Manager. Provide a QC Manager who has overall responsibility for the adequacy of production facilities, QC, sampling and testing, and fabrication of the product, and who will ensure items are fabricated as shown on the Standard Drawings. QC Managers are required to maintain an active ACI Grade I Field Technician Certification.

3. QC Personnel. Assign sufficient qualified personnel with precast concrete experience to be responsible for QC and sampling and testing during the complete fabrication process, storage, and shipment. Technicians responsible for concrete sampling and testing are required to provide written evidence they successfully completed certification requirements for an ACI Grade I Field Technician Certification or have approval from the Chief Structural Materials Engineer as a technician-in-training. Do not proceed with production until qualified personnel are present and approved.

714.5 PLANTS AND PLANT SITES—

(a) Description. Provide adequate and acceptable lighting for operations not completed in the daylight. Provide a drainage system as needed for the removal of rainfall and curing water. Provide a stabilized area for product storage.

Furnish necessary facilities for the inspection of material and work. Allow Inspectors employed by the Department unrestricted access to the premises during plant working hours. The necessary facilities for inspection include a plant office conforming to the following minimum requirements:

Number of Each	Requirements
150	Floor space: square feet
Yes	Air-conditioned/heated
1	Desk and chair
1	Plan rack
1	Work table
1	Two-drawer fire resistant (D-label) metal file cabinet
Adequate number	Chair and stools
1	Individual Access Phone line

1	Internet Service: a wired broadband Internet service, for exclusive use by Department personnel for official business purposes only. Choose a service that provides the fastest available highspeed broadband internet access, with a minimum connection of 5 Mbps per inspector, to the account by means of a Cable or Digital Subscriber Line (DSL). Provide a wireless broadband router, with a minimum-security setting of WPA2, to connect to the provided wired broadband. Based on the specific type of high-speed connection provided, furnish a compatible modem with built-in hardware firewall protection. If such high-speed wired broadband connection is not attainable at the Inspector Office desk area alternate internet connectivity options must be submitted to the Chief Structural Materials Engineer for review and acceptance. Demonstrate connectivity with the Internet Service Provider once the service is initiated. To ensure reliability and continued access, audits of this connection may be done at any time by a qualified PennDOT/OA IT Personnel.
1	Telephone (business and emergency calls only) and answering machine or voice-mail
1	Sanitary electric water cooler
1	Fire extinguisher
Adequate number	Cupboards, closets, lockers
1	First-aid kit (OSHA 1926.50(d) and 1926.50 Appendix A compliant)

714.6 FABRICATION—

(a) General. Plants must produce a sample element to verify their competency before receiving approval to produce a new product type.

Plants must produce test sections and conduct a prefabrication meeting as specified in Section 1085.3(g) for products containing an architectural finish or requiring staining or both.

(b) Bars, Mesh Reinforcement, Inserts, and Chairs. Fabricate and place bar and mesh reinforcement, as indicated, within specified tolerances. Secure reinforcing in beds and forms using chairs or blocking so the reinforcing maintains its position during placement and vibration of concrete. Bars may be fabricated into cages by tying and tack welding. Do not tack weld epoxy coated; galvanized; uncoated, corrosion-resistant; stainless steel; or Grade 60 reinforcement bars. Use acceptable chairs or ties for support.

If bar spacing is greater than or equal to 12 inches, tie all intersections with annealed iron wire or metal clips. If bar spacing is less than 12 inches, either tie all intersections or tie alternate intersections with annealed iron wire or metal clips in each direction to provide a staggered tie layout prohibit movement of reinforcement bars during manufacturing. For epoxy-coated reinforcement or galvanized reinforcement, provide plastic-coated tie wire, epoxy-coated tie wire, metal clips, or plastic clips.

(c) Beds and Forms. Support casting beds or forms on unyielding foundations. Use forms adequate for the manufacture of products within tolerances, according to approved drawings and specifications. Clean forms after each use to prevent accumulation of coatings. Wooden forms must be adequately coated and sealed to prevent leakage. Wooden form surfaces must be coated to eliminate transfer of wood grain to the finish product.

(d) Marking. Mark the manufacturer's name or trademark and the date of manufacture on one side or end of each precast unit as soon as possible after stripping using permanent marking system. For inlets, manholes, and junction boxes, also provide the type identification. Identify barrier meeting NCHRP 350 by indenting the top section of each barrier section with minimum 2-inch block lettering as follows: “T 350” for temporary barrier and “P 350” for permanent barrier. After 12/31/2019, NCHRP 350 barrier will no longer be fabricated. After 12/31/2025, NCHRP 350 barrier will be prohibited for use on Department projects.

Identify barrier meeting MASH by indenting the top section of each barrier section with minimum 2-inch block lettering as follows: “T-M-XX” for temporary barrier and “P-M-XX” for permanent barrier. The “XX” characters indicate the MASH compliance year (e.g. “16” for 2016 or “18” for 2018, etc.).

(e) Vertical Adjustment Device Assembly. Fabricate vertical adjustment device assemblies for precast concrete deck panels as shown on the Standard Drawings and as specified in Section 1107.01(b). Conduct welding and testing of assembly as specified in Section 1105 and according to the applicable AASHTO and AWS codes. Alternate vertical adjustment devices may be used if the structure can be produced within the specified erection tolerances.

714.7 CONCRETE—

(a) Testing. Verify the minimum curing strength and the 28-day minimum concrete strength, as specified in Section 704, for each lot. If the test results of the acceptance cylinders fail to meet the required 28-day minimum compressive strength, the disposition of the products will be resolved as specified in Section 110.13.

1. Traditional, Non-Self-Consolidating Mixtures. Select an appropriate slump value that provides a workable mix for the precast concrete units. At no time is the slump upper limit to exceed 5 inches for mixes without water-reducing admixtures, 6 1/2 inches for mixes with water-reducing admixtures, and 8 inches for mixes with high range water-reducing admixtures (superplasticizers). If the upper limit is exceeded on any slump test, the plant's technician must reject the cement concrete. Maintain the cement concrete consistency within 1 1/2 inches on either side of the selected value.

2. Self-Consolidating Concrete Mixtures (SCC). Perform slump flow testing according to ASTM C1611. Evaluate the visual stability index (VSI) of the mixture when the slump flow is measured during testing. Reject mixtures with a VSI>1. Conduct J-Ring testing according to ASTM C1621, whenever the slump flow test is performed. Establish a slump flow target for production of not less than 20 inches nor more than 30 inches and maintain the slump flow within a range of ± 3 inches of the target. Reject the concrete if the upper specification limit is exceeded. If the slump flow test result is less than the lower production range limit or the difference between the slump flow test result and J-Ring test result is greater than 2.0 inches reject the concrete mixture unless the mixture has been approved for vibration and is subsequently vibrated. Take immediate corrective action whenever the slump flow limits or action points are exceeded and test succeeding batches until material control has been reestablished.

(b) Mixture. For traditional, non-self-consolidating mixes, furnish concrete meeting the Class indicated and as specified in Section 704.

For SCC mixes, furnish concrete meeting the Class indicated and as specified in Section 704 except provide concrete with a plastic air content of 7% ± 2%. In addition, perform the following additional qualification tests before production:

- Column Segregation Test, ASTM C1610: 12% maximum
- Freeze Thaw Resistance, ASTM C666, Procedure A or B: minimum durability factor of 80

Fully automated batch systems using in-mixer moisture probes may be utilized, at the Fabricator's request and approval by the Chief Structural Materials Engineer. Fully automated batch systems must be operated according to Publication 145.

1. Aggregate Mineral Filler (AMF). Aggregate Mineral Filler (AMF), — is a finely divided inorganic material derived from quarried stone, for use as an ingredient in hydraulic cementitious mixtures and meeting specified chemical and physical requirements conforming to ASTM D1797.

AMF is to be used to replace a small percentage of fine aggregate to enhance the optimization of concrete mixes.

Material Specification

Gradation

Sieve	percent passing
#10	100 % passing (maximum)
#200	35% passing (maximum)

Methylene blue value (mg/g)	< 5.0%
Total Organic Carbon Content % by mass	< 0.5%

Moisture Content (%) by mass < 1.0%

Limits on Use

The percentage of AMF shall not exceed 15% (by mass) of the total cementitious factor.

(c) Placing Concrete. Place concrete without segregation. Deposit concrete in its final position in each part of the form. Methods of placement are subject to acceptance. Do not work or flow concrete along the forms from the point of deposit. Work concrete under and around reinforcement.

Place concrete batches in form within one half hour of each other. Consolidate the plastic concrete by internal vibration or external vibration or both. Do not consolidate SCC mixtures without approval and unless the mixture was qualified within 2.0 inches of the upper production slump flow limit during the trail batching and evaluation phase.

Air temperatures within the work area must remain above 40F for production.

(d) Lot Size. Lot size is one shift's production. Mold a minimum of four concrete test cylinders for each lot cast. Mold additional test cylinders for Department acceptance testing if directed.

Mold cylinders according to PTM No. 631. Cure cylinders the same as the product. Test cylinders according to PTM No. 604. Match-mark test cylinders with the lot represented. Record test results and give records to the Representative.

(e) Finishing. Make concrete surfaces true and even, and free from rough, open, or honeycombed areas, depressions, or projections. Do not add water to the concrete to facilitate finishing.

(f) Patching. Patch and repair manufacturing defects and minor damage according to Publication 145. Submit repairs beyond the scope of Publication 145 to the Chief Structural Materials Engineer for evaluation and disposition.

714.8 CURING AND PROTECTIVE COATING—

(a) Curing. Cure and protect concrete according to the approved QC Plan. Develop the QC Plan according to ACI 308.

Set stripping time based on the inherent characteristics of the product.

Accomplish secondary curing by approved methods.

Maintain precast concrete units, after stripping and during secondary curing, in a minimum 50F environment until they have reached a compressive strength of 80% of the 28-day minimum compressive strength for the product as indicated on the shop drawing. Do not place units in an environment of less than 32F after the secondary cure, unless the differential between the units and the air temperature is less than 30F.

Store units until the 28-day minimum compressive strength is obtained.

(b) Protective Coating. Apply protective coating to concrete barrier and inlet tops before shipment. Use boiled linseed oil and apply as specified in Section 503.3(b) or use a penetrating sealer from a manufacturer listed in Bulletin 15 applied according to the manufacturer's specifications. Penetrating sealer must not discolor the concrete. If curing compound is used for secondary curing, wait 14 days before applying the protective coating. Barriers for temporary use need not receive a protective coating.

714.9 TOLERANCES—As shown on the Standard Drawings, according to Publication 145, or according to PCI MNL 135 except as follows:

Length of Member—1/8 inch per 10 feet with a minimum of 1/4 inch and a maximum of 3/4 inch

Cross-Sectional Dimensions— ≤ 36-inch… ± 1/4-inch
> 36-inch… ± 3/8-inch

714.10 HANDLING AND STORAGE—Handle and move products to the storage yard when they have gained adequate strength to be moved without causing damage. Maintain adequate support when handling and storing the product. Store the product, until shipment, in areas accessible for inspection.

714.11 TRANSPORTATION—Provide 24-hour advance notice of loading and shipping schedule. Do not ship unapproved items. Include Form CS-4171 with each shipment. Observe hauling restrictions. Ensure that supports, bracing, and shipping methods dampen vibration. Provide adequate padding material between the tie chains or cables to prevent concrete chipping.

714.12 DISPUTES—In matters of disputes over products, the Chief Structural Materials Engineer, BDTD, Structural Materials Section, or the designated on-site representative have the final word on acceptability of the product.

714.13 CERTIFICATION—Section 106.03(b)3, and as further directed by the Chief Structural Materials Engineer, BDTD, Structural Materials Section.

SECTION 720—WATER

720.1 WATER FOR MIXING OR CURING CEMENT CONCRETE, MORTAR, OR GROUT—Use water conforming to ASTM C1602 that is reasonably clean, free from vegetable matter, oil, acid, alkali, sugar, or other substances injurious to the finished product.

720.2 WATER FOR USE OTHER THAN IN MIXING OR CURING CEMENT CONCRETE, MORTAR, OR GROUT—Suitable clean water may be used without testing. If the water source is relatively shallow, enclose the intake to exclude silt, mud, grass, or other undesirable foreign material.

SECTION 721—CALCIUM CHLORIDE

721.1 GENERAL—As listed in Bulletin 15 and conforming to the requirements of AASHTO M 144, Type S, Grade 1, Class A or B. Certify as specified in Section 106.03(b)3.

SECTION 722—SODIUM CHLORIDE

722.1 GENERAL—Sodium chloride for the purpose of roadway de-icing.

722.2 MATERIAL—Furnish sodium chloride from a manufacturer listed in Bulletin 15 and conforming to the requirements of ASTM D 632.

(a) Roadway De-icer – Mined rock salt.

- Classification – Type I, Grade 1, unless otherwise specified by the Department of General Services Statewide Sodium Chloride Contract which shall govern the classification requirement.

- Moisture Content – Shall not exceed 2.0-percent by weight, unless otherwise specified by the Department of General Services Statewide Sodium Chloride Contract which shall govern the moisture content requirement.

- Anti-Caking Compound – Shall be treated with either Yellow Prussiate of Soda (Sodium Ferrocyanide) or Prussian Blue (Ferric Ferrocyanide) introduced uniformly throughout at such a rate that a minimum of 20-ppm anti-caking compound is present, unless otherwise specified by the Department of General Services Statewide Sodium Chloride Contract which shall govern the anti-caking compound requirement.

(b) Certification – Certify as specified in Section 106.03(b)3.

SECTION 723—HYDRATED LIME

723.1 GENERAL—ASTM C 207, Type N. Legibly mark the manufacturer's name, the lot number, and the approximate net weight on each container or, in the case of bulk shipment, on the shipping notice. Certify as specified in Section 106.03(b)3.

SECTION 724—SUPPLEMENTARY CEMENTITIOUS MATERIAL

724.1 GENERAL—From a manufacturer listed in Bulletin 15. Legibly mark the name of the manufacturer, the lot number, and the approximate net mass on each container or, in case of bulk shipment, on the shipping invoice.

Supply sources desiring approval must write the LTS, stating their present QC program, as specified in Section 106.03(a)2.

The material is subject to assurance sampling and testing by the LTS. Materials not conforming to the requirements may result in suspension of source approval. The supply source may reapply for approval after making corrections necessary to ensure all sampled or tested materials meet all applicable Specifications.

Obtain material from a single source, unless directed otherwise in writing. Separate material of different types and from different sources. Use each type and source in continuous segregated portions of the project. If possible, limit material used in an individual structure to a single type or source. If this is not possible, use one type and source for footers, piers, and abutments, and one source for superstructures if allowed.

724.2 FLYASH—

(a) For Use with Lime. ASTM C593, tested according to AASHTO T 135. Certify as specified in Section 106.03(b)3.

(b) For Use with Cement Concrete. AASHTO M 295, Class C, F, or N, except limit Loss on Ignition to a maximum of 6.0%. Certify as specified in Section 106.03(b)3.

TR-7012 - FLYASH Test Results. Form must be filled out and delivered with every certified load.

724.3 SLAG CEMENT—

(a) For Use with Cement Concrete. AASHTO M 302, Grade 100 or 120. Do not use slag cement with a material temperature exceeding 180F at time of delivery to the mixer, unless directed in writing. Certify as specified in Section 106.03(b)3.

TR-7013 - Slag Cement Test Results. Form must be filled out and delivered with every certified load.

724.4 SILICA FUME—

(a) For Use with Cement Concrete. AASHTO M 307 except percent retained on the No. 325 sieve. If the percent retained on the No. 325 sieve is greater than 10%, test the material retained for contamination. Certify as specified in Section 106.03(b)3.

TR-7014 - Silica Fume Test Results. Form must be filled out and delivered with every certified load.

724.5 Mechanically Modified Supplementary Cementitious Materials (SCM) -Cement combinations

(a) For Use with Cement Concrete. Inter-ground Mechanically Modified SCM-Cement combinations which contain a minimum of 90% SCM by weight and as specified in Section 704.1(b) when replacing 50% cement by weight in cement concrete mixtures. Test according to the AASHTO standard for the base SCM as specified in Sections 724.2(b) or 724.3(a). Certify as specified in Section 106.03(b)3.

SECTION 725—LIME POZZOLAN

725.1 GENERAL—Submit samples to the LTS for testing, a minimum of 60 days before anticipated use. From a manufacturer listed in Bulletin 15, and conforming to the following requirements:

- Total calcium and magnesium oxides (nonvolatile basis)—min. 45%
- Available calcium oxide (rapid sugar test, ASTM C 25) plus total MgO content calculated to be equivalent $Ca(OH)_2$—min. 25%

  As received loss on ignition (carbon dioxide plus moisture, combined and free)—max. 35%
- Free water (as-received basis)—max. 2%
- Residue—The sieve analysis of the by-product lime shall be as follows:

Sieve	Maximum Percent Retained
No. 100	5
No. 200	20

SECTION 727—ASPHALT IMPREGNATED PAPER

727.1 GENERAL—Impregnated with asphalt or tar and conforming to the following requirements:

ENGLISH

	One-Ply	Two-Ply
Weight per square foot, ounces	4.8	6.3
Permissible variation, %	6	6

SECTION 735—GEOTEXTILES

735.1 GENERAL—From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

(a) Fabric. Use fabric consisting of long chain polymeric filaments or yarns such as polyethylene, polyamide, polyvinyledene-chloride, polypropylene, or polyester formed into a stable network so that the filaments or yarns retain their relative position to each other. Use fabric structures as noted in Table A. Slit film woven fabrics may only be used for Class 3 Geotextiles. Chemically- or thermally-bonded fabrics are not allowed for any class of geotextile. Use fabric inert to commonly encountered construction chemicals or substances. During periods of shipment and storage, protect the fabric from direct sunlight, ultra-violet rays, temperatures greater than 140F, mud, dirt, dust, and debris. To the extent possible, wrap the fabric in a heavy-duty covering or shield from direct sunlight.

Geotextiles will be rejected at the time of installation if any defects, deterioration, or damage was incurred during manufacture, transportation, or storage.

(b) Physical Requirements. Table A, for the indicated construction class and type.

(c) Acceptance. Acceptance of the geotextile will be based on certified test data submitted by the manufacturer and on testing by Laboratory Testing Section (LTS).

(d) Certification. Certify each shipment as specified in Section 106.03(b)3. Visibly label all shipments on the fabric or its container with the manufacturer's name, fabric type or trade name, lot number, and material quantity.

TABLE A
Geotextile Physical Requirements[(1) (2)]

Fabric Properties	Test Method	Construction Class				
		Class 1	Class 3		Class 4	
		Subsurface Drainage	Sediment Control		Separation and Erosion Control	Stabilization and GRS Abutments
			Type A	Type B	Type A	Type C
Fabric Structure	N/A	Woven Monofilament	Woven Slit Film	Woven Slit Film	Non-woven Needle Punched	Woven Polypropylene
Weight, oz/sy	ASTM D5261	N/A	N/A	N/A	12.0 min	N/A
Grab Tensile Strength, lbs.[(3)]	ASTM D4632	365 min MD x 190 min XD	185 min MD and XD	115 min MD and XD	305 min MD and XD	N/A
Grab Tensile Elongation, %[(3),(5)]	ASTM D4632	22 to 34 MD x 9 to 26 XD	13 to 31 MD and XD	13 to 31 MD and XD	50 min MD and XD	N/A
Ultimate Wide Width Tensile Strength, lb/ft	ASTM D4595	N/A	N/A	N/A	N/A	4,800 min MD and XD
Wide Width Tensile Strength @ 2% Strain, lb/ft	ASTM D4595	N/A	N/A	N/A	N/A	Design Specific[(4)]
Puncture, lbs. (2-in flat- end rod)	ASTM D6241	660 min	700 min	440 min	830 min	1,700 min
Trapezoid Tear Strength, lbs.	ASTM D4533	95 min MD x 75 min XD	70 min MD and XD	50 min MD and XD	110 min MD and XD	170 min MD and XD
Apparent Opening Size, mm (Sieve No.)	ASTM D4751	0.30 to 0.60 (No. 50 to No. 30 sieve)[(5)]	0.21 to 0.43 (No. 70 to No. 40 sieve)[(5)]	0.30 to 0.60 (No. 50 to No. 30 sieve)[(5)]	0.15 max	0.425 to 0.85 (No. 40 to No. 20 sieve)[(5)]
Percent Open Area, %	COE CW-02215	9.0 to 12.0[(5)]	N/A	N/A	N/A	N/A
Permittivity, sec^{-1}	ASTM D4491	1.9 min	0.05 min[(5)]	0.05 min[(5)]	0.70 min	0.40 min[(5)]
Water Flow Rate, g/min/sf	ASTM D4491	130 min	N/A	N/A	N/A	25 min
Ultraviolet Resistance Strength Retention, %	ASTM D4355	90 @ 500 hrs min	70 @ 500 hrs min	70 @ 500 hrs min	70 @ 500 hrs min	70 @ 500 hrs min

(1) The numerical values indicate the required minimum or maximum (as indicated) average values for ten test specimens. No more than 20% of the individual specimens may have a value less than the required minimum value or greater than the required maximum value (as indicated), except as noted (see Note 5).
(2) MD = Machine Direction, XD = Cross Machine Direction
(3) Test conducted using 1/32 inch thick neoprene pads on grip faces having a Shore A durometer value of 70±5.
(4) Wide width tensile strength at 2% strain in both the machine and cross machine directions (MD x XD), must be greater than or equal to required design tensile strength.
(5) The numerical values indicate the allowable range or required minimum (as indicated) based upon the numerical average of all test specimens from a sample.

SECTION 736—GEOMEMBRANE

736.1 GENERAL—From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

(a) Geomembrane. Fabricated from high-density polyethylene (HDPE).

(b) Physical Requirements.

- Density 59 pounds per cubic foot minimum, ASTM D 1505
- UV stabilization 2% carbon black, ASTM D 1603
- Sheet thickness 30 mils minimum, ASTM D 5199
- Tear resistance 22 pounds ASTM D 1004
- Resistance soil burial 90% retained strength ASTM D 3083
- Minimum roll width 20 feet minimum

(c) Acceptance. Acceptance of the geomembrane will be based on certified test data submitted by the manufacturer and on testing by LTS.

(d) Certification. Certify each shipment as specified in Section 106.03(b)3. Visibly label all shipments on the geomembrane or its container with the manufacturer's name, geomembrane type, model or trade name, lot number, and material quantity.

SECTION 737—GEOCELL

737.1 GENERAL—From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

(a) Physical Requirements. Provide geocell of cell geometric characteristics listed in Table A and meeting one of the depths listed in Table B, as indicated.

- Sheet material — High-density polyethylene (HDPE)
- UV Stabilization — 1.5 - 2% carbon black, ASTM D 1603
- Environmental Stress Crack Resistance — 1,500 hours minimum, ASTM D 1693
- Sheet surface — Sheet, perforated or non-perforated, smooth or textured
- Sheet density — 58.7 pounds per cubic foot minimum, ASTM D 1505
- Nominal sheet thickness — 47 mils minimum, ASTM D 5199
- Cell wall seams — Assemble each seam with 3/4-inch maximum melt pools using continuous or uniformly spaced ultrasonic spot welding. Space welded seams conforming to the requirements of Table A for the Type of geocell.
- Cell seam peel strength — Conform to the requirements of Table B, when tested according to PTM 301.

TABLE A
Cell Characteristics per Geocell Type

Type	Nominal Cell Dimensions in.*	Nominal Cell Area in.^{2}*	Avg. No. Cells per yd.^{2}*	Weld Spacing in.**
A	8.8x10.2	44.8	28.9	14.0 ± 0.12
B	11.3x12.6	71.3	18.2	17.5 ± 0.12
C	18.7x20.0	187.0	6.9	28.0 ± 0.12

*For informational purposes only.
**In unexpanded configuration.

TABLE B
Required Cell Seam Peel Strength

Depth in.	Cell Seam Peel Strength lbs.
3.0 ± 0.1	240
4.0 ± 0.1	320
6.0 ± 0.1	480
8.0 ± 0.1	640

(b) Certification. Certify each shipment as specified in Section 106.03(b)3. Visibly label all shipments on the geocell or its container, with the manufacturer's name and model number or trade name.

SECTION 738—GEOGRIDS

738.1 POLYMER REQUIREMENTS—

(a) General. Provide geogrid listed in Bulletin 15 and conforming to the following requirements. Geogrids must be manufactured from either PVC coated polyester (PET), high density polyethylene (HDPE), or polypropylene (PP) polymer according to the class indicated. No post-consumer recycled material is allowed in polymer resins used in the manufacturing of geogrid products. Requirements for the polymers are indicated in Table A.

Table A[1]
Requirements for Geogrid Polymers
(All values minimums unless indicated otherwise)

Property	Units	Test Method	PET	HDPE	PP
Carboxyl End Group (CEG) Content of PET Yarns	mmol/kg	GRI:GG7[2]	< 30.0	N/A	N/A
Number Average Molecular Weight (M_n) of PET Yarns	-	GRI:GG8[2]	25,000	N/A	N/A
PVC Coating	Except for manufacturing selvedge edges, the PVC coating for PET geogrids must be continuous with no more than 0.03% of the surface area having uncoated, unbound fiber bundles as determined according to ASTM D610.			N/A	N/A
Carbon Black Content[3]	%	ASTM D1603 or ASTM D4218	N/A	2.0 to 3.0	2.0 to 3.0
Melt Flow Index	g/10 min	ASTM D1238 using Condition190/2.16 for HDPE and Condition 230/2.16 for PP	N/A	0.50	0.25
Density	g/cm^3	ASTM D792 or ASTM D1505	N/A	0.940	0.955
Oxidative Induction Time	min	ASTM D3895	N/A	100.0	100.0
Resistance to UV Degradation[4]	%	ASTM D4355 and ASTM D6637 (Method B)	N/A	95	95

Notes:
1. All values are minimum average roll values (MARV), except for CEG for PET polymer which is a maximum average roll value. The maximum average roll value is determined mathematically the same as a MARV, except the value is a maximum.
2. GRI is a reference for the Geosynthetic Institute, formerly known as the Geosynthetic Research Institute.
3. For buried applications only. Do not use geogrids with long-term exposure to UV radiation.
4. A sample is exposed to 500 hours of UV radiation according to ASTM D 4355. The sample is then tested to determine the ultimate tensile strength in the machine direction (MD) for uniaxial geogrids and both the machine and cross machine directions (MD and XD) for biaxial geogrids. The value is calculated by dividing ultimate tensile strength of the UV exposed material by the ultimate tensile strength of the virgin material, and multiplying by 100. Ultimate tensile strengths of all samples are determined according to ASTM D6637, Method B. For biaxial geogrids the minimum required value must be met in both the MD and XD.

738.2 CLASS 1 GEOGRIDS, UNIAXIAL GEOGRID REINFORCEMENT—

(a) General. For use in geosynthetic reinforced soil (GRS) slopes or geosynthetic reinforced mechanically stabilized earth (MSE) walls.

(b) Physical Requirements. Required values and test methods for geogrid properties are indicated in Table B. Sample materials in accordance with ASTM D4354.

Table B Requirements Class 1 Geogrids – Uniaxial Geogrid Reinforcement (All values minimums unless indicated otherwise)				
Design Parameter	**Units**	**Test Method**	**Type A**	**Type B**
Polymer Type	-	N/A	PVC Coated PET	Integrally Formed[5] HDPE
Ultimate Tensile Strength	lbs/ft	ASTM D6637 (Method B)	Design Specific	
Tensile Strength at 10 percent elongation, (T_{10})	lbs/ft	ASTM D6637 (Method B)	Design Specific	
Creep Reduction Factor, (RF_C)[1] (determined for a 100 year design life)	-	AASHTO R 69, ASTM D5262, and ASTM D6992	1.60	2.60
Installation Damage Reduction Factor, (RF_{ID})[1, 2]	-	GRI:GG4 (method a or b as appropriate), ASTM D5818, and ASTM D6637	1.30	1.30
Durability Reduction Factor, (RF_D)[1]	-	N/A	1.20	1.10
Overall minimum required reduction factor (RF_{OV})[1, 3, 6]	-	N/A	2.50	3.70
Machine Direction (MD) Aperture Size	in.	N/A	0.60 to 6.0	0.60
Cross Machine Direction (XD) Aperture Size	in.	N/A	0.50	0.50
Rib Section Area Ratio[4]	-	N/A	0.30	0.30
Percent Open Area	%	N/A	45.0	45.0

Notes:

1. Value indicated is the minimum required reduction factor. If product specific data values are higher, the product specific data values must be used.
2. Installation Damage Reduction Factor (RF_{ID}) is valid for a maximum aggregate particle size of 0.5 inch.
3. $RF_{OV} = RF_C \times RF_{ID} \times RF_D$
4. Rib Section Area Ratio = Minimum XD Rib Section Area / Minimum MD Rib Section Area
5. Manufactured by a punched-drawn process.
6. Maximum allowable strain of the geogrid is five percent for the 100 year design live when applying the minimum required overall reduction factor (RF_{OV}).

1. Tensile Strength at 10 Percent Elongation, (T_{10}). Determine tensile strength at 10 percent elongation based upon minimum average roll values (MARV) determined in accordance with ASTM D6637 Method B. If 10 percent elongation cannot be achieved before reaching the ultimate strength, then use the ultimate strength as the 10 percent value, specifying the percent elongation at failure.

2. Creep Reduction Factor, (RF_C). Determine the geogrid creep reduction factor (RF_C) in accordance with AASHTO R 69, ASTM D5262, and ASTM D6992. Test samples unconfined in the direction in which the load will be applied. Use the ratio of ultimate strength to creep limiting strength to calculate the creep reduction factor. If the calculated creep reduction factor is greater than the creep reduction factor indicated in Table B, use the calculated creep reduction factor.

3. Installation Damage Reduction Factor, (RF_{ID}). Evaluate installation damage on geogrid tensile strength from the results of full scale installation damage tests in accordance with WSDOT T925, Appendix A, except as follows:

- Use a single drum vibratory smooth steel drum roller, operated in dynamic (vibratory) mode, having a minimum static drum axle load of 125 pounds per inch (drum static axle load divided by drum width), and a minimum centrifugal force of 350 pounds per inch (drum centrifugal force divided by drum width). Operate the vibratory roller at a speed not exceeding 1.0 foot per second.

- Place and compact two lifts (each lift approximately 8 inches loose, 6 inches compacted) of AASHTO No. 8 coarse aggregate meeting the requirements of Section 703.2, Type A material. Place the AASHTO No. 8 coarse aggregate on a flat, level, and firm foundation. Compact each lift of the AASHTO No. 8 coarse aggregate with a minimum of five passes of the roller, assuring full coverage with five passes is obtained for the entire test area (full footprint of the geogrid).
- Place the geogrid on top of the two compacted lifts of AASHTO No. 8 coarse aggregate. Pull the geogrid taught with no wrinkles or folds.
- Place and compact a lift (approximately 8 inches loose, 6 inches compacted) of AASHTO No. 8 coarse aggregate over the geogrid using the type of spreading equipment typically used in full scale construction. If necessary, pin the geogrid to maintain its position as the AASHTO No. 8 coarse aggregate is placed over the geogrid. Compact the AASHTO No. 8 coarse aggregate with a minimum of five passes of the roller, assuring full coverage with five passes is obtained for the entire test area (full footprint of the geogrid).
- Test samples subjected to installation damage for tensile strength in accordance with ASTM D6637, Method B. The number of specimens tested must be in accordance with D 6637, Method B. Compare test results from damaged specimens to tensile test results obtained from undamaged (i.e., not exposed to installation conditions) specimens taken from the same roll of geogrid as the damaged specimens.
- Determine the installation damage reduction factor, RF_{ID}, except as follows:

$$RF_{ID} = T_{un} / T_{dam}$$

where:

T_{un} = Lesser of T_{10} of undamaged samples from the same roll or the T_{10} for the manufacturer's minimum average roll value (MARV). Determine the T_{10} of the undamaged samples with the same number of test samples used to determine T_{dam}. Determine both the T_{10} of the undamaged samples and the T_{10} for the manufacturer's MARV according to ASTM D6637, Method B.

RF_{ID} must never be less than 1.3.

4. Durability Reduction Factor (RF_D). Use the minimum reduction factor for durability (RF_D) indicated in Table B unless project specific conditions or a specific geogrid indicates a higher value.

5. Allowable Geosynthetic Tensile Strength (T_L). Determine allowable tensile strength of the geogrid using the individual reduction factors to account for installation damage, durability, and creep. The overall reduction factor is the product of the individual reduction factors. Determine the allowable long term geogrid strength (T_L) from:

$$T_L = T_{10} / RF_{OV}$$

$$RF_{OV} = RF_C \times RF_{ID} \times RF_D$$

$$T_L \geq T_d$$

where:

T_L = long-term allowable geogrid tensile strength, (lbs/ft).

T_{10} = tensile strength at 10 percent elongation, (lbs/ft); When T_{ult} occurs at an elongation less than 10 percent, set $T_{10} = T_{ult}$.

RF_{OV} = overall reduction factor (dimensionless).

RF_C = creep reduction factor (dimensionless). Ratio of T_{ult} to creep-limiting strength, determined according to AASHTO R 69. Use the minimum value indicated in Table B, unless product specific values are greater, use the higher product specific value.

RF_{ID} = installation damage reduction factor (dimensionless). Use the minimum value indicated in Table B. If product specific value is higher, use the product specific value.

RF_D = durability reduction factor (dimensionless). Use the minimum value indicated in Table B,

unless project specific conditions or specific geogrid indicate a higher value.

T_d = required design tensile strength of geogrid reinforcement (lbs/ft).

738.3 CLASS 2 and 3 BIAXIAL GEOGRIDS—

(a) General – For use in a foundation load distribution pad, subgrade or subbase stabilization, or similar applications.

(b) Physical Requirements – Provide geogrid consisting of a regular network of integrally connected longitudinal and transverse polymer tensile elements having aperture geometry sufficient to permit mechanical interlock with the surrounding material. Provide biaxial geogrid conforming to the properties indicated in Table C.

Table C
Required Properties for Class 2 and 3 Biaxial Geogrids
(All values are minimums unless indicated otherwise)

Property	Units	Test Method	Class 2		Class 3	
			Type A	Type B	Type A	Type B
Polymer Type	–	–	HDPE	PP	HDPE	PP
Aperture Size[1, 2]	in	-	1.0 to 1.7		1.0 to 1.7	
Aperture Open Area[3]	in^2	-	1.0 to 2.9		1.0 to 2.9	
Percent Open Area	%	-	65		65	
Ultimate Tensile Strength[1, 4]	lbs/ft	ASTM D6637	1,080		1,780	
Elongation at Ultimate Tensile Strength[1]	%	ASTM D6637	5.0 to 15.0		5.0 to 15.0	
Junction Efficiency[5]	%	ASTM D7737 and ASTM D6637	90		90	
Resistance to Installation Damage[6]	%	GRI:GG4, ASTM D5818, and ASTM D6637	80		80	

Notes:

1. Both machine direction (MD) and cross machine direction (XD).
2. The value is the size of the opening in each direction.
3. The value is the product of the aperture openings in the MD and XD.
4. Values indicated are minimum average roll values (MARV).
5. Calculate by dividing junction strength (as determined by ASTM D7737) by the ultimate tensile strength (as determined by ASTM D6637) and multiplying by 100.
6. Conduct installation damage testing in accordance with Section 738.2(b)3 except use PennDOT No. 2A coarse aggregate. Calculate the resistance to installation damage by dividing the ultimate tensile strength of the geogrid (as determined by ASTM D6637) after it is exhumed from the compacted PennDOT No. 2A coarse aggregate by the ultimate tensile strength of the geogrid before placement and multiplying by 100.

738.4 HANDLING and STORAGE—At a minimum, follow ASTM D4873 for identification, storage, and handling of geogrid. Provide clear identification to every roll of geogrid that provides identification of product designation, the manufacturer's name, lot number, material quantity, and clearly differentiates between rolls of similar geogrid. Protect the geogrid from direct sunlight, ultra-violet rays, temperature greater than 140F, mud, dirt, dust, and debris.

738.5 CERTIFICATION—Certify each shipment as specified in Section 106.03 (b)3.

SECTION 800
ROADSIDE DEVELOPMENT

SECTION 801—STOCKPILING TOPSOIL OR TOPSOIL MIXTURE

801.1 DESCRIPTION—This work is separation and salvaging of topsoil or topsoil mixture encountered in grading the project and depositing it in stockpiles at locations within the right of way.

801.2 MATERIAL—

(a) Topsoil. Acceptable friable loam that is reasonably free of subsoil, clay lumps, brush, roots, weeds, other objectionable vegetation, stones, other foreign material larger than 2 inches in any dimension, litter, and/or other material unsuitable or harmful to plant growth.

(b) Topsoil Mixture. Designated top 8 inches to 12 inches of existing soil collected and combined with organic plant matter such as vegetative slashings consisting of crushed or shredded branches, stems, bark, leaves, seeds, and roots.

801.3 CONSTRUCTION—

(a) Topsoil. After clearing and grubbing the area and before starting other construction operations, remove topsoil from areas, as indicated or directed. Adjust equipment and methods of operation to avoid mixing subsoil with topsoil.

Separate the topsoil from other excavated material and stockpile at acceptable locations within the right of way. Do not compact and do not stockpile topsoil in a wet or frozen condition.

Satisfactorily and uniformly grade stockpiled topsoil not required for the project. Apply seeding and soil supplements to these stockpiles, using the formula, as directed, and apply, as specified in Section 804.3. Apply mulch of the type directed, on the stockpiles, as specified in Section 805.3.

(b) Topsoil Mixture. During clearing and grubbing operations and before other construction operations, shred all designated vegetation under 4 inches caliper in size using a crawler or loader mounted, self powered, land clearing shredder capable of shredding vegetation to a desired maximum rough size of 12 inches long and 2 inches in diameter. Collect and mix the organic slashings with the top 8 inches to 12 inches of soil to be salvaged, as indicated or directed.

Stockpile topsoil mixture at acceptable locations within the right of way. Do not compact material. Periodically water stockpile as directed.

801.4 MEASUREMENT AND PAYMENT—Cubic Yard

Measured in its final position, as specified in Section 203.4(a)2.

Stockpiled topsoil and topsoil mixture is incidental to Clearing and Grubbing, Excavation, and Borrow Excavation.

SECTION 802—TOPSOIL FURNISHED AND PLACED

802.1 DESCRIPTION—This work is the furnishing and placing of topsoil from outside the project, as indicated.

802.2 MATERIAL—Section 801.2 and containing not less than 2.0% nor more than 10.0% organic matter, according to AASHTO T 194.

Provide topsoil meeting the following grading analysis:

Sieve	Minimum Percent Passing
2 inches	100
No. 4	75
No. 10	60

Sand, silt, and clay material passing the No. 10 sieve, according to AASHTO T 88 and within the following ranges:

	Minimum Percent	Maximum Percent
Sand	5	70
Silt	10	70
Clay	5	36

Provide independent testing to confirm that the topsoil meets the above requirements. Independent testing must be less than 12 months old at the time topsoil is furnished to the project. Submit for approval as specified-in Section 106.02(a)2.c.

Obtain topsoil from outside the right of way, where the soil quality has proven ability to grow vegetation. Before topsoil removal, obtain acceptance for the quality of the source, for the depth of the topsoil to be removed, and for the method of removal.

Recondition areas from which topsoil was obtained, as specified in Section 105.14.

802.3 CONSTRUCTION—

(a) Preparation of Areas to be Topsoiled. Grade the areas to be covered by topsoil. Using acceptable methods, loosen soil to a depth of 2 inches before placing the topsoil. Remove stones and other foreign material 2 inches or larger in any dimension. Remove and satisfactorily dispose of unsuitable and surplus material.

(b) Placing and Spreading Topsoil. Place topsoil on the prepared areas and, unless otherwise indicated, spread and compact to a 4-inch uniform depth ±1 1/2 inches. Compact with a roller having a weight not over 120 pounds per foot width of roller or by other acceptable methods, as directed. Remove overdepth topsoil, unless otherwise agreed upon in writing. Do not place topsoil in a wet or frozen condition.

802.4 MEASUREMENT AND PAYMENT—

(a) Cubic Yard. Measured in the hauling vehicle at the delivery point, as specified in Section 109.01(b). The Contractor may leave overdepth topsoil in place, at no additional cost to the Department.

(b) Square Yard.

SECTION 803—PLACING STOCKPILED TOPSOIL OR TOPSOIL MIXTURE

803.1 DESCRIPTION—This work is the preparation of indicated areas and the placement of topsoil or topsoil mixture on the prepared areas, using topsoil or topsoil mixture removed from stockpiles located on the project or from other indicated areas.

803.2 MATERIAL—Section 801.2

803.3 CONSTRUCTION—Section 802.3 and as follows:

(a) Topsoil. Remove topsoil from stockpiles using an acceptable method, which does not mix the topsoil with foreign materials.

(b) Topsoil Mixture. Scarify and loosen soil surfaces to a depth of 6 inches lateral to the slope face. Moisten loosened soil, if dry, to optimum moisture content as directed. Remove debris and any other foreign material 2 inches or larger in any dimension. Place stockpiled topsoil mixture to a depth of 6 inches ± 1 inch measured in place after compaction.

Consolidate topsoil mixture and bond to soil surfaces using a sheepsfoot roller; and provide a firm, stable, rough textured surface. Compact areas not accessible to the sheepsfoot roller with a roller having a weight not over 120 pounds per foot width of roller or by other acceptable methods. Do not place topsoil mixture in a frozen or wet condition.

(c) Unused Material. Return unused topsoil or topsoil mixture to stockpiles and grade uniformly. Condition remaining stockpiles and stockpile areas as specified in Section 105.14.

803.4 MEASUREMENT AND PAYMENT—Cubic Yard

Measured in the hauling vehicle at the delivery point, as specified in Section 109.01(b).

SECTION 804—SEEDING AND SOIL SUPPLEMENTS

804.1 DESCRIPTION—This work is furnishing and placing of seed and soil supplements of the type indicated, the application of herbicides, and mowing requirements.

The following definitions apply:

(a) Certified Seed. Seed of known genetic identity that has been field and laboratory inspected and tested during its period of growth to provide a source of high quality ground cover and ensure genetic identity and purity. Seeds are certified by recognized certifying agencies that conform to the certification laws and regulations of Pennsylvania or other states. Certification identification is indicated on all seed lot tags or labels.

(b) Germination. The emergence and development from the seed embryo of essential plant structures that can produce a normal plant under favorable conditions and is represented by a percentage of an identified seed quantity exclusive of hardseed.

(c) Hardseed. Unscarified seed that remains hard or has not germinated at the end of a prescribed test period because the seed has not absorbed water due to an impermeable seed coat.

(d) Pure Live Seed (PLS). A term that defines the planting quality of seed exclusive of inert matter and all other seeds not of the seed type being analyzed as determined by inspection and testing regulations. PLS is often used where seed industry standards have not been established for minimum acceptable purity and germination limits.

(e) Purity. The genetic identity of a seed that will produce a known plant and is represented by a percentage of an identified seed quantity or seed lot.

(f) Seed Formula. A seed mixture of more than one variety of a seed kind in excess of 5% by weight of the whole.

(g) Seed Lot. A definite quantity of seed identified by an assigned number or mark which is uniform throughout for all seed quality factors stated on the lot label or are within permitted tolerances.

(h) Seed Mixture. A seed batch that consists of more than one kind of seed when each kind is present in excess of 5% of the whole.

(i) Variety. A plant subdivision that can be differentiated from other plants of the same kind by growth, yield, fruit, color, seed, or other identifying characteristics.

(j) Weed Seed. A seed producing plant generally recognized as a weed by the Pennsylvania Department of Agriculture which includes the seed of prohibited and restricted noxious weeds.

804.2 MATERIAL—The Department may require pretesting reports from the Pennsylvania Department of Agriculture for verification of analysis and legality of labeling, in addition to control of materials, as specified in Section 106.

(a) Soil Supplements.

1. Pulverized Agricultural Limestone. Conforming to the requirements of the Agricultural Liming Materials Act of 1978, P.L. 15, No. 9, as amended; The Agricultural Liming Materials Rules and Regulations (Title 7-Part V); 7 PA Code, Chapter 108 for labeling requirements; and as follows:

- % Total oxides (total calcium oxide and magnesium oxide equivalent) According to (ASTM C 25) 50
- % Calcium carbonate equivalent (% by weight) According to (ASTM C 25) 89

- % Fineness (minimum % by weight)

material passing No. 20 sieve	95
material passing No. 60 sieve	60
material passing No. 100 sieve	50

Furnish material having an Effective Neutralizing Value (ENV) of not less than 90 when calculated according to 7 PA Code Chapter 108 as follows:

- % by weight passing 20 mesh - % passing 60 mesh x 0.4 = (a)
  % by weight passing 60 mesh - % passing 100 mesh x 0.8 = (b)
  % by weight passing 100 mesh x 1.0 = (c)

- Minimum Calcium Carbonate Equivalent (CCE) = % by weight of calcium carbonate

- (a) + (b) + (c) x CCE divided by 100 = ENV

2. Commercial Fertilizer. Conforming to the requirements of the Pennsylvania Soil Conditioner and Plant Growth Substance Law, Act of December 1, 1977, P.L. 258, No. 86 (3P.S.68.2), as amended.

Use dry formulations of 10-20-20 analysis for seeded and sodded areas. Use dry formulations of 20-10-5 and 16-8-16 analysis controlled release for tree, shrub, and vine type planting operations. Use dry formulations of 19-6-12 analysis controlled release for herbaceous wetland planting operations. Use other analysis as indicated.

3. Slow-Release Nitrogen Fertilizer. Conforming to the requirements of the Pennsylvania Soil Conditioner and Plant Growth Substance Law, Act of December 1, 1977, P.L. 258, No. 86 (3P.S.68.2) as amended.

Use dry formulations of either 38-0-0 ureaform, 32-0-0 to 38-0-0 sulfur coated urea, 31-0-0 IBDU, or another analysis as indicated and conform to the following requirements:

- 38-0-0 ureaform

Total Nitrogen (TN)	—	38.0% minimum
Cold Water Insoluble Nitrogen (WIN)	—	25.0% minimum
Activity Index (AI)	—	40.0% minimum
Urea Nitrogen	—	3.5% minimum

- 32-0-0 to 38-0-0 sulfur coated urea with a 7-day dissolution range of 20% to 30%

- 31-0-0 IBDU — Coarse grade (28 mils to 98 mils)

- Water Insoluble Nitrogen (WIN) — 27.0% minimum

(b) Seed.

1. General. Seed conforming to the regulations of Chapter 71 – Seed of the Pennsylvania Seed Act 164 of 2004, effective January 29, 2005, and amendments. Meet other applicable regulations of the Seed, Testing and Certification Programs of the Pennsylvania Department of Agriculture (PDA), Bureau of Plant Industry.

Provide seeds that have been tested and approved for the specified seed formula's purity, germination, and weed seed analysis limits and other applicable PDA rules for seed testing.

Provide certified seed for all Kentucky Bluegrass, Perennial Ryegrass, Creeping Red Fescue, Chewings Fescue, and Hard Fescue varieties submitted for each seed formula.

Provide premixed seed mixtures from a licensed seed distributor/seed mixing company located within the State and mixed under the supervision of the PDA for the designated Table A seed formulas. Use only seed that has

an approved seed inspector's tag or label signed by a PDA inspector sewn or stapled to the outside of each seed bag or other container in a conspicuous place. Pressure sensitive labels may be used on paper or plastic containers.

Seed mixtures may also be mixed to project specifications at the project site for special seed formulas or mixtures not specified in Table A, if all specified seed species have been previously inspected, tested, and approved by PDA for the designated purity, germination, weed seed limits, or pure live seed analysis. Mix the seed species to the designated formula or mixture specifications under Department supervision.

Do not use seed from containers that have not been properly sealed. Do not use seed that has a sell-by date of more than 15 months from the date of the inspection test, exclusive of the month of the test. The Department may reject or request re-testing for any questionable seed delivered to the project.

2. Standard Seed Formulas. According to Table A.

3. Special Seed Formulas and Pure Live Seed. Seed for special seed formulas consisting mainly of warm-season grasses, forbs, or wildflowers may be required to be provided in quantities based on specified pure live seed application rates. Application rates for the special seed formulas may vary.

The PLS seed application rate is a method of adjusting the amount of seed required to compensate for low seed purity and low germination percentages. The normal amount of seed to be provided for each seed type is higher and based on each seed's PLS analysis. Provide PLS seed calculation amounts based on the seed label for all designated PLS seed formula types for verification and approval before application.

The specified PLS seeding rate for each seed type divided by the percentage PLS value of the proposed seed type will determine the amount of seed required to be provided for that seed type. Note: Seed with a purity of 85% and 70% germination rate would equal a PLS of 60% (85% x 70% divided by 100). A specified rate of 2.5 pounds/acre of PLS seed would therefore require 4.2 pounds quantity of seed to be provided for that seed type.

(c) Inoculant. Standard acceptable commercial product, for treating leguminous seed. A product consisting of a suitable carrier, containing a culture of nitrogen-fixing bacteria specific for the seed to be inoculated.

Keep lids on containers when not in use to avoid contamination. Store containers at moderate temperature. Do not use inoculant after the expiration date shown on the container.

(d) Herbicides. According to all applicable Federal and State pesticide acts and registration requirements and according to PCID No. 1094 – Herbicides (Weed and Brush Control) issued by the Pennsylvania Department of General Services, Bureau of Purchases, Quality Assurance Division, for the appropriate type.

Furnish herbicide in manufacturer's labeled container as follows:

1. Selective Control in Seeded Areas. In areas seeded with Formula B, D, or L, use Type 1, Class C-2, 4-D Liquid Amine Salt Formulations (Dimethylamine) listed in PCID No. 1094, for controlling broadleaf weeds.

(e) Mulch. Section 805.2(a)1., for the type indicated.

(f) Water. Section 720.2

TABLE A
Seeding Requirements

Formula and Species	% By Weight	Minimum %		Max % Weed Seed	Seeding Rate lb/1000 yd^2
		Purity	Germination		
Formula B Mix					**44.0 Total**
• Perennial Ryegrass mixture (Lolium perenne). A combination of improved certified varieties with No one variety exceeding 50% of the total Ryegrass component.	20	97	90	0.10	8.5
• Creeping Red Fescue or Chewings Fescue (Festuca rubra or ssp commutate) (Improved and Certified)	30	97	85	0.10	12.5
• Kentucky Bluegrass mixture (Poa pratensis). A combination of improved certified varieties with no one variety exceeding 50% of the total Bluegrass component.	45	97	80	0.15	21.0
• Annual Ryegrass (Lolium multiflorum)	5	95	90	0.10	2.0
Formula C Conservation Mix					**12.0 Total**
• Crownvetch (Coronilla varia)	45	99	70*	0.10	5.5
• Annual Ryegrass (Lolium multiflorum)	55	95	90	0.10	6.5
Formula D Conservation Mix					**50.0 Total**
• Tall Fescue (Festuca arundinacea var. Kentucky 31)	60	96	85	0.10	30.0
• Creeping Red Fescue or Chewings Fescue (Festuca rubra or ssp commutate) (Improved and Certified)	30	97	85	0.10	15.0
• Annual Ryegrass (Lolium multiflorum)	10	95	90	0.10	5.0
Formula E					**10.0 Total**
• Annual Ryegrass (Lolium multiflorum)	100	95	90	0.10	10.0
Formula L Mix					**48.0 Total**
• Hard Fescue mixture (Festuca longifolia). A combination of improved certified varieties with no one variety exceeding 50% of the total Hard Fescue component	55	97	85	0.10	26.4
• Creeping Red Fescue (Festuca rubra) (Improved and Certified)	35	97	85	0.10	16.8
• Annual Ryegrass (Lolium multiflorum)	10	95	90	0.10	4.8

Formula N Conservation Mix					**30.0 Total**
• Hard Fescue mixture (Festuca longifolia). A combination of improved certified varieties with no one variety exceeding 50% of the total Hard Fescue component	30	97	85	0.10	9.0
• Creeping Red Fescue (Festuca rubra) (Improved and Certified)	30	97	85	0.10	9.0
• Little Bluestem (Andropogon scoparius)	4	80	70	0.20	1.2
• Canada Wild Rye (Elymus canadeis)	6	85	70	0.20	1.8
• Virginia Wild Rye (Elymus virginicus)	4	85	70	0.20	1.2
• Indiangrass (Sorghastrum nutans)	3	85	70	0.20	0.9
• Annual Ryegrass (Lolium multiflorum)	10	95	90	0.10	3.0
• Black Eyed Susan (Rudbeckia hirta)	5	80	60	0.20	1.5
• New England Aster (Symphyotrichum novae-anglie)	3	80	50	0.20	0.9
• Ox-eye Sunflower (Heliopsis helianthoides)	5	80	60	0.20	1.5
Formula W Wetland Conservation Mix					**15.0 Total**
• Tall Fescue (Festuca arundinacea var. Kentucky 31)	30	96	85	0.10	4.5
• Birdsfoot Trefoil (Lotus corniculatus).	10	92	80*	0.10	1.5
• Redtop (Agrostis alba)	10	92	80	0.20	1.5
• Virginia Wild Rye (Elymus virginicus)	24	85	70	0.20	3.6
• Tioga Deertongue (Panicum clandestinum)	14	95	80	0.20	2.1
• Fox Sedge (Carex vulpinoides)	12	85	60	0.20	1.8
Formula S Special Seed Mix	As indicated				

* Including hardseed and normal seedlings.

804.3 CONSTRUCTION—

(a) General. Spread seeds where indicated and at the rates according to Table A, or as otherwise indicated. Spread seeds within the following dates, or as otherwise indicated or directed.

- Formula B, D, and L — March 15 to June 1
  August 1 to October 15
- Formula C — Ryegrass Portion:
  March 1 to October 15

  Crownvetch Portion:
  Anytime except September and October
- Formula E — March 15 to October 15

- Formula N — March 15 to October 15
- Formula W — April 1 to June 15
August 16 to September 15
- Formula S — As indicated

Extend seeding dates where project conditions warrant. Apply full treatment or apply only 50% of the permanent seeding and soil supplements and apply the remaining 50% within the next seeding dates, as directed in writing.

Use tillage and soil supplements before permanent seeding on topsoiled areas, where temporary seeding or mulching has been applied.

The Contractor may apply permanent seed and/or soil supplements without tilling on untopsoiled areas, where temporary seeding or mulching has been applied.

(b) Tillage. On topsoiled areas, 3:1 and flatter, loosen the surface to a depth of at least 2 inches by disking, harrowing, or other acceptable methods until the tillage is satisfactory. On untopsoiled areas, 3:1 and flatter, till only as directed. Also, till or scarify areas if the surface is glazed or crusted.

Correct surface irregularities by filling depressions and leveling rough or uneven areas. Remove metal objects, stones larger than 2 inches in any dimension, and other debris or objects deemed detrimental to maintenance operations.

(c) Soil Supplements. Prepare areas for seeding by uniformly applying supplements, except in areas that will receive Formula E seed. Document bulk delivery as specified in Section 804.2(a)2.

Blend the initial soil supplements into the soil at least 2 inches, on topsoiled areas, by raking, disking, harrowing, or other acceptable methods. Blend the supplements into the soil during tillage operations.

Apply slow-release nitrogen fertilizer to the surface of Formula B, D, L, W, and S seeded areas before project completion. Do not apply slow-release nitrogen fertilizer supplement to Formula C seeded areas.

Apply soil supplements as follows, unless otherwise indicated:

- Pulverized Agricultural Limestone — 800 lb/1000 yd^2
- 10-20-20 Analysis Commercial Fertilizer — 140 lb/1000 yd^2
- 38-0-0 Ureaform Fertilizer — 50 lb/1000 yd^2

  or
- 32-0-0 to 38-0-0 Sulfur Coated Urea Fertilizer — 59 lb/1000 yd^2 to 50 lb/1000 yd^2 as directed

  or
- 31-0-0 IBDU Fertilizer — 61 lb/1000 yd^2

(d) Inoculating Legumes. Inoculate leguminous seed, such as Crownvetch and Birdsfoot Trefoil, with proper cultures, according to the manufacturer's directions. Protect inoculated seed from prolonged exposure to sunlight before sowing. Reinoculate seed not sown within 24 hours. If using hydraulic seeders, use inoculant four times the manufacturer's recommended rate.

If inoculated seed is held in a slurry with fertilizers for more than 1 hour, reinoculate or apply legumes separately.

(e) Seeding. At the rates according to Table A, or as indicated sow seeds uniformly on the prepared areas by the helicopter, hydraulic placement, broadcasting, drilling, or hand seeding methods. Inspect seeding equipment and adjust the equipment, if required, to ensure the specified application rates. Periodically perform a check on the rate and uniformity of application, as directed.

Prior to seed application of each designated seed formula, thoroughly clean-out seed tank by rinsing with clean water to prevent contamination from one seed formula to the next. Repeat rinsing cycle until tank is clean. Collect all non-applied seed derived from each clean-out event and remove as waste from the project.

(f) Rolling. After seeding, roll topsoiled areas that are to be mowed. Use a roller with a weight not more than 65 pounds per foot. If soil is wet or frozen, roll only when directed.

(g) Mulching. Section 805.3(a).

(h) Herbicides. Apply herbicides as directed, to areas that are to be mowed and where weed growth is prominent.

The Representative will designate existing plants or groups of plants to be saved within these areas before herbicide application. If directed, more than one application may be required to control undesirable growth.

Apply material with application personnel certified by the Department of Agriculture and with equipment specified in Section 108.05(c).

(i) Liability and Rejection. Final acceptance of seeding and soil supplement materials and installation are subject to the results of official sampling and testing as specified before use and installation and the resultant establishment of the specified vegetation. Remove non-approved materials from the project.

1. Liability. Reseed rejected areas with additional applications of the specified seed and soil supplement materials. Redress soil surfaces when directed. Perform reapplication of seed and soil supplements within the next applicable seeding date if necessary or as directed. When directed, reseed areas damaged by herbicide applications and mowing operations. NOTE: Reseeded areas will also require the application of appropriate mulch as specified in Section 805.

2. Rejection Criteria. Seeded areas may be rejected based on the lack of actual grass seedling establishment exhibited in the area for the specified seed formula.

2.a Table A Seed Formulas. Table A formula seeded areas that exhibit less than 70% surface area coverage with the specified germinated grass seedlings after 90 days of growth may be rejected upon visual inspection. The seed germination and growth period is determined from the date of the seeding operation for the area when these operations are performed within the specified seeding dates.

2.b Eroded Areas. Seeded areas exhibiting soil surface erosion rills or gullies deeper than 1-inch may be rejected upon visual inspection. Redress and reseed designated eroded areas with specified materials and application rates as directed.

(j) Maintenance. Maintain grass and legume ground cover areas, within the grading limits, until the entire project has been completed. Mow as specified in Section 804.3(k).

Control any noxious weed growth found within the right of way by herbicide spraying and cutting. These plants are defined according to the Pennsylvania Weed Control Act of 1982, P.L. 228, No. 74 and as amended by further legislation. Submit for approval a schedule of work and list of herbicide material to be used before starting this operation.

If a slope failure occurs on a slope previously completed, and requires further excavation and redressing to reestablish the slope, reapply the seeding and soil supplement work as specified for the original slope.

(k) Mowing. Maintain turf grass areas within the grading limits, by mowing with approved equipment until the entire project has been completed.

Submit a proposed schedule of mowing operations that covers the length of the construction project for approval.

1. Roadside Turf Areas. Turf grass areas established with Formula D require a different degree of mowing maintenance than areas established with Formulas B and L. Three mowing cycles per year, scheduled between April and October, are anticipated for mowing areas seeded with Formula D. The number of cycles may be adjusted based on the degree of turf establishment, project length, weather conditions, or other factors. Consult the District Roadside Manager for schedule, safety requirements, and mowing equipment approvals.

Schedule the first mowing cycle early in the growth flush period before all seed heads have emerged. Schedule the second mowing approximately 3 to 4 weeks after the first cut to remove the remaining seed heads. Schedule the last mowing cycle in the fall, as directed. Do not mow grass shorter than 4 inches to allow a low growing, competitive ground cover. Do not mow under the following conditions:

- When soil and grass blades are wet.
- During drought conditions, or during summer months when the temperatures are consistently over 90F, and when the grass exhibits dormancy.
- Within 7 days of any scheduled herbicide application or 7 days after a herbicide treatment.

2. Lawn Turf Areas. Maintain Formula B and L turf grass areas at a desired height of 2 inches. Initiate mowing operations when grass seedlings reach a height of 3 inches. Continue mowing operations during the active growing season throughout the length of the project. Follow the non-mow requirements indicated for Formula D grass. Mow at a normal frequency when the grass reaches the 3-inch height, unless directed otherwise.

804.4 MEASUREMENTS AND PAYMENT—

(a) Seeding and Soil Supplements. Pound

Measured by the number of pounds of seed or actual PLS rated seed utilized in the work for designated seed formula and soil supplement applications. Do not use bulk weight of PLS rated seed packages for seed payment.

The Department will pay for reseeding and reapplying soil supplements on slopes that fail due to weather conditions as specified in Section 804.3(j), at the contract unit price, in addition to the original accepted application of seeding and soil supplements.

The Department will not pay for reseeding and reapplying soil supplements on seeded areas that are rejected due to failure of seed germination and growth as specified in Section 804.3(i).

When indicated, the cost of the mulch will be incidental to the seeding and soil supplements item of work and will not be paid for separately.

(b) Seeding. Pound

Measured by the number of pounds of seed or actual PLS rated seed utilized in the work for the designated seed formula. Do not use bulk weight of PLS rated seed packages for seed payment.

The Department will pay for reseeding on slopes that fail due to weather conditions as specified in Section 804.3(j) at the contract unit price, in addition to the original accepted application of seeding.

The Department will not pay for reseeding on seeded areas that are rejected due to failure of seed germination and growth as specified in Section 804.3(i).

When indicated, the cost of the mulch will be incidental to the seeding item of work and will not be paid for separately.

(c) Herbicides. 1000 (M) Gallons

For the type indicated.

(d) Mowing. Acre

(e) Mulch. Section 805.4(a)

SECTION 805—MULCHING

805.1 DESCRIPTION—This work is the furnishing, placing, anchoring, and maintaining of mulch of the type indicated.

805.2 MATERIAL—

(a) Mulches. Free from foreign material, coarse stems, mold, substances toxic to plant growth, and mature seed bearing stalks or roots of prohibited and noxious weeds, as defined by law.

1. Seeded Areas. Either one or a combination of the following, as specified:

1.a Hay. Timothy hay, mixed clover and timothy hay, or other acceptable native or forage grasses, well-cured to less than 20% moisture content, by weight.

1.b Straw. Either wheat or oat straw, reasonably free of viable seed, well cured to less than 20% moisture content, by weight.

1.c Wood Fiber. Specially prepared, biodegradable, air-dried wood fibers manufactured from 100% wood chips or bark from lumber mill processing operations, tinted with nontoxic, green dye and containing an organic tackifier approved for use with wood fibers; manufactured to be applied with hydraulic seeding equipment; and conforming to the following requirements:

• Moisture content	15% maximum
• Organic matter (Oven-dried basis)	95% minimum
• Water holding capacity (Grams of water per 100 grams of fiber)	1000 minimum
• Tackifier content (By weight)	2.5% to 3.5%

Submit a certified physical analysis of the product for approval before application.

1.d Pellet Mulch. A biodegradable, water-absorbing, paper-based pellet that when wetted loses its pellet shape, breaks down and adheres to other pellets, forming a thin, protective mulch mat, and meeting the following requirements:

• Paper content	85%
• Fertilizer	5%
• Polyacrylater	2% to 5%
• Moisture content	5% to 8%
• Dimensions	1/8-inch diameter, 1/4 inch to 3/4 inch length
• Absorption potential	minimum, 3 times dry weight

1.e Bonded Fiber Matrix (BFM). Specially prepared, water soluble, biodegradable, hydraulically applied system of long strand wood fibers held together by a bonding agent, which adheres to the soil surface and upon drying forms a continuous, insoluble, three dimensional, non-dispersible protective crust-like soil covering.

1.e.1 Polymer or Hydrocolloid Binder Matrix.

1.e.1.a Wood Fiber. Specially prepared, long strand (min. 25% 3/8-inch length), air-dried wood fibers (88% to 92% by weight) manufactured from wood chips, bark, or clean wood waste products, and conforming to the following requirements:

Moisture content	15% maximum
Water holding capacity	1000 minimum (Grams of water per 100 grams of fiber)

1.e.1.b Bonding Agent. High-strength tackifier of powdered polysaccharide guar gum, blended hydrocolloid-based binder, hydrophyllic, or co-polymer material 5 to 12% by weight.

1.e.1.c Synthetic Fiber. System may contain up to 5% by weight of crimped, polyester fibers or other synthetic fibers with wetting and dispersion agents manufactured for use in mulching applications.

1.e.1.d Dye. System may contain a nontoxic, water soluble, colored dye to aid in the visual application coverage of the matrix.

1.e.1.e Activator. System may contain up to 1% by weight of organic and mineral fertilizers.

1.e.2 Gypsum Binder Matrix.

1.e.2.a Wood Fiber. Specially prepared, long strand (min. 25% 3/8-inch length), air-dried wood fibers manufactured from wood chips, bark, or clean wood waste products, and conforming to the following requirements:

Moisture content	15% maximum
Water holding capacity	1000 minimum (Grams of water per 100 grams of fiber)

1.e.2.b Bonding Agent. Naturally occurring, high purity, processed hemi-hydrate gypsum with manufacturer's system additives, which when combined with water will form a cementitious binder that will produce a crust-like soil covering within 4 to 8 hours after application. Material that has become partially air set, lumpy, or caked before use is not acceptable for use.

1.e.2.c Synthetic Fiber. Synthetic fibers manufactured for use in mulching applications, coated with wetting and dispersion agents.

1.e.2.d Dye. System may contain a nontoxic, water soluble, colored dye to aid in the visual application coverage of the matrix.

2. Planting and Other Areas. One of the following:

2.a Tanbark. Suitable fibrous shredded, ground or chunked, aged tanbark derived as a by-product of the tannin extraction process, free from insect life, not decomposed, and between 1/4 inch and 2 inches in any dimension.

2.b Shredded Bark. Suitable shredded, chunked, or ground pieces of predominantly aged, but not decomposed, hardwood or pinewood tree bark produced from lumber mill processing operations, free of excessively fine particles and having a general size range of 1/4 inch to 2 inches in any dimension.

2.c Washed Gravel. Uncrushed, washed, No. 57, as specified in Section 703.2(a)2.

2.d Coarse Aggregate. No. 67, Type C, as specified in Section 703.2(a)1.

2.e Sewage Sludge Compost. A blend of secondary dewatered sewage sludge and wood chips, aerobically composted at a DEP, Bureau of Waste Management permitted site for at least 21 days and cured for 30 to 60 days to ensure pathogen destruction. Free of foreign material and substances toxic to plant growth, nonburning, weed free, screened, and conforming to the following requirements:

- Minimum of 50% organic matter (oven dry basis)
- Minimum of 100% water holding capacity
- Particle Size—3/8 inch to 3 inches
- pH—6.0 minimum
- Heavy metals and toxic compounds (based on sewage sludge content)

	MAXIMUM PPM
Cadmium	25
Chromium	1000
Copper	1000
Lead	1000
Mercury	10
Nickel	200
Zinc	2500
PCBs	3

Submit a certified laboratory analysis with each shipment.

2.f Wood Chips. Suitable chipped or ground wood material produced from predominantly live or non-decayed trees, logs, brush including leaves or post-consumer lumber having a general size range of 1/2 inch to 2 inches in any dimension and free of excessively fine or stringy particles. Chips produced and stockpiled during clearing and grubbing operations or aged chips, at least 6 months old, from lumber mill operations of the desired size and free from foreign debris will also be accepted.

2.g Spent Mushroom Soil Compost. Organic substrate used in mushroom production that has been steam sterilized, then composted for a minimum of 90 days in well-managed windrows, and on a properly surfaced and protected composting pad and blended with ground brush (yard waste), recycled wood, and/or composted bark. Conforms to the requirements specified in Section 808.2(f)4 except as follows:

- Minimum Organic Matter (Oven Dry Basis)—40%
- Moisture Content—60% maximum
- Particle Size—3/8 inch to 3 inches
- Soluble Salt Concentration—20 dS maximum

(b) Mulch Binders. Other acceptable binder materials manufactured for this purpose or the following.

1. Recycled Cellulose Fiber. Specifically prepared, biodegradable, shredded paper particles, comprised of recycled newsprint or other recycled wood cellulose fiber, containing a surfactant and nontoxic, green dye; manufactured to be applied with hydraulic seeding equipment; and conforming to the following requirements:

- Moisture content 17% maximum

- Organic matter — 80% minimum (Oven-dried basis)
- Water holding capacity (Grams of water per 100 grams of fiber) — 900 minimum

2. Wood Fiber. Section 805.2(a)1.c

3. Nonasphaltic Emulsion. Either water soluble natural vegetable gum blended with gelling and hardening agents or a water soluble blend of hydrophyllic polymers, viscosifiers, sticking aids, and gums.

4. Polyvinyl Acetate. Emulsion resin, containing 60% ± 1% total solids by weight.

5. Recycled Cellulose Fiber/Wood Fiber Mixture. Specially prepared mixture of biodegradable, air-dried wood fiber, manufactured from wood chips or bark, and shredded paper particles, comprised of recycled newsprint or other recycled cellulose fiber combined with a surfactant and a nontoxic, green dye; manufactured to be applied with hydraulic seeding equipment; and conforming to the following requirements:

- Wood fiber — 45% to 55%
- Recycled cellulose fiber — 45% to 55%
- Moisture content — 21% maximum
- Organic matter (Oven-dried basis) — 97% minimum
- Water holding capacity (Grams of water per 100 grams of fiber) — 900 minimum

(c) Mulch Control Netting. One of the following:

1. Plastic. A uniformly extruded, rectangular, plastic mesh conforming to the following requirements:

- Weight — 0.23 ounce per square yard, minimum
- Mesh opening — Nominal 13/4-inch by 3/4-inch

2. Coconut Coir. Undyed, biodegradable, coconut coir yarn woven into a mesh conforming to the following requirements:

- Weight — 6 ounces per square yard, minimum
- Mesh opening — Nominal 2-inch by 2-inch, maximum

(d) Weed Barrier and Weed Control Mats.

1. Weed Barrier Mat. Stable, evenly distributed, permeable, network of polymeric woven, non-woven or a woven/non-woven combination of polypropylene or polyester filaments or yarns manufactured for weed barrier/soil separator use, inert to commonly encountered construction chemicals or substances and conforming to the following physical requirements:

Type	MARV*	Property
Woven or combination	0.03 sec-1	Permittivity flow rate

Non-woven fabric	1.3 sec-1	ASTM D 4491
Woven or combination Non-woven fabric	0.004 cm/sec 12 gal/min/sq. ft.	Permeability coefficient Permeability flux ASTM D 4491 Falling head test
All fabric	40 lbs.	Puncture strength (5/16-inch flat head rod) ASTM D 4833
All fabric	70% after 150 hours	Ultraviolet resistance Strength retention ASTM D 4355

* Minimum Average Roll Value (+95% of the fabric in a lot will meet or exceed the minimum requirements).

Certify as specified in Section 106.03(b).

2. Weed Control Mat. Stable, permeable network of spunbonded, long chain synthetic polyolefins (minimum 95% by weight) filaments or yarns with nodules of trifluralin, carbon black and polyethylene compounded together utilizing time-release characteristics permanently attached to the fabric on 1 1/2-inch centers and conforming to the following requirements.

Physical Property	**MARV***
Trifluralin (Nodule)	20%
Puncture strength (5/16-inch flat head rod) ASTM D 4833	39 lbs.
Permittivity ASTM D 4491	0.7 sec-1
Ultraviolet resistance Strength retention ASTM D 4355	70% after 500 hours

* Minimum Average Roll Value (+95% of the fabric in a lot will meet or exceed the minimum requirement).

Certify as specified in Section 106.03(b).

(e) Staples. Section 806.2(c)1

(f) Wood Stakes. Section 806.2(c)3.

805.3 CONSTRUCTION—

(a) Mulching Seeded Areas. Place mulch, of the type indicated, immediately after seeding or within 48 hours after seeding is completed. Unless otherwise indicated, place only straw or wood fiber over topsoiled areas. Use hay, straw, or wood fiber in other areas, as indicated or specified.

Place hay or straw uniformly, in a continuous blanket, at a minimum rate of 1,200 pounds per 1,000 square yards or as otherwise indicated. If directed, increase the rate of application, depending upon the material used, season, soil conditions, or method of application. An acceptable mechanical blower may be used to apply mulch. Do not use machines that cut mulch into short pieces. Anchor mulch with specified mulch binders applied at the following rates:

- Recycled cellulose fiber—160 pounds per 1,000 square yards
- Wood fiber—160 pounds per 1,000 square yards
- Nonasphaltic emulsion—At manufacturer's recommended rate
- Polyvinyl acetate—At manufacturer's recommended rate
- Recycled cellulose fiber/wood fiber mixture—160 pounds per 1,000 square yards

The mulch binder application is incidental to the application of straw and hay mulch.

Apply wood fiber mulch hydraulically according to the manufacturer's tank-mixing instructions. It may be incorporated as an integral part of the slurry after the seed and soil supplements have been thoroughly mixed. Apply uniformly at the rate of 320 pounds per 1,000 square yards unless otherwise indicated.

Mulch temporary seeded areas with hay.

1. Median Areas. On slopes 6:1 or flatter, place pellet mulch by hand or using a mechanical spreader immediately after seeding. Apply uniformly at application rate of 540 pounds per 1,000 square yards. Thoroughly wet pellet mulch with water without dislodging mulch.

(b) Mulch Control Netting.

1. Plastic. Install netting over designated mulch surface. Staple upslope ends, edges, bottom, and overlaps at 24-inch intervals. Overlap adjacent fabric to outside edges. Secure remaining fabric areas by putting in approximately 1 staple per 1 square yard of area.

2. Coconut Coir. Install netting over designated mulch surface. Stretch fabric tightly and anchor with wood stakes along all edges at 7-foot maximum interval. Overlap adjacent fabric widths by not less than 8 inches.

(c) Mulching Planted Areas.

1. Individual Plant Pits. Uniformly apply a designated mulch specified in Section 805.2(a)2 to the entire plant pit to a loose depth of 3 inches and as shown on the Standard Drawing. Apply mulch within 48 hours after completion of the planting operation.

2. Planting Beds. Cover designated shrub beds with mulch or mulch and weed barrier mat or mulch and weed control mat as indicated. Cut mat around the plant stem to ensure mat will not extend above the mulch. Secure mat to the soil surface with staples or other approved anchoring devices at a maximum interval spacing of 3 feet and along all edges and overlaps. Overlap mat edge with 2-inch minimum.

Uniformly apply a designated mulch specified in Section 805.2(a)2 over the entire bed area to a loose depth of 3 inches. Redistribute excessive mulch depth. Taper mulch depth at plant pit as shown on the Standard Drawing. Apply mat and mulch within 48 hours after completion of the planting operation.

(d) Maintenance. Properly maintain mulched areas until the entire project has been completed. Promptly reapply mulch materials, which become dislodged or lost due to wind, rain, or other causes, at initial or modified rates, as directed.

After mulching work on a slope has been satisfactorily completed, if a slope failure occurs, one that requires redressing, excavation, or the establishment of a new slope, replace the mulch, as directed.

(e) Bonded Fiber Matrix.

1. General. Prepare surfaces as specified in Section 804.3(b). Scarify all slopes greater than 3:1 to ensure a rough texture for lodging of seed and BFM. Apply seed at twice the rate specified in Section 804.2(b)2 Table A. Apply soil supplements as specified in Section 804.3(c).

2. Application. Apply bonded fiber matrix components hydraulically with hydromulching (hydroseed)

equipment manufactured for this purpose. Follow manufacturer's mixing and application instructions.

The bonded fiber matrix components may be incorporated as an integral part of the seeding and soil supplement application if seeding and soil supplements are applied hydraulically.

Apply polymer binder or hydrocolloid binder matrixes at an application rate of 3,000 pounds per acre or as indicated to provide a uniform soil surface coverage thickness of 0.16 inch maximum after drying. Test application procedures to ensure a uniform application rate. Do not apply within 24 hours of anticipated rainfall.

Mix gypsum binder matrix components in a homogenous slurry in the following proportions for each 100 gallons of water: gypsum binder—150 pounds; wood fiber—40 pounds; and synthetic fiber—0.6 pounds. Apply gypsum binder matrix at an application rate of 6,000 pounds per acre or as indicated so that the soil surface is covered uniformly. Do not apply within 12 hours of anticipated rainfall.

Place BFM material at least 18 inches beyond the toe and top of all slopes. Apply material in at least two different directions to provide as much uniform coverage with no gaps or spaces greater than 0.04 inch.

805.4 MEASUREMENT AND PAYMENT—

(a) Seeded Areas. Ton
For the type indicated. Measured by the number of tons of mulch actually incorporated into the work, at the specified rates.

(b) Planted Areas. Square Yard
For the type indicated.

(c) Mulch Replacement. The Department will pay for replacing mulch on failed slope areas, as specified in Section 805.3(c), at the contract unit price, in addition to the original accepted mulch application.

(d) Mulching and Weed Barrier Mat. Square Yard
For the type indicated.

(e) Mulching and Weed Control Mat. Square Yard
For the type indicated.

(f) Mulching - Bonded Fiber Matrix. Square Yard

(g) Mulch Control Netting. Square Yard

SECTION 806—ROLLED EROSION CONTROL PRODUCTS

806.1 DESCRIPTION—This work is furnishing, placement, and maintenance of temporary and permanent rolled erosion control products of the types indicated.

806.2 MATERIAL—

(a) Temporary Rolled Erosion Control Products (Temporary RECPs). Ultra short-term, short-term, extended-term, and long-term temporary RECPs meeting the requirements of Tables A, B, C and D, respectively, and having a functional longevity of sufficient duration to allow establishment of permanent vegetation before RECP degradation. Provide manufacturer's RECP specifications, product data sheets, and drawings. Submit for local approval by the Representative (i.e., at the District or project level) as specified in Section 106.02(a)2.c.

TABLE A
Ultra Short-Term Temporary RECP (3 Month Functional Longevity)

Type	Product and Material Description	Slope Applications		Channel Applications	Minimum Tensile Strength (lb/ft)(1)	Minimum Seed Germination Enhancement (Percent)(3)	Minimum Weight Per Unit Area (oz/yd^2)(4)
		Maximum Slope (H:V)	Maximum Allowable C-Factor at Maximum Slope(5)	Maximum Shear Stress (lb/ft^2)(2)			
1.A	Mulch Control Netting - A photodegradable synthetic mesh or woven biodegradable natural fiber netting.	5:1	0.10	0.25	No Requirement	200	6.5
1.B	Erosion Control Blanket Without a Net - Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together.	4:1	0.10	0.50	No Requirement	200	6.5
1.C	Single Net Erosion Control Blanket and Open Weave Textile - Processed degradable natural and/or polymer fibers mechanically bound together by one rapidly degrading, synthetic or natural fiber net, or an open weave textile composed of rapidly degrading natural or polymer yarns or twines woven into a continuous matrix.	3:1	0.15	1.5	50	200	6.5
1.D	Double Net Erosion Control Blanket - Processed degradable natural and/or polymer fibers mechanically bound together between two rapidly degrading, synthetic or natural fiber nets.	2:1	0.20	1.75	75	200	6.5

(1) Tensile Strength machine direction as per ASTM D6818.
(2) The Channel Applications Maximum Shear Stress that an RECP (unvegetated area) can sustain without physical damage or excessive erosion (> 0.5 inch soil loss) during a 30 minute flow event in large-scale testing. An acceptable large scale test method is ASTM D6460.
(3) Seed Germination Enhancement as per ASTM D7322.
(4) Weight Per Unit Area: ASTM D6475 for Temporary Erosion Control Blankets.
(5) Cover-Factor (C-Factor) measured in accordance with the requirements in ASTM D6459.

TABLE B
Short-Term Temporary RECP (12 Month Functional Longevity)

Type	Product and Material Description	Slope Applications		Channel Applications	Minimum Tensile Strength (lb/ft)(1)	Minimum Seed Germination Enhancement (percent)(3)	Minimum Weight Per Unit Area (oz/yd^2)(4)
		Maximum Slope (H:V)	Maximum Allowable C-Factor at Maximum Slope(5)	Maximum Shear Stress (lb/ft^2)(2)			
2.A	Mulch Control Netting - A photodegradable synthetic mesh or woven biodegradable natural fiber netting.	5:1	0.10	0.25	No Requirement	200	6.5
2.B	Erosion Control Blanket Without A Net - Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together.	4:1	0.10	0.50	No Requirement	200	6.5
2.C	Single Net Erosion Control Blanket and Open Weave Textile - Processed degradable natural and/or polymer fibers mechanically bound together by one rapidly degrading, synthetic or natural fiber net, or an open weave textile composed of rapidly degrading natural or polymer yarns or twines woven into a continuous matrix.	3:1	0.15	1.5	50	200	6.5
2.D	Double Net Erosion Control Blanket - Processed degradable natural and/or polymer fibers mechanically bound together between two rapidly degrading, synthetic or natural fiber nets.	2:1	0.20	1.75	75	200	6.5

(1) Tensile Strength machine direction as per ASTM D6818.
(2) The Channel Applications Maximum Shear Stress that an RECP (unvegetated area) can sustain without physical damage or excessive erosion (> 0.5 inch soil loss) during a 30 minute flow event in large-scale testing. An acceptable large scale test method is ASTM D6460.
(3) Seed Germination Enhancement as per ASTM D7322.
(4) Weight Per Unit Area: ASTM D6475 for Temporary Erosion Control Blankets.
(5) Cover-Factor (C-Factor) measured in accordance with the requirements in ASTM D6459.

TABLE C
Extended-Term Temporary RECP (24 Month Functional Longevity)

Type	Product and Material Description	Slope Applications		Channel Applications	Minimum Tensile Strength (lb/ft)(1)	Minimum Seed Germination Enhancement (Percent)(3)	Minimum Weight Per Unit Area (oz/yd^2)(4)
		Maximum Slope (H:V)	Maximum Allowable C-Factor at Maximum Slope(5)	Maximum Shear Stress (lb/ft^2)(2)			
3.A	Mulch Control Netting - A slowly degrading synthetic mesh or a woven natural fiber netting.	5:1	0.10	0.25	25	200	6.5
3.B	Erosion Control Blanket and Open Weave Textile - An erosion control blanket composed of slowly degrading polymer or natural fibers mechanically bound together between two slowly degrading synthetic or fiber nets to form a continuous matrix or an open weave textile composed of processed slow degrading polymer or natural yarns or twines woven into a continuous matrix.	1.5:1	0.25	2.00	100	200	6.5

(1) Tensile Strength machine direction as per ASTM D6818.
(2) The Channel Applications Maximum Shear Stress that an RECP (unvegetated area) can sustain without physical damage or excessive erosion (> 0.5 inch soil loss) during a 30 minute flow event in large-scale testing. An acceptable large scale test method is ASTM D6460.
(3) Seed Germination Enhancement as per ASTM D7322.
(4) Weight Per Unit Area: ASTM D6475 for Temporary Erosion Control Blankets.
(5) Cover-Factor (C-Factor) measured in accordance with the requirements in ASTM D6459.

TABLE D
Long-Term Temporary RECP (36 month Functional Longevity)

Type	Product and Material Description	Slope Applications		Channel Applications	Minimum Tensile Strength (lb/ft)(1)	Minimum Seed Germination Enhancement (percent)(3)	Minimum Weight Per Unit Area (oz/yd^2)(4)
		Maximum Slope (H:V)	Maximum Allowable C-Factor at Maximum Slope(5)	Maximum Shear Stress (lb/ft^2)(2)			
4	Erosion Control Blanket and Open Weave Textile - An erosion control blanket composed of slowly degrading polymer or natural fibers mechanically bound together between two slowly degrading synthetic or fiber nets to form a continuous matrix or an open weave textile composed of processed slow degrading polymer or natural yarns or twines woven into a continuous matrix.	1:1	0.25	2.25	125	200	6.5

(1) Tensile Strength machine direction as per ASTM D6818.
(2) The Channel Applications Maximum Shear Stress that an RECP (unvegetated area) can sustain without physical damage or excessive erosion (> 0.5 inch soil loss) during a 30 minute flow event in large-scale testing. An acceptable large scale test method is ASTM D6460.
(3) Seed Germination Enhancement as per ASTM D7322.
(4) Weight Per Unit Area: ASTM D6475 for Temporary Erosion Control Blankets.
(5) Cover-Factor (C-Factor) measured in accordance with the requirements in ASTM D6459.

(b) Permanent Rolled Erosion Control Products (Permanent RECPs). Permanent RECPs meeting the requirements of Table E and capable of permanently reinforcing vegetation in applications where vegetation alone cannot provide sufficient protection against erosive forces. Provide manufacturer's RECP specifications, product data sheets, and drawings. Submit for local approval by the Representative (i.e., at the District or project level) as specified in Section 106.02(a)2.c.

TABLE E
Permanent RECP[5]

Type	Product and Material Description	Slope Applications Maximum Slope (H:V)	Channel Applications Maximum Shear Stress (lb/ft^2)[2]	Minimum Tensile Strength (lb/ft)[1]	Minimum Seed Germination Enhancement (percent)[3]	Minimum Weight Per Unit Area (oz/yd^2)[4]
5.A	Turf Reinforcement Mat - Composed of non-degradable synthetic fibers, filaments, nets, wire mesh and/or other materials processed into a three-dimensional matrix.	1:1	6	125	200	8
5.B		1:1	8	150	200	8
5.C		1:1	10	175	200	8

(1) Tensile Strength machine direction as per ASTM D6818.
(2) The Channel Applications Maximum Shear Stress for a RECP (unvegetated area) can sustain without physical damage or excessive erosion (> 0.5 inch soil loss) during a 30 minute flow event in large-scale testing. An acceptable large scale test method is ASTM D6460.
(3) Seed Germination Enhancement as per ASTM D7322.
(4) Weight Per Unit Area: ASTM D6566 for Permanent Erosion Control Blankets.
(5) UV Stability for Permanent Erosion Control Blankets- 80% per ASTM D4355 (500 hours).

(c) Anchoring Devices.

1. Staples. No. 8 gage steel wire, bent U-shaped or square top with a throat width of 1 inch to 2 inches, with an effective minimum driving depth of 8 inches.

2. Metal Pin. Carbon steel pin, 3/16-inch shank diameter, 18-inch length with attached 1 1/2-inch minimum outside diameter steel washer head.

3. Wood Stakes. Sound, rough sawn, approved hardwood 1-inch by 4-inch nominal stake tapered to a point throughout, with a minimum length of 18 inches.

4. Substitutes. Submit other anchoring devices, as recommended by the RECP manufacturer, for review and approval.

(d) Seeding and Soil Supplements. Section 804.2

(e) Mulch for Seeded Areas. Section 805.2

806.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Temporary RECPs.

1. Site Preparation. Prepare final graded and dressed soil surfaces to receive seeding as specified in Section 804.3. Soil surfaces to be free of rocks or other obstructions that prevent the RECP from lying in direct contact with soil.

2. Seeding. Place designated seed formula mixture as specified in Section 804.3. Mulch application normally associated with seeding operation is not required for installation of Temporary RECPs.

3. RECP Installation. Unroll, place, and anchor the RECP evenly and smoothly without stretching. Use appropriate anchoring devices and follow installation directions of manufacturer. Drive staples or anchoring pins flush with soil surface.

(b) Permanent RECPs.

1. Site Preparation. Prepare final graded and dressed soil surfaces to receive permanent seeding or the RECP placement as specified in Section 804.3. Soil surfaces to be free of rocks or other obstructions that prevent the RECP from lying in direct contact with soil.

2. Seeding. Follow the RECP manufacturer's instructions for the correct sequence of seed and RECP placement. When seeding is required before RECP placement, place designated seed formula mixture as specified in Section 804.3. Mulch application normally associated with seeding operation is not required for installation of Permanent RECPs.

3. RECP Installation. Unroll, place, and anchor the RECP evenly and smoothly, without stretching, to conform to the shape of and be in uniform contact with the soil surface. Use appropriate anchoring devices and follow installation directions of the RECP manufacturer. Drive staples or anchoring pins flush with soil surface.

4. Topsoil Placement. When seeding is required after RECP placement, broadcast designated seed formula mixture into the RECP matrix as specified in Section 804.3. After seeding, uniformly place 1/2 inch to 3/4 inch of approved topsoil on the RECP. Work soil into RECP voids to completely fill the RECP matrix flush with top of the RECP. Remove excess topsoil.

(c) Maintenance. Properly maintain designated RECP until entire project is accepted. If a protected slope, swale, or other soil surface failure occurs after installation of work, redress affected soil areas and reinstall protection material as specified for original treatment, unless directed otherwise.

806.4 MEASUREMENTS AND PAYMENT—

(a) Temporary RECPs.

1. Ultra Short-Term RECP. Square Yard
For the type indicated.

2. Short-Term RECP. Square Yard
For the type indicated.

3. Extended-Term RECP. Square Yard
For the type indicated.

4. Long-Term RECP. Square Yard
For the type indicated.

(b) Permanent RECPs. Square Yard
For the type indicated.

(c) Seeding and Soil Supplements. Section 804.4(a) for the type indicated.

(d) Mulch. Section 805.4(a) and (c) for the type indicated.

SECTION 808—PLANTS, PLANTING, AND TRANSPLANTING

808.1 DESCRIPTION—This work is the furnishing, planting, and transplanting of trees, shrubs, vines, live stakes and other woody or herbaceous plants, and includes shrub-bed preparation.

808.2 MATERIAL—According to the current edition of "American Standard for Nursery Stock" (ASNS), ANSI, Z60.1 of the American Nursery and Landscape Association (ANLA), and as follows:

(a) Plant Stock.

- True to type and name, according to the current edition of Standardized Plant Names of the American Joint Committee on Horticulture Nomenclature;
- Each bundle or each plant, if not bundled, labeled with not less than the plant's common name and size;
- Typical of the species or variety indicated;
- Free from disease and injurious insects, according to State and Federal laws;
- Free from mechanical injuries, cutback leaders, broken branches, decay, or other defects;
- Unless otherwise designated, nursery-grown plants, acclimated to Pennsylvania soil and climatic conditions; and
- Dormant, other than those specified as container grown.

1. Nursery Stock. Grown in a licensed nursery for a period of at least one full-growing season. The use of mechanical digging equipment at the nursery will be allowed only when its use is not detrimental to nursery stock survival.

Pennsylvania is located within U.S. Department of Agriculture (USDA) Plant Hardiness Zones 5 and 6 with winter temperatures ranging from -20F to -10F for Zone 5 and -10F to 0F for Zone 6. Provide plants that have been grown for a period of at least 1 year in a nursery located within the same USDA Plant Hardiness Zone or colder Zone that exists at the location of the planting project.

Submit for approval a complete and detailed source of supply for each plant item indicated in the contract at least 90 days before the anticipated start of the planting operations. The Department reserves the right to reject plants from nurseries that do not qualify for the USDA Hardiness Zone growing requirement.

2. Collected Plants. Plants collected from native or previously established plantings that have not been re-established in a nursery row or grown under regular nursery cultural practices for at least two full-growing seasons. Designate collected plants as such.

3. Balled and Burlapped (B&B) Plants.

- Firmly balled with the original and undisturbed soil in which the plant was growing.
- Wrapped with untreated, biodegradable burlap or similar acceptable material, then tightly laced with biodegradable lacing to hold the ball firm and intact.
- Plants delivered to the planting site with balls broken, loose, or manufactured will be rejected.
- Acceptable nursery trade root protection devices will be allowed in lieu of burlap wrap, as approved.

4. Container-Grown Plants. Grown for at least one year, but not more than 2 years, in the same container so that the roots and soil ball held together and retained its shape when removed from the container. The Department will reject plants that exhibit a “pot-bound” condition with girdling and encircling primary roots. Only ground-cover, vine-type plants with roots exhibiting a “pot-bound” condition will be accepted.

5. Herbaceous Plants.

5.a Rhizome. Resilient, underground propagule collected during dormant condition and exhibiting light colored buds or shoots.

5.b Bulb or Tuber. Firm, underground propagule collected during dormant condition and exhibiting light colored buds or shoots.

5.c Peat Pot. Generally 1 3/4-inch to 2 1/4-inch square, commercial peat pot, filled with an approved potting soil mixture. Containing at least three nursery-grown plants, each with a minimum active top growth of at least 6 inches and having roots sufficiently developed through the peat pot surface so as to be firmly contained.

5.d Plug (Grasses, Rushes, and Sedges). Cubical or cylindrical plant extracts, minimum of 4 inches wide by 4 inches deep, cut from existing plant communities containing stems, roots, associated underground parts, and soil. Keep plug moist and viable for planting. Plug may also be provided in 2 inches square nursery pots or 2 inch wide by 6 inch deep pre-molded plastic tubes (tublings) manufactured to encourage deep root development. Minimum active top growth development of 4 inches.

5.e Starter Plant. Bare root plants with developed root systems capable of being transplanted and generated from seed, rhizome, or rootstock. Starter plant may also be provided in 2 inches square nursery pots or 2 inch wide by 6 inch deep pre-molded plastic tubes (tublings) manufactured to encourage deep root development. Minimum active top growth development of 6 inches.

6. Bare Root (BR) Plants. Plants that have been dug while dormant and have had the soil removed from the roots exhibiting a live, moist, and well-branched, fibrous root system characteristic of the species, free from rot, mold, and damage. Roots dipped into, and thoroughly covered with, a gel comprised of water and a superconcentrated, water-absorbent, nontoxic, neutral pH, starch graft/acrylate copolymer, insoluble material manufactured for this dipping purpose. Mix gel dip to manufacturer's recommended rate.

7. Crownvetch Plants.

7.a Crowns. No. 1, whole, field-grown crowns of certified variety at least one growing season old. Overall plant length of 6 inches to 9 inches, including 1/2 inch of top growth. Measuring not less than 1/8 inch or more than 3/8 inch in caliper, at a point 1 inch below the root collar.

7.b Potted Plants. Certified variety, grown for a period of at least 100 days. In 2 1/4-inch or larger peat pots and “pot-bound,” with a top growth of not less than 6 inches.

8. Live Stakes. Provide live stakes harvested locally, within the same physiographic ecoregion and plant hardiness zone. Live Stakes are composed of freshly cut, dormant branches, with side branches removed cleanly, 1/2 to 2 inches in diameter, 24 to 36 inches in length. Butt ends must be cut at a 30 to 45-degree angle for insertion into the soil. Tops must be cut square or blunt to allow for installation. At least 2 to 5 bud scars are required near the top to facilitate branch development. Collect live cuttings during the dormant period between November 1st and March 31st; live stakes provided and / or installed outside this period are not permitted. Where local conditions warrant, these dates may be extended, if directed in writing by the District Executive. Do not store live stakes for more than 2 weeks after they have been prepared for installation.

9. Storage, Packing, and Handling. According to good nursery practice. Plants showing signs of improper storage, packing, or handling will be rejected.

10. Inspection and Rejection. Plant materials will be inspected at the project planting site prior to planting. Complete form CS 6104, Plant Material Inspection Report, for each shipment. Provide certification as

specified in Section 106.03(b)3. A state nursery inspection certificate is required with each shipment, invoice, or order of plants to verify inspection for pest control, as well as freedom from disease and insect pests, before removal from the nursery or place of growth.

Inspection at the project site is to ensure that plant stock is from an approved source, is in healthy and undamaged condition, and according to size, type, quantities, and appropriate ANSI Z60.1 Standards.

Plants exhibiting the following defects or damage may be rejected:

- Decayed tissue on plant trunk, branches, or twigs.
- Sunscald or sunburn resulting in cambium tissue or bark damage.
- Mechanical damage/bark abrasions resulting in damage to cambium tissue.
- Frost cracks appearing as splits in bark or wood.
- Disease resulting in abnormal growth of leaves, twigs, fruit, bark, discoloration of leaves and bark, or sap discharge.
- Insect damage appearing as borer holes into bark or wood or insect eggs or larvae.
- Other damage or injury such as branch and twig die-back, dry buds, or dead leaves.
- Improper pruning resulting in improper stubs left on trunk, branches, or twigs, removal of excessive branches that leaves the plant asymmetrical or non-uniform in plant density, and pruning wounds larger than 1 inch in diameter.
- Girdling roots appearing as roots growing in a damaging, encircling configuration.
- Non-standard growth patterns for single or multiple stem plants, non-typical for their plant genus, species, or varieties.
- Sheared evergreen trees or shrubs not representative of full-foliaged, natural-growth plants.
- Evidence of undue damage to root ball structure causing broken root balls and plants loosened in the soil ball.
- Evidence of insufficient roots throughout the entire soil ball and with fewer than five undamaged, viable, balanced, primary roots.
- Excessive top growth not in acceptable balance with the root system.

Plant materials will be accepted, subject to responsibility for latent defects, as specified in Section 107.16(b).

Plants damaged during planting operations will also be rejected and require replacement with appropriate indicated plants.

Segregate and remove rejected plants from the planting site within 48 hours or as directed.

11. Substitutions. No substitutions will be allowed without authorization, as provided in Form CS 616, Request for Plant Material Substitution.

12. Shipment. Carefully pack the roots of bare-rooted stock in spaghnum moss, moist straw, or other suitable material that will ensure the plant's arrival in acceptable condition. For material shipped in open vehicles, cover with securely fastened canvas, burlap, or other material to prevent wind burn or drying. Plant material that has heated or “sweated” by reason of tight packing or poor ventilation will be rejected. For plants approved to be shipped during the active growing season, treat plants with antidesiccant and/or antitranspirant material, applied by spraying

or dipping, to prevent excessive transpiration. Comply with local, State, and Federal laws relative to plant material shipment.

(b) Antidesiccant/Antitranspirant. ASTM E 96 in liquid form.

(c) Fertilizer. 20-10-5 tablets (10 gram), 16-8-16 packets, and 19-6-12 fertilizers conforming to the requirements of Section 804.2(a)2. When using packets, use in 4-ounce, individual, heat-sealed, polyethylene envelopes. Application rates are as shown on the Standard Drawings or as directed.

(d) Mulch. Section 805.2(a)2

(e) Backfill Mix for Planting or Transplanting. A uniform mixture of one part peat or compost material, as specified in Section 808.2(f), and three parts soil by volume that was removed from the planting pit.

Where it is determined by the Representative that wet and poorly drained planting conditions exist, backfill with soil removed from the planting pit.

The ratio of peat to soil for plants requiring an acid soil is one part peat to two parts soil by volume.

(f) Soil Amendments.

1. Peat. Shredded reedsedge peat or spaghnum moss peat, or a combination of both, from fresh water sites. Do not use peat material in an advanced stage of decay. Provide peat material, conforming to the following requirements:

- Minimum of 80% organic matter.*
- Maximum of 15% ash content.*
- Minimum of 400% water holding capacity.*
- Maximum delivered density of 30 pounds per cubic foot.
- pH—4.5 to 6.0 (use laboratory analysis to indicate the liming required).

* Oven dry basis.

Submit a laboratory analysis of the peat intended for use. Do not ship peat material to the project until acceptance is received.

2. Paper Mill Compost. A blend of fibrous bark fines and wood-pulp fibers, composted, free of foreign material and substances toxic to plant growth, and conforming to the following requirements:

- Minimum of 70% organic matter.*
- Maximum of 25% ash content.*
- Minimum of 200% water holding capacity.*
- Particle size—1/2 inch maximum.
- Free of weeds.
- pH—7.0 ± 0.5.

* Oven dry basis.

Submit a certified laboratory analysis with each shipment.

3. Sewage Sludge Compost. A blend of composted sewage sludge and wood chips, conforming to the requirements specified in Section 805.2(a)2.e, except the maximum size particle is 3/8 inch.

4. Compost. Decomposed product derived from agricultural, food and yard organic matter source. Composted at a DEP, Bureau of Waste Management permitted site under industry standards and U.S. EPA regulations, to provide a stable, weed free, nontoxic, soil amendment with a non-objectionable odor, and conforming to the following requirements:

- moisture content—35 to 55%
- trace elements and heavy metals—meet U.S. EPA Part 503 Exceptional Quality

Concentration Limits

- particle size—pass 1-inch standard screen
- pH—5.5 to 8.0
- soluble salt concentration—3.0 dS maximum
- manufactured foreign matter—less than 1% by weight

For plants requiring an acid soil, provide only compost that has not received the addition of liming agents or ash by-products and having a pH value ranging from 5.5 to 7.0.

5. Water Absorbent Polymer. A synthetic, nontoxic, granular polymer (polyacrylamide) product manufactured to increase the water holding capacity of the soil. Dry, free flowing granules capable of absorbing at least 200 times their weight in water, and conforming to the following requirements:

- Material—cross-linked modified acrylic polymer
- Granular size—40 mils to 157 mils
- Density—45.5 lbs/ft^3
- Time to achieve 100% absorption—56 minutes
- Absorption—minimum of 400 g/g (grams of water per gram of product)
- Deionized water—minimum of 200 g/g (grams of water per gram of product)
- Tap water—(rated 160 mg NaCl/liter of water)

6. Mycorrhizal Inoculation.

6.a Trees. Premeasured 3-ounce packets containing live endo and ectomycorrhizal fungi, plant biostimulants, and water absorbent polymers conforming to the following typical requirements:

• Endomycorrhizal fungi	Minimum 1000 live spores of Vesicular arbuscular (VA) fungi to include entrephospora columbiana, glomus etunicatum, glomus clarum, and glomus species
• Ectomycorrhizal fungi	Minimum 60 million live spores of pisolithus tinctorius

• Biostimulants	Dry soluble yucca extract (yucca schidigera); soluble sea kelp extract (ascophylum nodosum); and humic acid (leonardite humates)
• Water absorbent polymer	0.7 mm to 1.5 mm particles of cross-linked polyacrylamide copolymer with certified free acrylamide monomer level of less than 0.05%

6.b BR Seedlings and Transplants. Root dip material containing live endo and ectomycorrhizal fungi, plant biostimulants, and water absorbent polymers conforming to the following typical requirements:

• Endomycorrhizal fungi	Minimum 50 000 live spores of VA fungi per pound of product to include entrephospora columbiana, glomus etunicatum, glomus clarum and glomus species
• Ectomycorrhizal fungi	Minimum 140 million live spores of pisolithus tinctorius per pound of product.
• Biostimulants	Dry soluble yucca extract (yucca schidigera); soluble sea kelp extract (ascophylum nodosum); and humic acids (natural humates)
• Water absorbent polymer	0.2 to 0.8 mm sized particles of polyacrylamide copolymer

7. Spent Mushroom Soil Compost. Organic substrate used in mushroom production that has been steam sterilized, then composted for a minimum of 90 days in well-managed windrows, and on a properly surfaced and protected composting pad. Conforms to the requirements specified in Section 808.2(f)4 except the soluable salt content is 20 dS maximum and the moisture content is 60% maximum.

(g) Stakes and Collar Strap Attachments. As shown on the Standard Drawings and conforming to the following requirements:

1. Wood Stakes. Rough-sawn, red or white cedar, southern yellow pine, or other acceptable hardwoods. Provide stakes free from knots, rot, or other defects that impair strength or render them unfit for the intended purpose.

2. Steel Stakes. Section 1103.08(a)

3. Collar Strap Attachments.

3.a Rubber Collar Strap. A wide, flexible rubber strip ranging in width from 1 1/2 inches to 3 inches with minimum length ranging from 14 inches to 19 inches made from recycled tire inner tube with a 1/2-inch minimum diameter brass plated grommet on each end.

3.b Fiber Collar Strap. High tenacity, flexible, non-stretch polypropylene or heavy-duty nylon fibers; or natural cotton fibers, woven into tubular or flat surfaced, soft edged, abrasion resistant straps with a minimum width of 3/4 inch manufactured for staking trees and conforming to the following requirements:

1. Straps made from a continuous roll of synthetic strap material cut to the appropriate length required to encircle the tree trunk and attach to the stake as specified in Section 808.3(g)5.

2. A manufactured, synthetic strap with #1 brass grommets positioned 1 inch from each end and of an appropriate length to encircle the tree trunk and attach to the stake as specified in Section 808.3(g)5.

3. A manufactured, synthetic strap with a 1-inch galvanized, ribbed nail within a plastic retaining washer at one end of the strap and of an appropriate length to encircle the tree trunk and attach to the stake as specified in Section 808.3(g)5.

4. A manufactured natural cotton strap with #1 brass grommets positioned 1 inch from each end and of an appropriate length to encircle the tree trunk and attach to the stake as specified in Section 808.3(g)5.

3.c Strap Tie. All-purpose, biodegradable, 3 or 4-ply, non-stretch, cotton, hemp, jute, or sisal, natural fiber, twisted twine or rope that will pass through the grommet ends of the straps specified in Section 808.2(g)3.b.

(h) Water. Section 720.2

(i) Time-Release Water. A nontoxic, pH neutral, poly cellulose gel form of water in a biodegradable carton that slowly liquefies in contact with soil micro-organisms as its container decomposes, and conforming to the following requirements:

1. Poly Cellulose Gel.

- 98% water
- 2% vegetable gum and alum

2. Carton. Biodegradable, 1-quart standard size.

808.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Plant Protection and Temporary Storage. Untie and completely remove any binding materials from plants that were transported with bound branches.

Protect plants at all times. Plants will be rejected if left out of the ground, unprotected overnight; left with roots exposed to wind or sun; or left improperly protected during transit, unloading, storage, or during the planting operation.

Secure a suitable storage area near the planting site that is shaded, if possible, during the hottest times of the day.

Protect root systems from undue exposure to sun and wind during planting operations as follows:

1. B&B and Container Plants. Place the root balls and plant containers close together at the storage area without damaging the plants. Cover root systems with wet burlap, wet mulch, wood chips, straw, or other approved materials to keep the roots moist. Keep cover material moist.

2. BR Plants. Heel-in plants by digging a shallow trench and placing roots in the trench. Cover root systems with wet burlap, wet mulch, wood chips, straw, or other approved materials to keep the roots moist. Keep cover material moist.

3. Live Stakes. During transport, live stakes must be bundled and covered with a tarpaulin or wet burlap. Transport in unheated portions of a vehicle, and in a moist condition to prevent drying out and tree stress.

When on site, protect from overheating, wind damage, and drying out by storing in a cool, moist, and shaded environment. Spray daily or immerse in cool water less than 60F to prevent drying. Do not store for more than 2 weeks.

(b) Layout of Plantings. Delineate the plant pit locations, plant bed, and planting area outlines as indicated. Identify the plants to be placed at the delineated location. Do not start excavation or cultivation until the locations and outlines are accepted. Use shrub bed preparation in all shrub beds.

If rocks or other obstructions prevent planting at indicated locations, the Representative will determine alternate locations or deletions.

(c) Shrub Bed Preparation. For all shrub bed areas, remove any existing sod or other vegetation growth from the bed areas. Add additional topsoil, if required, to re-establish grade.

Uniformly spread approved peat or compost material to a 3-inch depth, and thoroughly incorporate it into the soil to a depth of 6 inches. Remove and dispose of undesirable material larger than 2 inches in any dimension as directed.

(d) Preparation of Plant Pits. Schedule digging operations, particularly on slopes, so that the actual planting operation occurs within 1 week of the digging, unless a delay is approved. Prepare planting pits to the size shown on the Standard Drawing and as follows:

1. Trees. Dig pits with tapered sides and flat bottom so that the pit is wider at the top than at the root mass depth and large enough to accommodate the roots without crowding. Allow for the placement of at least 12 inches of backfill mix around all sides at the bottom of the root mass. Scarify, loosen, or roughen the tapered pit sides for any glazed or hardened soil surfaces immediately before planting.

2. Shrubs and Seedling Transplants. Dig pits, except for slope plantings, with tapered sides and flat bottom so that the pit is wider at the top than at the root mass depth and large enough to accommodate the roots without crowding. Allow for the placement of at least 6 inches of backfill mix around all sides at the bottom of the root mass. Scarify, loosen, or roughen the tapered pit sides for any glazed or hardened soil surfaces immediately before planting. Dig pits for slope plantings with vertical sides and flat bottom.

3. Vines. Dig pits of appropriate size with tapered sides to accommodate the roots without crowding for vine plants such as periwinkle, pachysandra, and ivy. Provide at least 4 inches of backfill mix beneath and around all sides of the root system.

(e) Pruning.

1. Branches. Prune any dead, dying, broken, or undesirable branches not adequately pruned at the nursery or damaged during transport or installation. The removal of too many damaged branches that leaves an asymmetrical or non-uniform sided plant will be grounds for rejection of the plant. Prune according to best horticultural practice for the health of the plant and the natural or designed form and growth characteristics of the individual species.

2. Roots. Cut damaged or broken primary roots immediately above the damage with a clean, oblique cut.

(f) Transplanting Existing Plants. Relocate plant material designated for transplanting to areas indicated. Move plants while dormant unless otherwise approved.

Apply an approved antidesiccant/antitranspirant, according to the manufacturer's application recommendations, to all evergreen plant material and any deciduous trees or shrubs in leaf before digging.

Dig plants with root balls of sufficient diameter and depth to encompass enough fibrous and feeding roots for the full recovery of the plant. Root ball sizes and depths to correspond to the next largest size nursery grown stock listed in the ASNA Standard for deciduous and evergreen trees and shrubs. Dig root ball to have a flat bottom. Keep roots protected and moist at all times during transplanting procedures. Ball and burlap roots using tightly sewn, untreated, biodegradable burlap laced with heavy twine as specified in Section 808.2(a)3 and approved nursery industry practices.

Prune any damaged, broken, or diseased main roots as specified in Section 808.3(e)2.

Carefully transport plants to the transplant site within 24 hours after digging. Handle plants only by the root ball. Pad trunks and major branches to prevent damage.

Replant, prune, water, and maintain transplanted material in the same manner as new stock.

As specified in Section 808.3(a), locate and prepare an acceptable, secured, temporary site for heeling in or above ground storage of all plants that cannot be replanted within 24 hours at their designated transplant site due to construction sequencing. Keep all root balls moist during the storage period.

(g) Planting. Plant when soil and climatic conditions are favorable, according to the following schedule:

- Deciduous trees and shrubs: October 15 to November 30 and April 1 to May 15
- Evergreen trees and crownvetch plants: March 1 to May 15 and August 1 to September 15
- Seedlings and seedling transplants: March 1 to May 15

- Rhizomes, bulbs, tubers, and starter plants: March 1 to May 15
- Plugs and peat pots: March 1 to September 15
- Live stakes: November 1 to March 31

Where local conditions warrant, these dates may be extended, if directed in writing by the District Executive.

1. Placing Plants. Set plants plumb and at the required depth as shown on the Standard Drawings and conforming to the following requirements:

1.a B&B. Handle B&B plants by the ball or other root protective device, not by the stem or branches. Cut or untie the root ball lacing and lay back or cut off the burlap wrap from the top one-third of the root ball. Remove the top one-third of any root ball wire protective baskets.

1.b BR. Carefully handle BR plants by the main plant stem and any packaging material to avoid damage to the bark and roots. Form a raised soil mound in the planting pit of sufficient size to match the lateral spread of the root mass and to bring the plant up to the proper planting depth. Spread roots evenly over the mound before backfilling.

1.c Container Grown. Handle plants by the packing container, not by the stem or branches. Remove the container from the root mass formed by the container. Separate and spread any compacted roots outward in the planting pit before backfilling.

1.d Live Stakes. Soak the bottom half of the live stake in cool water for a minimum of 24 hours before installation. Do not install into frozen ground. Create a pilot hole 1/2to 1 inch larger in diameter than the diameter of live stakes in firm soil a minimum of 2/3 of the total length of the live stake, puncturing geotextile or matting as needed. Using a rubber mallet or a wooden tamping surface install live stakes with the square end upward and the pointed end downward at approximately a 45-degree angle pointed downstream. Live stakes may be hammered directly into the soft soil when allowed by the Representative.

Install live stakes with a minimum of 2/3 of the total length below the ground and the bud scars above ground. After installation, firmly pack soil removing all gaps and pockets around the live stake. Splits that occur during installation that extend beyond only one bud scar are acceptable. Splits that extend beyond two bud scars will be rejected. Remove and replace at no cost to the Department any rejected live stakes.

2. Fertilizing and Backfilling. Fertilize, according to the fertilizer schedule and as detailed. Mix the specified quantity of water absorbent granules into the backfill material spread around the plant roots in the bottom half of the planting hole. Use 0.5 ounce of water absorbent polymer granules for each 4-inch width of root ball for shrubs and 2 ounces for each 1-inch caliper of trees. Cultivate and completely tamp backfill mix around the ball or roots, in a manner that fills voids and eliminates air pockets. Avoid breaking or damaging roots during backfilling and tamping operations. When backfilling is two-thirds complete, lay back or cut off and remove the top one-third of the root ball wrapping material on B&B plants. Cut off and remove any wire root protection devices from the top one-third of the root ball. Thoroughly water the backfill material around the roots. Complete backfilling and broadcast mycorrhizal fungi around the perimeter of the root ball and incorporate into the top 10 inches of the backfill mix. Thoroughly water again after the initial watering has been completely absorbed. Firm backfill material around the top of the planting hole and plant stem. Fill in any surface irregularities of the planting hole and level soil. Apply one fungi packet of material for each 1 inch of tree caliper measured 6 inches above the top of the root ball. Fungi application is not required for shrub or ground cover plants.

Do not expose fungi packets to direct sunlight until ready to use at the planting pit.

Provide documentation of delivery to planting site of approved fertilizer(s) and fungi product. Certify that fertilizer and fungi requirements were installed as specified in the aforementioned paragraphs.

3. Crownvetch Plants. Plant crownvetch crowns or plants using Reforestation Method A. For areas planted with crownvetch plants, treat the soil before planting with lime and fertilizer at the rates specified in Section 804.3(c). Apply Formula E seed at the rate of 5 pounds per 1,000 square yards. Mulch with hay as specified in Section 805.

4. Reforestation Methods. Space and arrange plants as indicated or as directed. Puddle plants in a mud slurry immediately before planting.

4.a Method A—Crownvetch Plants. Make a vertical hole in the soil 6 inches to 8 inches deep, but do not excessively loosen the soil. Insert the root in a vertical position in the hole with the root collar resting at the same depth as it grew originally. Firmly tamp to close the hole and exclude air pockets without damaging the plant. Thoroughly water the planted area after installation.

4.b Method B—Seedling Material and Seedling Transplants. Prepare plant pits as specified in Section 808.3(d). Dig pits as large as necessary to accommodate plant root system and gel water carton.

Dip all BR seedling and transplant roots into the mycorrhizal fungi root dip inoculant gel immediately prior to planting. Thoroughly cover root surfaces.

Insert plant in a vertical position in the plant pit with the root collar positioned at the same depth as it grew originally. Place fertilizer tablet or fertilizer contact packet(s) and gel water carton(s) at, but not below, the root zone. Cut bottom of gel carton before installation to facilitate gel contact with the soil. Backfill the pit with excavation material from the plant pit. Thoroughly water the plant and firm soil around the plant root collar and gel carton to hold both in an upright position.

Use one gel carton for plants up to 12 inches in height; two cartons for plants from 12 inches to 24 inches in height; and three cartons for plants from 24 inches to 36 inches in height.

5. Staking. Stake trees using either rubber or fiber collar straps immediately after completion of the backfilling operation of the tree pit as shown on the Standard Drawing and as follows:

5.a Rubber Collar Strap. Use the size of collar strap shown on the Standard Drawings for the appropriate tree caliper size. Wrap straps around the tree trunk so that the rubber strap lies flat against the trunk. Securely fasten strap ends to stake with approved natural fiber twine or rope run through the grommet hole at each end of the strap and wrapped, tightened, and knotted around the stake.

5.b Fiber Collar Strap. Wrap collar strap around the tree trunk so that the fiber material lies flat against the trunk. Follow the strap manufacturer's attachment instructions for the type of collar strap used. Securely fasten the strap ends with either a tied knot; approved natural fiber twine or rope run through the grommet holes at each end of the strap and wrapped, tightened and knotted around the stake; or nailed to the stake. Use polypropylene straps with grommets for trees 3-inch caliper and smaller. Use heavy-duty nylon straps with grommets for trees over 3-inch caliper. Polypropylene straps without grommets can be used for all tree calipers 4 inches and smaller. Cotton straps can be used for trees 3-inch caliper and smaller.

6. Period of Establishment. Maintain all plants in a living, healthy condition until the entire project has been accepted. Plants are required to have been growing in place at least 60 days before project acceptance. During this period of establishment, perform the necessary watering, weeding, applying of acceptable insecticides or fungicides, cultivating, remulching to maintain a depth of 3 inches, and adjusting stakes, all as directed.

7. Watering. Water during the period of establishment as directed. Perform watering promptly with sufficient personnel and equipment to complete the watering requirements within 5 calendar days after having been directed. Apply water using an open-end hose supplied by gravity or low-pressure pump rated less than 10 pounds per square inch. Allow water to thoroughly soak and percolate into the soil without run-off. Furnish measurements and capacities of water tanks used in this operation. Submit source of water and watering schedule for acceptance.

8. Clean-Up. Remove and dispose of any subsoil, rock, debris, and other undesirable planting excavation materials from the planting site. Leave planting sites with a clean and acceptable groundcover condition. An acceptable groundcover condition may include seeding bare soil or damaged ground areas with Formulas B, D, or L as directed and mulching with straw at rates typical for the affected areas.

9. Plant Replacements.

9.a Nursery Stock. Plants not alive or showing declining health and having died back beyond a normal recognize pruning point at the time of final inspection will be rejected and require replacement within the next

specified planting dates. Replace the rejected plants with plants of the same species, size, and quality as originally indicated and specified unless plant substitutions have been approved for these plants. The Representative will determine plants that are not acceptable. Remove unacceptable plants from the project and replace with approved plants within 30 days of official notification in writing from the District Executive and before acceptance of the entire project. Make replacements at the beginning of the next planting season if directed, or if agreed upon in writing, the unacceptable material will be deleted from the contract. Only living, healthy plants are accepted at the time of final inspection.

9.b Transplanted Material. Replace any dead or unhealthy transplanted material with approved nursery grown plants of the same species and general size before final acceptance of the project. If directed, make replacements at the beginning of the next planting season.

10. Mulching. When indicated, mulch the entire individual plant pit or the entire planting bed as specified in Section 805.3(c). Use coarse aggregate mulch for all individual plant pits to be located in non-maintained, unmowed areas. In maintained, mowed areas, use shredded bark, tanbark, wood chips, or approved compost mulch for the individual plant pits.

11. Herbaceous Plants.

11.a Peat Pots and Plugs. Loosen soil to a depth of 6 inches. Wet peat pot surfaces and root masses to saturation before planting. Plant pot or plug approximately 3 inches deep, in wet soil, leaving the growing stems above the surrounding soil. Firm soil by hand around each plant. Water thoroughly.

11.b Tubers, Bulbs, and Rhizomes (Roots). Loosen soil around each planting site to a depth of at least 4 inches. Push roots 1 inch to 2 inches into the soil and firm soil around each root. When planting under standing water, add sufficient weight, such as #8 penny nails held with rubber bands, or place several roots into a loose knit, biodegradable, mesh bag along with several small stones in order to submerge roots to bottom of planting site.

11.c Fertilization. Side dress each plant with 1 ounce of 19-6-12 controlled release fertilizer at the time of planting. Apply fertilizer in furrow around each plant and cover with at least 1 inch of soil. Do not fertilize when planting under standing water.

11.d Starter Plants. Keep roots of plant moist during the planting operation. Loosen soil at planting site to a depth of at least 4 inches. Make a vertical hole in the soil deep enough to accommodate the root depth. Insert roots in a vertical position with the root collar at the proper soil depth. Firmly tamp soil to close the hole and expel air pockets. Water thoroughly.

808.4 MEASUREMENT AND PAYMENT—

(a) Plants, Live Stakes, Planting and Transplanting. Each
The Department will not pay for plants deleted from the contract by the Representative.

(b) Shrub Bed Preparation. Square Yard

(c) Mulching.

1. **Individual Plant Pits.** Incidental to the planting operation.

2. **Planting Beds.** Section 805.4(b)

(d) Watering. Watering done at the time of planting or transplanting will be incidental to the planting or transplanting. Any subsequent watering indicated or directed, to keep the plants alive will be measured and paid for by the 1,000 Gallons.

SECTION 809—SODDING

809.1 DESCRIPTION—This work is furnishing, placing, and maintaining cultivated sod on designated areas.

809.2 MATERIAL—

(a) Sod. Conforming to the current edition of the Turfgrass Producers International's Guideline Specifications to Turfgrass Sodding, and as follows:

- Certified sod cultivated of two or more approved Kentucky bluegrass varieties.
- Containing not more than 10% of other fine turf grass species.
- Entirely free from weeds, as defined in the Pennsylvania Seed Act of 1965 and amendments.
- Free from harmful insects, disease, and nematodes.
- Cultured in mineral soil.
- Certified by the Pennsylvania Department of Agriculture or the Department of Agriculture of the state from which sod is obtained.
- Rectangular machine sections 12 inches to 24 inches wide, 2 feet to 6 feet long, with a uniform soil thickness of approximately 3/4 inch excluding top growth and thatch. Broken sections or sections having torn or uneven ends will not be accepted.
- Grass height, maximum 1 1/2 inches.
- Well-moistened condition.
- Relatively free of thatch (up to 1/2 inch uncompressed thickness acceptable).

Net sod may be used after submitting a sample to obtain acceptance.

(b) Lime. Section 804.2(a)1

(c) Fertilizer. Section 804.2(a)2

(d) Water. Section 720.2

809.3 CONSTRUCTION—

(a) Sod. Place sod within 36 hours after having been cut.

(b) Temporary Storage. For sod in temporary storage, protect from drying due to sunlight or wind. Keep sod moist.

(c) Site Preparation. Before placing sod, complete soil preparation or topsoiling, as specified in Section 802.3. Provide a sod bed graded so that, after placing, the top of the sod is flush with the surrounding finished grade.

Apply soil supplements, as specified in Section 804.3(c), to areas to be sodded. Moisten soil before placing sod.

(d) Placing Sod. Place sod when soil moisture and temperature conditions are suitable. Do not cut or place sod if the temperature is lower than 32F. Do not place frozen sod.

Carefully place sod by hand, with tight joints, no overlap, and in straight lines with rows placed parallel to and tight against each other. Break or stagger transverse joints. Do not use pitchforks or other tools that may damage the sod. Do not dump sod from vehicles. Immediately after placing, saturate sod with water to its full depth. After the initial watering, tamp the sod to close joints and ensure close contact between the sod and sod bed. Tamp to obtain a smooth, even sod surface, free from bumps and depressions. If directed, use a roller having a weight not more than 65 pounds per foot of width to complete firming and smoothing the sod.

If placing sod in ditches, place the strip with the longer dimension perpendicular to the flow of water. At any point where water will start flowing over a sodded area, turn the upper edge of the sod strips into the soil, then place a layer of compacted earth over this juncture to conduct the water over the sod edge. On slopes, place sod with the long axis parallel to the contour, starting at the bottom of the slope. Stagger sod joints.

In ditches and on slope areas (3:1 or greater), stake each strip of sod securely using at least one wood stake for each 2 square feet of sod. Use stakes 1/2 inch by 1 inch and with a length of 8 inches to 8 inches to 12 inches. Drive stakes flush with the top of the sod, with the wide face parallel to the slope contour. .

(e) Maintenance. Properly maintain sodded areas until the project has been accepted. This may include repeated watering, mowing, and repairs or replacement of sod in areas that fail to show a uniform growth of grass, or that are damaged in any way.

Do not mow sodded areas until sod is firmly rooted and secured in place. Maintain grass height at 1 1/2 inches unless otherwise directed.

809.4 MEASUREMENT AND PAYMENT—

(a) Sodding. Square Yard

(b) Watering and Mowing. Initial watering and mowing at the time of sodding is incidental to sodding. The Department will measure and pay for subsequent watering, requested and required for grass survival, or as otherwise directed, by the 1,000 (M) gallons. The Department will measure and pay for subsequent directed mowing by the acre.

SECTION 810—TREE TRIMMING AND SELECTIVE TREE REMOVAL

810.1 DESCRIPTION—This work is the removal of selected trees and shrubs, the trimming of trees and shrubs, the treatment of tree injuries, and the removal of stumps and debris.

810.2 MATERIAL— Stump or Basal Treatment Herbicide—Type 10, Class B or C, Triclopyr liquid formulations. Use either Class B – butoxyethyl ester of triclopyr and inerts or Class C – butoxyethyl ester of triclopyr in ready to use form according to PCID No. 1094 Herbicides (Weed and Brush Control) issued by the Pennsylvania Department of General Services, Bureau of Purchases, Quality Assurance Division. Conform to all current Federal and State pesticide acts and registration requirements. Furnish herbicides in the manufacturer's labeled container.

810.3 CONSTRUCTION—

(a) Tree and Shrub Removal. Trees and shrubs to be removed will be designated either by separate marking, marking in sample areas, or as otherwise identified. Where sample marking is adopted, do not disturb these sample areas until other areas are complete.

For designated trees, shrubs, and stumps, cut to the ground line or to a height of not more than 4 inches, as directed. Fell and remove in a manner preventing injury to remaining vegetation. In areas where felling is not permitted, due to possible damage for any reason, remove trees in sections.

(b) Herbicide Treatment. Treat stumps of cut trees and shrubs with herbicide on the day of cutting. Apply herbicides according to the manufacturer's recommendation. Repeat the herbicide treatment, as directed, if suckers or sprouts develop at any time before final inspection.

(c) Tree Trimming. Selected tree trimming will be designated by separate markings or otherwise identified and indicated. Trim branches 1 inch or more in diameter growing within the legal Right of Way or growing on an adjacent property that overhang or encroach upon the legal Right of Way, to the height indicated. Trim branches to the branch collar as shown on the Standard Drawing.

Provide skilled workers to perform cutting and trimming, according to accepted arboricultural practices. Use acceptable tools and methods to perform the work. Do not use climbing spurs or spikes.

Treat work-related injuries to remaining trees and shrubs, regardless of species, according to accepted arboricultural practices at no additional cost to the Department.

(d) Surrender Material. Trees and branches resulting from the removal and/or trimming operation belong to the property owner. Surrender all such material to the abutting property owner or dispose of it if not accepted by the property owner.

Transport wood chips to approved stockpile areas that will not interfere with construction operations, obstruct drainage, or cause water pollution.

(e) Clean-up. Chip, burn, or dispose of brush and debris resulting from work. Burn, as specified in Section 201.3. Do not burn within 40 feet of vegetation designated to remain.

As directed, dispose of rubbish, broken concrete, litter, and other objectionable material.

(f) Maintenance. Until the project is completed, properly maintain selective tree removal and trimming, including retreatment of sucker growth, the removal of wind-thrown trees and plants or parts of plants, which die from any cause.

810.4 MEASUREMENT AND PAYMENT—

(a) Tree Trimming. Lump Sum or Linear Foot, measured longitudinally along roadway.

To a maximum height of 20 feet or to an unlimited height, as indicated within the limit of work.

(b) Selective Tree Removal. Lump Sum or Each

(c) Selective Tree Trimming. Each

SECTION 811—TEMPORARY PROTECTIVE FENCE

811.1 DESCRIPTION—This work is furnishing, installing, and maintaining temporary protective fencing within the project limits for sedimentation traps and basins and for existing trees, shrubs, vegetated wetland areas, and archaeological sites, as indicated.

811.2 MATERIAL—

(a) Fence. Acceptable, undamaged, standard picket snow fence or other acceptable, highly visible, weather resistant, easily maintained fencing that provides a substantial barrier.

(b) Posts. High carbon channel bar steel, 7 feet in length. Designed to drive satisfactorily into the ground and with at least ten fence-holding lugs of the rivet type. The Representative may accept other posts.

811.3 CONSTRUCTION—Fence desirable wooded areas, individual trees, and shrubs designated for protection, before beginning other general project work. Where directed, fence other adjacent areas to be protected such as sedimentation traps and basins, existing archaeological sites, and existing vegetated wetland areas. To verify extent of protection, conduct a field observation before clearing and grubbing operations with the Representative, and if necessary, the Design Project Manager and the District Environmental Manager.

Do not stockpile materials under, or within, protected vegetation areas. Prohibit construction traffic within protected areas. Place the fence at the dripline of trees or plants, but avoid causing root damage when driving posts. Replace damaged fence in kind within 24 hours of damage, as directed. Remove temporary protective fence when directed or after completion of project.

811.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 845—UNFORESEEN WATER POLLUTION CONTROL

845.1 DESCRIPTION—This work is construction of temporary or permanent control measures, as ordered during the contract life, to control unforeseen pollution of surface water and groundwater.

845.2 MATERIAL—

- As specified in applicable parts of Sections 804, 805, and 806.
- Erosion and sediment pollution control devices—as shown on the Standard Drawings.
- Other water pollution control measures and devices as directed.

845.3 CONSTRUCTION—As directed during construction, provide water pollution control measures to prevent or abate unforeseen pollution of surface water and groundwater resources. These measures are separate from those temporary and permanent water pollution control features designed for the project.

Coordinate control measures with the Erosion and Sediment Control Plan and permanent features to ensure economical, effective, and continuous pollution control throughout the construction and post-construction periods. Also comply with the requirements specified in Section 107.28.

If directed, place pollution control measures for authorized construction areas outside the right of way.

Comply with all applicable Federal, State, and local laws, rules, or regulations.

845.4 MEASUREMENT AND PAYMENT—Dollar

The proposal will include an item and a predetermined amount of money for Unforeseen Water Pollution Control. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Unforeseen Water Pollution Control item as follows:

(a) Contract Items. The Department will pay for performance of work, identified as having similar items listed in the contract, at the contract unit price.

(b) Non-Contract Items. The Department will pay for items of work not identified in the contract as follows:

1. Negotiated Price. At price agreed upon with the Department before performing the work. If applicable, agreement is also required with FHWA.

2. Force Account Basis. Section 110.03(d)

SECTION 849—ROCK CONSTRUCTION ENTRANCE

849.1 DESCRIPTION—This work is construction, maintenance, and removal of a temporary rock construction entrance.

849.2 MATERIAL—

(a) Aggregate. AASHTO No. 1. Section 703.2

(b) Geotextile. Class 4, Type A. Section 735

(c) Wash Rack.

- Reinforced Precast Concrete. Section 714.3
- Welded Steel Pipe. Section 1105.02

849.3 CONSTRUCTION—As shown on the Standard Drawings, as indicated, and as follows:

Clear and grub the footprint of the rock construction entrance as specified in Section 201.3. Construct the rock construction entrance by excavating as specified in Section 203.3, forming embankment as specified in Section 206.3.

Place the geotextiles, as specified in Section 212.3(d)2.

Place wash rack as indicated. Place wash rack such that all wash water is directed to a sediment removal device.

Provide satisfactory drainage through the rock construction entrance.

When directed, place additional rock to satisfactorily maintain the rock construction entrance. Remove sediment from drain space when the drain space becomes clogged. Dispose of removed sediment in a manner satisfactory to the Representative.

When the construction entrance is no longer needed, as directed, remove the entrance and restore the area as specified in Section 105.14.

849.4 MEASUREMENT AND PAYMENT—

(a) Rock Construction Entrance. Each

(b) Rock Construction Entrance with Wash Rack. Each

(c) Material Used Basis.

1. **Aggregate.** Cubic Yard
2. **Geotextile.** Section 212.4(c)
3. **Class 1 Excavation.** Section 203.4
4. **Wash Rack.** Each

SECTION 850—ROCK LINING

850.1 DESCRIPTION—This work is construction of rock lining of the class indicated.

850.2 MATERIAL—

(a) Rock.

1. General. Acceptable quality; sound; free from structural defects and foreign substances, such as soil, shale, and organic materials. Unless the rock comes from material providing an approved Type A aggregate, listed in Bulletin 14, submit samples to the LTS for petrographic examination for durability before use.

Use rock conforming to the following requirements:

- No shale seams.
- Hard and angular shaped rock with neither width nor thickness less than one-third its length.
- Minimum specific gravity of 2.5, as determined according to AASHTO T 85, bulk-saturated, but surface-dry basis.
- Each load of rock well-graded, from the smallest to the largest size.

2. Size and Gradation.

Percent Passing (Square Openings)						
Class, Size No. (NCSA)	**R-8****	**R-7****	**R-6**	**R-5**	**R-4**	**R-3**
Rock Size, inches						
42	100*					
30		100*				
24	15-50		100*			
18		15-50		100*		
15	0-15					
12		0-15	15-50		100*	
9				15-50		
6			0-15		15-50	100*
4				0-15		
3					0-15	15-50
2						0-15
Nominal Placement Thickness, inches	48	36	30	24	18	12

* Maximum allowable rock size.
** Use Class 4, Type A geotextile

Acceptance of gradation will be based upon visual inspection and certification. Provide two samples of rock, at least 5 tons each or each one-half the total project quantity, whichever is smaller. Provide one sample in place at the construction site and provide the other sample at the quarry. The construction site sample may be incorporated into the work. These samples will be used as a reference for judging the size and gradation of the rock supplied and placed. Certify as to gradation, as specified in Section 106.03(b)3.

(b) Geotextiles. Class 4, Type A, for the type required. Section 735.

850.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

Prepare the area required for placing the geotextile and rock.

This preparation may include, but not be limited to excavating, removing unsuitable material, backfilling, placing embankment, and clearing and grubbing, as specified in Section 201.3. Place the geotextiles, as specified in Section 212.3(d)2.

Carefully place the rock on the geotextiles to produce an even distribution of pieces, with a minimum of voids and without tearing the geotextile. Place the full course thickness in one operation in a manner to prevent segregation and to avoid displacement of the underlying material. Do not place rock in layers, by dumping into chutes, or by similar methods likely to cause segregation or geotextile damage. Rearrange individual rocks, if necessary, to ensure uniform distribution.

850.4 MEASUREMENT AND PAYMENT—

(a) Rock. Square Yard or Cubic Yard

(b) Geotextile. Square Yard
Section 212.4(c).

(c) Excavation. Cubic Yard
Section 203.4 or 204.4, for the class indicated.

SECTION 851—OUTLET PROTECTION: ROCK

851.1 DESCRIPTION—This work is construction of a rock outlet protection of the type indicated. This work includes the maintenance and removal of temporary outlet protection as indicated.

851.2 MATERIAL—

(a) Rock, Class as required—Section 850.2(a)

(b) Geotextiles, Class 4, Type A, for the type required—Section 735

(c) Grout—Section 601.2(c)

851.3 CONSTRUCTION—As shown on Standard Drawings, as specified in Section 850.3, and as follows:

(a) Rock Basin. Control flow of surface water runoff as needed. Excavate below final grade as required, install geotextile, and backfill with rock of the class indicated. If required, after rock is in place, saturate the rock with water, then completely fill the voids between pieces with grout, for at least the top 6 inches, and sweep the surface with a stiff broom. Do not place grout if the air temperature is below freezing. In hot, dry weather, protect grouted rock from excessive heat and keep moist for at least 3 days after grouting, using saturated burlap.

(b) Rock Energy Dissipator. Control flow of surface water runoff as needed. Excavate below final grade as required, install geotextile, and backfill with rock of the class indicated. Make appropriate connection to downstream receiving watercourse as indicated. If required, after rock is in place, saturate the rock with water, then completely fill the voids between pieces with grout, for at least the top 6 inches, and sweep the surface with a stiff broom. Do not place grout if the air temperature is below freezing. In hot, dry weather, protect grouted rock from excessive heat and keep moist for at least 3 days after grouting, using saturated burlap.

(c) Rock Apron. Control flow of surface water runoff as needed. Excavate below final grade as required, install geotextile, and backfill with rock of the class indicated. If required, make appropriate connection to downstream receiving watercourse as indicated.

(d) Riprap Basin. Control flow of surface water runoff as needed. Excavate below final grade as required, install geotextile, and backfill with rock of the class indicated. Make appropriate connection to downstream receiving watercourse as indicated.

(e) Temporary Installations. Remove rock and geotextile from temporary outlet protection as indicated. Stockpile rock used in temporary installations on site if necessary before permanent installations. Reuse rock for permanent outlet protection as indicated.

(f) Maintenance. Maintain outlet protection until the project has been completed. Remove excessive sediment and repair or replace washed out areas to restore outlet protection functionality.

851.4 MEASUREMENT AND PAYMENT—

(a) Rock Basin. Each

(b) Rock Energy Dissipator. Each

(c) Rock Apron. Square Yard

(d) Riprap Basin. Square Yard

(e) Temporary Installations. Each

SECTION 852—PAVED ENERGY DISSIPATOR

852.1 DESCRIPTION—This work is construction of a reinforced cement concrete channel, with embedded stones or solid precast blocks.

852.2 MATERIAL—

- Class A Cement Concrete—Section 704
- Reinforcement—Section 709.3
- Precast Concrete Blocks—Section 713.2(a)
- Joint Sealing Material—Section 705.4(b) or (c)
- Premolded Expansion Joint Filler—Section 705.1
- Asphalt Impregnated Paper—Section 727
- Stones—Section 850.2

852.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

Excavate to the required paving depth. Remove unsuitable material below the bottom of the paving and replace with suitable material. Thoroughly compact and finish the entire foundation area to a firm, even surface.

Mix, place, finish, and cure the concrete, as specified in the applicable parts of Section 1001.3. Hold the reinforcement firmly in position during the placing of concrete.

Pave in uniform 10-foot lengths or sections except where shorter sections are necessary for closures or curves. Form intermediate joints between sections, with two thicknesses of one-ply asphalt impregnated paper cut neatly to the paving cross section.

Place premolded expansion joint filler, 1/2 inch thick, cut to conform to the paving cross section at the ends of curved sections, at intervals of not more than 100 feet, at the end of a day's work, and where paving is adjacent to a rigid structure. Use premolded expansion joint filler that has a depth of 1/2 inch less than the paving depth and press firmly against the adjacent concrete. Seal the joint top with joint-sealing material.

Protect paving from the elements, flowing water, or other disturbances until curing is completed.

852.4 MEASUREMENT AND PAYMENT—

(a) Paved Energy Dissipator. Cubic Yard

(b) Excavation. Cubic Yard

For removal of unsuitable material of the same class of excavation for the ditch or channel above the paving.

SECTION 854—TEMPORARY SLOPE PIPE

854.1 DESCRIPTION—This work is construction of a temporary slope drainage facility.

854.2 MATERIAL—

- End Section—Section 616.2
- Pipe (Inlet and Outlet)—Section 601.2
- Fill Slope Pipe—Plastic, metal, or flexible rubber pipe of acceptable quality.
- Geotextiles, Class 4, Type A—Section 735

854.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

Construct the berms of suitable compacted embankment material, as specified in Section 206.3. Construct the inlet end to channel water into the temporary drain. Use a slope pipe that can easily be moved, with the length varying, as necessary, to reach a suitable discharge area. Place the discharge end so the outlet water does not cause erosion. Place geotextiles, Class 4, Type A, at the discharge end of the pipe; if necessary, use rock, to prevent erosion. Place fabric, as specified in Section 212.3(c).

Remove and satisfactorily dispose of pipes and end sections if they are no longer required.

854.4 MEASUREMENT AND PAYMENT—Each

SECTION 855—PUMPED WATER FILTER BAG

855.1 DESCRIPTION— This work is furnishing, installing, maintaining, and disposing of a Pumped Water Filter Bag as indicated.

855.2 MATERIAL—

(a) Pumped Water Filter Bag. From a manufacturer listed in Bulletin 15, meeting the following requirements:

1. Constructed from non-woven geotextile material with the physical properties listed below:

Property	Test Method	Units	Value
Mass per Unit Area, Min.	ASTM D 5261	oz/sy	10
Breaking Load (Grab Strength), Min.	ASTM D 4632	lbs	250
Tearing Strength (Trapezoidal Method), Min.	ASTM D 4533	lbs	100
Puncture Strength, Min.	ASTM D 6241	lbs	775
UV Resistance After 500 Hours, Min. Strength Retained	ASTM D 4355	%	70
Apparent Opening Size (AOS), Max. Sieve Size	ASTM D-4751, Method A	U.S Standard Sieve	No. 100 (0.150 mm)

2. Bag size: 15.0 feet by 15.0 feet (± 0.25 feet).

3. Sewn with a double 401 chain lock stitch or double needle stitch with a minimum seam strength of 100 pounds per inch according to ASTM D 4884.

4. Constructed with an adjustable sewn in spout capable of handling a maximum hose size diameter of 6 inches.

5. Labeled with maximum flowrate of bag in gallons per minute.

(b) Coarse Aggregate. AASHTO No. 57. Section 703

(c) Lifting Straps. Of sufficient strength to support load of bag.

(d) Geotextile for Underlayment. Class 4, Type A. Section 735

855.3 CONSTRUCTION—As shown on the Standard Drawings, at the location indicated or directed, and as follows:

Locate bag in a well vegetated (stabilized) area. Discharge onto a stable, erosion resistant area. When vegetated area is not available, provide geotextile (Class 4, Type A) lined flow path to a stable erosion resistant receiving water course or a well vegetated (stabilized) area.

Install compost berm or compost filter sock below bags located in High Quality (HQ) or Exceptional Value (EV) watersheds, within 50 feet of any receiving surface water, or where a well vegetated (stabilized) area is not available.

Locate bag on level area. When level area is not available, place AASHTO No. 57 Coarse Aggregate to level bag. Do not install bags in areas with slopes steeper than 5%.

Do not exceed a pump rate of 750 gallons per minute or half the maximum specified by the manufacturer, whichever is less.

Insert hose into sewn-in spout and double clamp bag firmly to pump discharge hose. Do not install more than one pump hose into a single bag.

Do not allow discharge from the bag to drain back into work or access areas of the project.

Monitor and evaluate entire pumping operation to assure that bag continues to function properly. Replace bag when contained silt reduces flow to approximately 50 percent of rate of initial bag discharge, or when directed.

Dispose of bag and sediment in a manner satisfactory to the Representative.

Do not cut open bags and seed.

Restore area as specified in Section 105.14.

855.4 MEASUREMENT AND PAYMENT—Each

SECTION 856—ROCK BARRIER

856.1 DESCRIPTION—This work is construction, maintenance, and removal of a rock barrier for channel and slope protection.

856.2 MATERIAL—

(a) Rock, Class R-4—Section 850.2(a), except petrographic examination by the LTS is not required.

(b) Coarse Aggregate, No. 57—Section 703.2

856.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Installation. Determine the required dimensions of the rock barrier. Produce an even distribution of rock with minimum voids. Provide a 12” layer of coarse aggregate on the uphill side of the barrier.

(b) Maintenance. Inspect the rock barrier weekly and after each runoff event throughout the duration of the project. If needed, immediately repair any damaged areas of the rock barrier found during inspection. Remove sediment when accumulations reach half the height of the barrier. Remove and dispose of sediment in an approved manner.

(c). Remove sediment and rock barrier upon stabilization of each channel as indicated.

856.4 MEASUREMENT AND PAYMENT—

(a) Rock. Square Yard or Cubic Yard

(b) Coarse Aggregate. Cubic Yard

(c) Removal Sediment and Rock Barrier. Each
Includes removal of accumulated sediment and proper disposal of all removed materials.

SECTION 857—CONCRETE BLOCK REVETMENT SYSTEMS

857.1 DESCRIPTION—This work is construction of an articulating system of interlocking precast concrete blocks or cable-connected precast concrete block mats for erosion protection of slopes and channels.

857.2 MATERIAL—

(a) Blocks. Precast, Section 714, or if machine-made, Section 713 and having 28-day compressive strength of 4,000 pounds per square inch and an absorption of 6% or less when tested according to ASTM C140 and a minimum durability factor of 80 when tested according to ASTM C666 (Procedure A, freezing and thawing in water).

(b) Stainless Steel Cable. For connected block systems, ASTM A368 or MIL-W-87161.

(c) Geotextile. As specified by the system manufacturer, and from a manufacturer listed in Bulletin 15.

(d) Soil Anchors. Conforming to the manufacturer's recommendations.

(e) Other Material. Backfill.

1. Aggregate. Section 703

2. Topsoil. Section 802

- Seeding and Soil Supplements—Section 804
- Mulching—Section 805
- Rolled Erosion Control Products—Section 806.2(a)

(f) Hydraulic Performance Requirements. Provide documented evidence that the system being furnished meets hydraulic performance characteristics, derived from tests conducted under controlled flow conditions and conforming to U.S. Federal Highway Administration and U.S. Bureau of Reclamation Testing protocol, as documented in "Hydraulic Stability of Articulating Concrete Block Revetment Systems During Overtopping Flow," Report No. FHWA-RD-89-199.

(g) Certification. Section 106.03(b)3

(h) Delivery, Storage, and Handling. Transport blocks in a manner that minimizes damage during shipping. Store and handle in a manner that protects them from damage by construction activities or traffic.

857.3. CONSTRUCTION—Excavate to allow placement of the geotextile and concrete blocks as indicated or directed. Remove obstructions such as tree roots, projecting stones, or other foreign matter to a depth of 6 inches below subgrade. Grade the slope to a smooth surface. Backfill voids or soft areas with suitable material and compact to non-movement. Fine grade the area and hand dress, where necessary, before placing the geotextile. Place geotextile as specified in Section 212.3(d)2.

Place concrete blocks over a geotextile, according to the system manufacturer's instructions. Submit field samples to LTS to verify that the manufacturer's prescribed geotextile is installed. Secure cable connected concrete block systems to the slope with soil anchors as indicated or directed. Do not use unsound or damaged blocks. Minor cracks, incidental to the usual methods of manufacturer, or minor chipping resulting from shipment and delivery are not grounds for rejection unless the Representative determines the material unacceptable. After placing blocks, backfill the open areas of the block with topsoil or aggregate, as indicated, to the top of the blocks. Complete backfilling within 7 days of placing the geotextile. If using aggregate, size aggregate according to the manufacturer's recommendation. If using topsoil, seed the backfill area as specified in Section 804 and mulch as specified in Section 805. Use Rolled Erosion Control Products (RECP), as specified in Section 806.2(a), to establish vegetation in a wet weather channel

as directed.

857.4 MEASUREMENT AND PAYMENT—

(a) Concrete Block Revetment System. Square Yard
Aggregate backfill, if used, is incidental to the work.

(b) Seeding and Soil Supplements. Section 804.4(a) as indicated.

(c) Mulching. Section 805.4 as indicated.

(d) Rolled Erosion Control Products. Section 806.4(a) as indicated.

(e) Topsoil. Section 802.4 as indicated.

SECTION 858—GEOCELL CONFINEMENT SYSTEM

858.1 DESCRIPTION—This work is furnishing, placement, and maintenance of a geocell confinement system for slope erosion protection.

858.2 MATERIAL—Use geocell as specified in Section 737

(a) Stakes. Conforming to manufacturer's recommendations and as indicated.

(b) Fasteners. Heavy-duty 3/8-inch steel wire staples clinched on the reverse side or No. 1 hog rings.

(c) Backfill.

1. Topsoil. Section 802

2. Coarse Aggregate. Section 703.2. AASHTO No. 67 or No. 2A, as indicated.

(d) Seeding and Soil Supplement. Section 804.2

(e) Mulching. Section 805.2

(f) Geotextile, Class 4, Type A, Non-Woven. Section 735

858.3 CONSTRUCTION—Construct as indicated and as follows:

(a) Geotextile. Place geotextile as specified in Section 212.3(a) and (d)2.

(b) Geocell Confinement System. Store and transport geocell confinement sections in an unexpanded configuration until ready to install. Place and expand the geocell sections on the geotextile with the longer dimension up and down (parallel with the slope direction) the side slope. Place geocell section flush or slightly lower than the adjacent terrain or final grade. Anchor as indicated. Mechanically fasten adjacent sections using wire staples or hog rings as shown on the shop drawings. Align abutting external cells at contact points and keep top edges flush before fastening. Place backfill material flush with the top of cells, as indicated. Do not operate equipment on finished subgrade, geotextile, unfilled geocell sections, or uncompacted backfill, except compaction equipment.

(c) Seeding and Mulching. As indicated and as follows:

1. Seeding and Soil Supplements. Section 804.3

2. Mulching. Section 805.3.

(d) Maintenance. Properly maintain slope erosion protection systems until the entire project has been completed. Maintenance includes regrading of washed-out areas and replacing fill material, reseeding, and mulching, as directed as specified in Section 105.13.

858.4 MEASUREMENT AND PAYMENT—

(a) Geocell Confinement System. Square Yard
The unit price includes backfill as indicated.

(b) Seeding and Soil Supplements. Section 804.4(a)

(c) Mulching. Section 805.4

(d) Geotextile. Class 4, Type A, non-woven, Section 212.4 (b).

SECTION 859—SEDIMENTATION POND

859.1 DESCRIPTION—This work is construction of a dam to impound water in a storage area.

859.2 MATERIAL—

(a) Rock Basin. Section 851.2

(b) Other Material. As shown on the Standard Drawings and as follows:

- Embankment—Section 206.2(a)
- Seeding and Soil Supplements—Section 804.2
- Mulch—Section 805.2
- Class A Cement Concrete—Section 704
- Corrugated Metal Pipe—Section 601.2(a)4.b or 4.c
- Reinforcement—Section 709.1
- Steel Plate—Section 1105.02
- Welding Material—Section 1105.02(t)

859.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

As specified in Section 201.3, clear and grub the storage area and embankment foundation area site. Excavate the key trench for the full length of the dam. Excavate the emergency spillway in natural ground. Install the pipe spillway, with the anti-seep collar attached, at the location indicated. Construct the concrete footing for the riser pipe, as specified in the applicable parts of Section 1001.3. Construction of the embankment and trench before placing the pipe is not required. Do not use coarse aggregate as backfill material around the pipe. Backfill the pipe with suitable embankment material to prevent dam leakage along the pipe. Construct rock basin at outlet end of pipe, as specified in Section 851.3(a). Place the embankment material, as specified in Section 206.3. If required, obtain borrow excavation for the formation of the embankment, as specified in Section 205. Apply seeding and soil supplements, as specified in Section 804.3. Mulch, if required, as specified in Section 805.3.

When the sedimentation dam is no longer required, or if otherwise directed, satisfactorily recondition the site by filling in excavated areas, and by removing embankments, riser pipe assemblies, corrugated metal pipe, and anti-seep collars. Restore the areas as specified in Section 105.14. Satisfactorily dispose of removed materials.

859.4 MEASUREMENT AND PAYMENT—

(a) Class 1 Excavation. Cubic Yard
Section 203.4.

(b) Riser Pipe Assembly. Lump Sum

(c) Corrugated Metal Pipe. Linear Foot
Section 601.4(a).

(d) Anti-Seep Collar. Each

(e) Embankment. Section 206.4

(f) Borrow Excavation. Cubic Yard
Section 205.4.

(g) Seeding and Soils Supplements. Section 804.4 for the type indicated.

(h) Mulch. Section 805.4 for the type indicated.

(i) Rock Basin. Section 851.4(a)

SECTION 860—STORM INLET PROTECTION

860.1 DESCRIPTION—This work is the furnishing, installing, maintaining, and removal of storm inlet protection of the type indicated.

860.2 MATERIAL—

(a) Inlet Filter Bag.

1. Provide bag from woven polypropylene material with the properties listed below:

Property	Test Method	Units	Value*
Grab Tensile Strength	ASTM D4632	lbs	300
Grab Tensile Elongation	ASTM D4632	%	15-50
Seam Strength	ASTM D4632	%	90
Puncture Resistance	ASTM D4833	lbs	120
Mullen Burst Strength	ASTM D3786	psi	800
Trapezoidal Tear Strength	ASTM D4533	lbs	120
UV Resistance	ASTM D4355	% @ 150 hrs	80
Apparent Opening Size	ASTM D4751	Sieve No.	40
Flow Rate	ASTM D4491	gal/min/sf	40
Permitivity	ASTM D4491	Sec -1	0.55

* The numerical values indicate minimum average roll value (MARV).

2. Provide manufacturer's inlet filter bag specifications product data sheets and drawings. Submit for project-specific, local approval by the Representative (i.e. at the District or project level) as specified in Section 106.02(a)2.c.

(b) Concrete Block/Gravel Inlet Protection for Type M, S, or C Inlets.

1. Aggregate. AASHTO No. 57. Section 703.2

2. Precast Concrete Block. Hollow Cores, Section 713.2

3. Mesh.

3.a Wire Mesh, Galvanized, No. 11 gage, 0.25 inch maximum opening. Section 626.2(c)1 OR

3.b Plastic Mesh, 0.25 inch maximum opening.

4. Wood Stud. Spruce/pine/fir, 2-inch x 4-inch nominal sizing, Construction Grade

(c) Pipe/Gravel Inlet Protection for Type M, S, or C Inlets.

1. Aggregate. AASHTO No. 57. Section 703.2

2. Mesh.

2.a Wire Mesh, Galvanized, No. 11 gage, 0.25 inch maximum opening. Section 626.2(c)1 OR

2.b Plastic Mesh, 0.25 inch maximum opening.

3. Pipe. Polyvinyl Chloride, 15-inch diameter, ASTM D3034, SRD-35

(d) Other Material. As follows:

- Embankment—Section 206.2(a)
- Sandbags—Provide sandbags as indicated, directed and approved by the Representative.

860.3 CONSTRUCTION—As shown on the Standard Drawings, at the location indicated or directed, and as follows:

(a) Inlet Filter Bag. Install bag in accordance with manufacturer's recommendation. Construct downstream earthen or sandbag berm as indicated and directed. Inspect bag after each runoff event to ensure that the bag continues to function properly. Replace or remove and clean bag when sediment has accumulated to 1/3 full or when flow capacity has been reduced so as to cause flooding or bypassing of the inlet. Upon final stabilization of tributary area, when directed, remove bag and downstream earthen or sandbag berm in a manner satisfactory to the Representative. Dispose of bag and sediment in a manner satisfactory to the Representative.

(b) Concrete Block/Gravel Inlet Protection. Install as indicated. Construct downstream earthen or sandbag berm as indicated and directed. Inspect inlet protection after each runoff event to ensure that it continues to function properly. Remove and replace aggregate when it is contaminated with sediment, washed out, or as directed. Upon final stabilization of tributary area, when directed, remove inlet protection and downstream earthen or sandbag berm in a manner satisfactory to the Representative. Dispose of sediment and materials in a manner satisfactory to the Representative.

(c) Pipe/Gravel Inlet Protection. Install as indicated. Construct downstream earthen or sandbag berm as indicated and directed. Inspect inlet protection after each runoff event to ensure that it continues to function properly. Remove and replace aggregate when it is contaminated with sediment, washed out, or as directed. Upon final stabilization of tributary area, when directed, remove inlet protection and downstream earthen or sandbag berm in a manner satisfactory to the Representative. Dispose of sediment and materials in a manner satisfactory to the Representative.

860.4 MEASUREMENT AND PAYMENT—

(a) Inlet Filter Bag. Each

(b) Concrete Block/Gravel Inlet Protection. Each

(c) Pipe/Gravel Inlet Protection. Each

SECTION 861—CLEANING SEDIMENTATION STRUCTURES

861.1 DESCRIPTION—This work is removal and disposal of sediment deposited in erosion and sedimentation control structures and/or devices.

861.3 CONSTRUCTION—Install cleanout stakes near the center of sediment trap and/or sediment basin as indicated or directed. When sediment accumulation has reached the associated cleanout elevations indicated on plans and as directed, remove and dispose of the sediment. Do not damage the structure or device. Maintain or replace cleanout stake as required, as indicated, or as directed.

861.4 MEASUREMENT AND PAYMENT—Cubic Yard

The sediment removed will normally be measured by the number of full loads hauled multiplied by the rated capacity of the hauling equipment, in cubic yards. Cross-sectional measurements will be used for large quantities and when not using hauling equipment.

SECTION 864—DIVERSION DITCH

864.1 DESCRIPTION—This work is construction of a ditch, at the indicated locations, to divert surface run-off water.

864.2 MATERIAL—

- Seeding and Soil Supplements—Section 804.2
- Mulch—Section 805.2

864.3 CONSTRUCTION—Windrow the excavated material on the low side of the ditch, then satisfactorily compact with a heavy wheel load or other acceptable method. On the entire ditch area, apply soil supplements and sow Formula D seed as specified in Section 804.3. Mulch with hay as specified in Section 805.3.

864.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 865—SILT BARRIER FENCE

865.1 DESCRIPTION—This work is furnishing, placement, maintenance, and removal of silt barrier fences of the height indicated.

865.2 MATERIAL—

(a) Geotextile. Class 3, Type A or B. Section 735

(b) Mesh Support. Metallic coated steel, 14.5 gage wire mesh, arranged in a maximum grid of 6 inches by 6 inches, or an acceptable, equivalent plastic mesh.

(c) Posts. Of sufficient length for 18-inch embedment in the ground. Either wood, nominal 2.0 inches square; or steel, 1.25-inch by 1.00-inch T-section or equivalent; or acceptable plastic, with an equivalent section.

(d) Fasteners. No. 9 staples, 1.5-inch long, or tie wires, 17 gage steel, of appropriate length, acceptably metallic coated.

(e) Ground Anchors. 1-inch by 2-inch by 12-inch wooden stakes or steel equivalent to anchor guy wire as shown on the Standard Drawings.

(f) Guy Wires. No. 10 gage, galvanized, according to ASTM A 392, Class II. Install as directed.

(g) Rock Filter Outlet.

1. **AASHTO No. 1 Coarse Aggregate.** Section 703.2

2. **AASHTO No. 57 Coarse Aggregate.** Section 703.2

865.3 CONSTRUCTION—As shown on the Standard Drawings, with or without mesh support fencing, and as follows:

(a) Installation. Excavate trench and install posts. Fasten the geotextile securely to the top of the mesh, at a maximum spacing of 30 inches, and to the posts. Keep sag to a minimum. Extend the geotextile a minimum of 6 inches vertically along the front face of the excavated trench and a minimum of 6 inches along the bottom of the excavated trench, backfill the trench with the excavated soil, and compact.

(**b) Maintenance.** After installation, satisfactorily maintain the silt barrier fence. Periodically clean silt barrier fence by tapping the dry geotextile from the downstream side. When directed, provide rock filter outlets to replace undercut and overtopped sections of the silt barrier fence.

When the barrier fence is no longer needed, remove the fence and restore the area as specified in Section 105.14.

865.4 MEASUREMENT AND PAYMENT—

(a) Silt Barrier Fence. Linear Foot

(b) Silt Barrier Fence Replacement. If silt barrier fence is required to be replaced, the Department will pay for it at the contract unit price for Silt Barrier Fence.

SECTION 866—HEAVY DUTY SILT BARRIER FENCE

866.1 DESCRIPTION—This work is furnishing, placement, maintenance, and removal of heavy duty silt barrier fence.

866.2 MATERIAL—

(a) Geotextile. Class 3, Type A. Section 735

(b) Posts. Of sufficient length for 36 inches embedment into the ground and 2 1/2 inch diameter galvanized steel or aluminum

(c) Fasteners. Tie wires, 17 gage steel, of appropriate length, acceptably metallic coated to fasten geotextile to wire fabric.

(d) Wire Fabric and Components. Section 1110.01(a)

(e) Rock Filter Outlet.

1. **AASHTO No. 1 Coarse Aggregate.** Section 703.2
2. **AASHTO No. 57 Coarse Aggregate.** Section 703.2

866.3 CONSTRUCTION—As shown on the Standard Drawings, as indicated, and as follows:

(a) Installation. Excavate trench and install posts. Provide drive anchors when required or as directed by the Representative. Fasten the geotextile securely to the top of the wire fabric, at a maximum spacing of 24 inches and to the posts. Keep sag to a minimum. Extend the geotextile and wire fabric a minimum of 8 inches into the excavated trench backfill the trench with the excavated soil, and compact.

(b) Maintenance. After installation, satisfactorily maintain the heavy duty silt barrier fence. Periodically clean heavy duty silt barrier fence by tapping the dry geotextile from the downstream side. When directed, provide rock filter outlets to replace undercut and overtopped sections of the heavy duty silt barrier fence.

When the fence is no longer needed, as directed, remove the fence and restore the area as specified in Section 105.14.

866.4 MEASUREMENT AND PAYMENT—

(a) Heavy Duty Silt Barrier Fence. Linear Foot

(b) Heavy Duty Silt Barrier Fence Replacement. If silt barrier fence is required to be replaced, the Department will pay for it at the contract unit price for Heavy Duty Silt Barrier Fence.

SECTION 867—COMPOST FILTER SOCK

867.1 DESCRIPTION—This work is furnishing, placement, and maintenance of a compost filter sock erosion and sedimentation pollution control system.

867.2 MATERIAL—

(a) Compost. Provide well-decomposed, stable, weed-free, organic compost derived from agriculture, food, stump grindings, and yard or wood/bark organic matter sources – aerobically composted with no objectionable odors. The compost product should not resemble the raw material from which it was derived. Wood and bark chips, ground construction debris, or reprocessed wood products are not acceptable as the organic component of the mix. Provide compost meeting the compost standards for compost filter socks contained in the DEP Erosion and Sediment Pollution Control Program Manual:

• Moisture content, dry weight basis	30% - 60%
• pH	5.5 - 8.5
• Soluble salt concentration (electrical conductivity) maximum	5.0 dS/m
• Man-made inert contaminants, dry weight basis	Less than 1%
• Organic matter content, dry weight basis	25%-100%
• Particle size, % passing 3/8 sieve, dry weight basis	30%-50%

Provide a written statement by the supplier certifying that the compost meets the above requirements. Submit for project-specific, local approval by the Representative (i.e. at the District or project level) as specified in Section 106.02.(a)

(b) Filter Sock. Provide filter sock meeting the compost filter sock requirements of the DEP Erosion and Sediment Pollution Control Program Manual, as shown in the Table below. Provide manufacturer's filter sock specifications, product date sheets, and drawings. Submit for project-specific, location approval by the Representative (i.e. at the District or project level) as specified in Section 106.02(a)2.c.

Material Type	3 mil HDPE	5 mil HDPE	5 mil HDPE	Multi-Filament Polypropylene (MFPP)	Heavy Duty Multi-Filament Polypropylene (HDMFPP)
Material Characteristics	Photo-degradable	Photo-degradable	Bio-degradable	Photo-degradable	Photo-degradable
Filter Sock Diameters (in.)	12 and 18	12, 18, 24, and 32	12, 18, 24, and 32	12, 18, 24, and 32	12, 18, 24, and 32
Mesh Opening (in.)	3/8	3/8	3/8	3/8	1/8
Tensile Strength (psi)	N/A	26	26	44	202
Ultraviolet Stability % Original Strength (ASTM G-155)	23% at 1000 hr.	23% at 1000 hr.	N/A	100% at 1000 hr.	100% at 1000 hr.
Minimum Functional Longevity	6 months	9 months	6 months	1 year	2 years

867.3 CONSTRUCTION— As shown on the Standard Drawings, as indicated, and as follows:

(a) Installation. Fill filter sock with compost at the designated erosion control area or fill and transport to the project site. Fill filter sock with compost using pneumatic (blower) equipment or similar filter sock filling equipment to the length required.

Place compost filter sock downslope of the earth disturbance on level contour as indicated. Extend both ends of the compost filter sock at least 8 feet upslope at 45 degrees to the main compost filter sock alignment. For lengths greater than 200 feet, use multiple compost filter sock sections and overlap ends at least 12 inches.

Anchor compost filter socks placed on earthen slopes with stakes driven through the center of the compost filter sock or immediately downslope of the compost filter sock at 10 foot intervals consistent with the RC Standard Drawings and the DEP Erosion and Sediment Pollution Control Program Manual. Use concrete blocks immediately downslope of the compost filter sock (at the same intervals recommended for the stakes) where compost filter socks are placed on paved surfaces.

Do not place the compost filter sock where it will concentrate drainage runoff or channel water to another location.

(b) Maintenance. Maintain compost filter sock until the project has been completed. Routinely inspect compost filter sock installation for damage that would make the compost filter sock non-functioning. Repair or replace damaged areas as directed. Replace compost filter socks after the minimum functional longevity time period identified in the Section 867.2(b) table for the type of filter sock material used. Remove built-up sediment retained by the compost filter sock when the sediment reaches 1/2 of the exposed height of the compost filter sock. Dispose of sediment as specified in the Erosion & Sediment Control Plan.

Upon stabilization of the area tributary to the compost filter sock, remove the stakes. Remove compost filter sock or leave in place. If left in place, cut open the filter sock to expose the compost material completely and spread evenly to the contours of the site. Remove the filter sock unless the Representative authorizes it to remain.

867.4 MEASUREMENT AND PAYMENT— Linear Foot for the specified filter sock diameter.

SECTION 868—COMPOST BLANKET AND COMPOST FILTER BERM

868.1 DESCRIPTION—This work is furnishing, placement, and maintenance of a compost blanket or compost filter berm erosion and sedimentation pollution control system.

868.2 MATERIAL—

(a) Compost. Provide well-decomposed, stable, weed-free, organic compost derived from agriculture, food, stump grindings, and yard or wood/bark organic matter sources – aerobically composted with no objectionable odors. The compost product should not resemble the raw material from which it was derived. Wood and bark chips, ground construction debris, or reprocessed wood products are not acceptable as the organic component of the mix. Provide compost meeting the compost standards for compost filter berm contained in the DEP Erosion and Sediment Pollution Control Program Manual:

• Moisture content, dry weight basis	30% - 60%
• pH	5.5 to 8.5
• Soluble salt concentration (electrical conductivity) maximum	5.0 dS/m
• Manufactured inert contaminants, dry weight basis	Less than 1%
• Organic matter content, dry weight basis	25%-100%
• Particle size, % passing 3/8 inch size sieve, dry weight basis	30%-50%

Provide a written statement by the supplier certifying that the compost meets the above requirements. Submit for project-specific, local approval by the Representative (i.e. at the District or project Level) as specified in Section 106.02(a)2.c.

(b) Seed. Section 804 for the designated seed formula. Soil supplements are not required with these compost systems.

868.3 CONSTRUCTION—As shown on the Standard Drawings, as indicated, and as follows:

(a) Compost Blanket.

1. Soil Preparation. Roughen/scarify soil surface with appropriate equipment. Remove and dispose of large unworkable soil clumps, debris, large rocks, and undesirable woody matter such as stumps. Track soil surface before compost application with equipment capable of working perpendicular to the slope gradient in order to create soil indentations that will hold compost. Avoid excessive soil compaction during this operation.

2. Compost Application. Uniformly apply compost to the specified depth with approved pneumatic (blower) units, or other appropriate equipment designed to handle and distribute compost material. Do not apply compost in direct-flow drainage channels such as ditches or the centerline of swales.

Apply compost approximately 3 feet beyond and overlapping all edges of the bare soil surfaces designated to receive the compost.

2.a Application Rate.

- Surfaces to be seeded up to 2:1 slope – 270 cubic yards/acre or 2 inches depth with ± 1/2 inch tolerance.

- Surfaces not to be seeded up to 2:1 slope – 540 cubic yards/acre or 4 inches depth with ± 1/2 inch tolerance.

3. Seeding Designated Areas. Apply seed by injection of the appropriate seed formula into the compost flow stream during the compost application, or apply the seed in a separate surface applied operation. Apply seed at twice the seeding rate indicated in Section 804.2(b)2, Table A, for the designated seed formula. Test and verify the specified application rates for the equipment used.

Soil supplements and separate mulch application are not required.

4. Maintenance. Maintain compost blanket depth until the project has been completed or directed otherwise. Routinely inspect blanket for any material dislodgement. Replace and redress any dislodged material and reseed if necessary. Control any noxious weeds with approved herbicides meeting the applicable requirements of Section 804.3(j).

Leave compost blanket in place upon completion of the project.

(b) Compost Filter Berm.

1. Installation. Apply approved compost using specially designed pneumatic (blower) equipment and a berm forming/shaping device, or other appropriate equipment designed to handle compost and form berms. If blower is used, blow compost directly at the soil surface to help settle, compact, and shape the berm.

Construct compost filter berm to comply with the requirements of the DEP Erosion and Sediment Pollution Control Program Manual. Construct berm downslope of the earth disturbance on level contour as indicated. Extend both ends of the berm at least 8 feet upslope at 45 degrees to the main berm alignment.

Construct a trapezoidal shaped compost filter berm, 2 feet high by 4 feet wide at the base with 1:1 side slopes. Position the berm around the designated disturbed soil areas and parallel to the slope base. Construct berm ends pointing upslope so that the ends are at a higher elevation than the berm body to prevent drainage water from flowing around the ends of the berm. Net or anchor the berm after installation.

2. Maintenance. Maintain filter berm in a functional condition. Routinely inspect berm and replace any dislodged compost or reshape any collapsed berm areas. Compost may be replaced by hand and tamped into place. Remove built-up sediment retained by the berm when the sediment reaches 1/3 of the height of the berm. Dispose of sediment as specified in the Erosion & Sediment Control Plan. Replace any compost dislodged by this operation. At completion of project or when directed, leave compost in place by pushing over the berm and spreading the compost material evenly over the adjacent ground to match the contours of the site.

868.4 MEASUREMENT AND PAYMENT—

(a) Compost Blanket, Seeded. Square Yard for the designated seed formula.

(b) Compost Blanket, Unseeded. Square Yard

(c) Compost Filter Berm. Linear Foot

SECTION 870—SEDIMENT TRAP – EMBANKMENT

870.1 DESCRIPTION—This work is construction, maintenance, and removal of an embankment type sediment trap.

870.2 MATERIAL—

(a) Aggregate. AASHTO No. 57. Section 703.2

(b) Rock. Class R-3, Section 850.2(a), except petrographic examination by the LTS is not required.

(c) Plywood Extensions. Where indicated.

- **Posts.** 2-inch by 2-inch Alkaline Copper Quat (ACQ) Pressure Treated, Spruce/Pine/Fir, Grade 2 (minimum) of the length required. Certify as specified in Section 106.03(b)3.
- **Plywood.** 3/4-inch thick, Alkaline Copper Quat (ACQ) Pressure Treated, Spruce/Pine/Fir. Certify as specified in Section 106.03(b)3.
- **Fasteners**. Deck screws of adequate length and approved for use with Alkaline Copper Quat (ACQ) Pressure Treated wood. Certify as specified in Section 106.03(b)3.

(d) Geotextile. Section 735

(e) Embankment. Section 206.2(a)

(f) Seeding and Soil Supplements. Section 804.2

(g) Mulch. Section 805.2

(h) Cleanout Stakes. 2 inches by 2 inches, Spruce/Pine/Fir, Construction Grade, of the length required, or other approved material of adequate size and length.

870.3 CONSTRUCTION—Construct, as shown on the Standard Drawings, at the location indicated or directed, as follows:

Clear and grub the site, as specified in Section 201.3. Construct the sediment trap by excavating as specified in Section 203.3, forming embankments as specified in Section 206.3, and placing aggregate or rock at the outlet as indicated.

If a plywood extension is required, construct as indicated to the elevations indicated.

Place geotextiles, as specified in Section 212.3 for the type indicated. If required, obtain borrow excavation for the formation of the embankment, as specified in Section 205. Apply seeding and soils supplements, as specified in Section 804.3. Mulch, if required, as specified in Section 805.3. Install and maintain cleanout stake as required, as indicated, or as directed.

Inspect sediment trap after each runoff event. Remove accumulated sediment as specified in Section 861.3 and replace aggregate when it is contaminated with sediment, washed out, or as directed.

When the tributary area to the sediment trap is stabilized, or the sediment trap is no longer required, or when directed, recondition the site by filling in excavated areas, by removing embankments, plywood extension (where required), and aggregate and by restoring the area, as specified in Section 105.14.

870.4 MEASUREMENT AND PAYMENT—

(a) Class 1 Excavation. Section 203.4.

(b) Embankment. Section 206.4

(c) Aggregate. Cubic Yard

(d) Borrow Excavation. Cubic Yard
Section 205.4.

(e) Seeding and Soil Supplements. Section 804.4
For the type indicated.

(f) Mulch. Section 805.4
For the type indicated.

(g) Rock. Cubic Yard
Section 850.4(a).

(h) Geotextile. Section 212.4
For the type indicated.

(i) Plywood Extensions. Each

(j) Cleaning of Sedimentation Structures. Section 861.4

SECTION 871—SEDIMENT TRAP – RISER

871.1 DESCRIPTION—This work is the construction, maintenance, and removal and/or conversion of riser type sediment trap to a permanent stormwater management facility.

871.2 MATERIAL—

(a) Embankment. Section 206.2(a)

(b) Pipe. Section 601.2 (for the type indicated)

(c) Outlet Protection: Rock. Section 851.2

(d) Temporary Baffle Wall. Section 873.2

(e) Cleanout Stake. 2-inch by 2-inch, Spruce/Pine/Fir, Construction Grade, of the length required, or other approved material of adequate size and length.

(f) Temporary Riser Pipe Assembly. Section 874.2 (where indicated)

(g) Concrete Outlet Structure. Section 875.2 (where indicated)

(h) Emergency Spillway. (Where indicated)

- **Rock.** Section 850.2(a)
- **Geotextile.** Class 4, Type A. Section 735

(i) Seeding and Soil Supplements. Section 804.2

(j) Mulch. Section 805.2

871.3 CONSTRUCTION—As shown on the Standard Drawings, at the location indicated or directed, and as follows:

As specified in Section 201.3, clear and grub the storage area and embankment foundation area site. Excavate the key trench for the full length of the embankment (when located in permanent stormwater management facility). Install the outlet protection, outlet pipe with the anti-seep collar attached (where indicated), and outlet structure at the location indicated.

When indicated, construct the temporary riser pipe assembly, as specified in Section 874.3.

When a concrete anti-seep color is specified, construct collar as specified in the applicable parts of Section 1001.3.

When the sediment trap is located in a permanent stormwater management facility and a concrete outlet structure is indicated, construct concrete outlet structure as specified in Section 875.3.

Construction of the embankment before placing the pipe is not required. Do not use coarse aggregate as backfill material around the pipe. Backfill the pipe with suitable embankment material to prevent embankment leakage along the pipe. Construct outlet protection of the type indicated at outlet end of pipe, as specified in Section 851.3. Place the embankment material, as specified in Section 206.3. When required, obtain borrow excavation for the formation of the embankment, as specified in Section 205. Apply seeding and soil supplements, as specified in Section 804.3. Mulch, if required, as specified in Section 805.3.

Install and maintain cleanout stake as required, as indicated, or as directed.

Inspect sediment trap after each runoff event to assure that it continues to function properly. Remove accumulated sediment as specified in Section 861.3 and repair as required or as directed.

When the tributary area to the sediment trap is stabilized or the sediment trap is no longer required, or if otherwise directed, satisfactorily recondition the site as follows:

- Temporary Sediment Trap: Fill in excavated areas, removing embankments, riser pipe assemblies, outlet

pipe, and anti-seep collars, or as directed. Restore the areas as specified in Section 105.14. Satisfactorily dispose of removed materials.

- Sediment Trap located in a Permanent Stormwater Management Basin area: Remove accumulated sediment and restore sediment trap to final basin contouring as indicated, stabilize disturbed areas as indicated, remove temporary orifice covers, temporary stand pipes, affix permanent stormwater management features as specified in Section 875.3, as indicated, or as directed. Satisfactorily dispose of removed materials.

871.4 MEASUREMENT AND PAYMENT—

(a) Class 1 Excavation. Section 203.4.

(b) Temporary Riser Pipe Assembly. Section 874.4

(c) Pipe. Section 601.4
For the type indicated.

(d) Anti-Seep Collar. Each.
For the type indicated.

(e) Embankment. Section 206.4

(f) Borrow Excavation. Cubic Yard
Section 205.4.

(g) Seeding and Soil Supplements. Section 804.4
For the type indicated.

(h) Mulch. Section 805.4
For the type indicated.

(i) Concrete Outlet Structure. Section 875.4

(j) Outlet Protection: Rock. Section 851.4
For the type indicated.

(k) Rock. Cubic Yard
Section 850.4

(l) Geotextile. Square Yard
Section 212.4

(m) Cleaning of Sedimentation Structures. Section 861.4

(n) Temporary Baffle Wall. Section 873.4

SECTION 872—SEDIMENT BASIN

872.1 DESCRIPTION—This work is the construction, maintenance, removal and/or conversion of a sediment basin to a permanent stormwater management facility.

872.2 MATERIAL—

(a) Embankment. Section 206.2(a)

(b) Pipe. Section 601.2 (for the type indicated)

(c) Outlet Protection, Rock. Section 851.2

(d) Temporary Baffle Wall. Section 873.2

(e) Cleanout Stake. 2 inch by 2 inch, Spruce/Pine/Fir, Construction Grade, of the length required, or other approved material of adequate size and length.

(f) Temporary Riser Pipe Assembly. Section 874.2 (where indicated)

(g) Concrete Outlet Structure. Section 875.2 (where indicated)

(h) Emergency Spillway.

- **Rock.** Section 850.2(a)
- **Geotextile. Class 4, Type A.** Section 735

(i) Seeding and Soil Supplements. Section 804.2

(j) Mulch. Section 805.2

872.3 CONSTRUCTION—As shown on the Standard Drawings, at the location indicated or directed, and as follows:

As specified in Section 201.3, clear and grub the storage area and embankment foundation area site. Excavate the key trench for the full length of the embankment. Excavate the emergency spillway as indicated. Install the outlet protection, outlet pipe with the anti-seep collar attached, and outlet structure at the location indicated.

When indicated, construct the temporary riser pipe assembly, as specified in Section 874.3.

When concrete anti-seep collar is specified, construct collar as specified in the applicable parts of Section 1001.3.

When the sediment basin is located in a permanent stormwater management facility and a concrete outlet structure is indicated, construct concrete outlet structure as specified in Section 875.3.

Construction of the embankment and trench before placing the pipe is not required. Do not use coarse aggregate as backfill material around the pipe. Backfill the pipe with suitable embankment material to prevent embankment leakage along the pipe. Construct outlet protection of the type indicated at outlet end of pipe, as specified in Section 851.3. Place the embankment material, as specified in Section 206.3. If required, obtain borrow excavation for the formation of the embankment, as specified in Section 205. Apply seeding and soil supplements, as specified in Section 804.3. Mulch, if required, as specified in Section 805.3.

Install and maintain cleanout stake as required, as indicated, or as directed.

Inspect sediment basin after each runoff event. Remove accumulated sediment as specified in Section 861.3 and repair as required or as directed.

When the tributary area to the sediment basin is stabilized, or the basin is no longer required, or when directed, satisfactorily recondition the site as follows:

- Temporary Sediment Basin: Fill in excavated areas, removing embankments, riser pipe assemblies, corrugated metal pipe, and anti-seep collars, or as directed. Restore the areas as specified in Section 105.14.

Satisfactorily dispose of removed materials.

- Sediment Basin located in a Permanent Stormwater Management Basin area: Remove accumulated sediment and restore basin to final contouring as indicated, stabilize disturbed areas as indicated, remove temporary orifice covers, temporary stand pipes, affix permanent stormwater management features as specified in Section 875.3, as indicated or as directed. Satisfactorily dispose of removed materials.

872.4 MEASUREMENT AND PAYMENT—

(a) Class 1 Excavation. Section 203.4.

(b) Temporary Riser Pipe Assembly. Section 874.4

(c) Pipe. Section 601.4
For the type indicated.

(d) Anti-Seep Collar. Each
For the type indicated.

(e) Embankment. Section 206.4

(f) Borrow Excavation. Cubic Yard
Section 205.4.

(g) Seeding and Soil Supplements. Section 804.4
For the type indicated.

(h) Mulch. Section 805.4
For the type indicated.

(i) Concrete Outlet Structure. Section 875.4

(j) Outlet Protection, Rock. Section 851.4
For the type indicated.

(k) Rock. Cubic Yard
Section 850.4

(l) Geotextile. Square Yard
Section 212.4

(m) Cleaning of Sedimentation Structures. Section 861.4

(n) Temporary Baffle Wall. Section 873.4

SECTION 873—TEMPORARY BAFFLE WALL

873.1 DESCRIPTION—This work is construction, maintenance, and removal of a temporary baffle wall.

873.2 MATERIAL—

(a) Posts. 4-inch by 4-inch Alkaline Copper Quat (ACQ) Pressure Treated, Spruce/Pine/Fir, Grade 2 (minimum) of the length required. Certify as specified in Section 106.03(b)3.

(b) Plywood. 3/4-inch thick, Alkaline Copper Quat (ACQ) Pressure Treated, Spruce/Pine/Fir. Certify as specified in Section 106.03(b)3.

(c) Fasteners. Deck screws of adequate length and approved for use with Alkaline Copper Quat (ACQ) Pressure Treated wood. Certify as specified in Section 106.03(b)3.

873.3 CONSTRUCTION—As shown on the Standard Drawings, and as follows:

Place the pressure treated posts and fasten plywood sheets as indicated and directed. Drive posts and plywood to minimum dimensions indicated to insure flow is diverted along the length of the baffle. Clean the baffle as necessary to insure adequate flow is maintained during all construction phases. When no longer required, satisfactorily remove.

873.4 MEASUREMENT AND PAYMENT—Linear Foot.
All necessary hardware is incidental.

SECTION 874—TEMPORARY RISER PIPE ASSEMBLY

874.1 DESCRIPTION—This work is furnishing, placement, maintenance and removal of a temporary riser pipe assembly that functions as an outlet structure for a temporary sediment trap or sediment basin.

874.2 MATERIAL—

(a) Riser and Stub Pipe.

- **Pipe.** Corrugated Metal Pipe, Section 601.2(a)4(d) for the size indicated.
- **Welding Material.** Steel Shapes - Section 1105.02(t)

(b) Class A Cement Concrete. Section 704

(c) Joint Sealing Material. Section 705.4

(d) Trash Rack and Anti-Vortex Device.

- **Reinforcement.** Section 709.1
- **Steel Shapes.** Section 1105.02(a)2
- **Welding Material.** Steel Shapes - Section 1105.02(t). Reinforcement – AWS D1.4 Structural Welding Code, Reinforcing Steel.

874.3 CONSTRUCTION—As shown on the Standard Drawings, as indicated, and as follows:

Fabricate riser and stub pipe as indicated.

Fabricate trash rack and anti-vortex device as indicated.

Excavate for temporary riser pipe assembly as required.

Place concrete foundation and form bottom of riser pipe assembly with Class A Cement Concrete to channel the flow toward the outlet pipe as indicated.

Join the riser pipe assembly to the outlet pipe using acceptable connections. Seal connection as specified in Section 601.3(d) and (i).

Backfill using suitable embankment material.

Attach trash rack to structure as indicated.

Maintain as required or directed.

When indicated or directed, remove temporary riser pipe assembly.

Satisfactorily dispose of unsuitable and surplus material.

874.4 MEASUREMENT AND PAYMENT—Each

SECTION 875—CONCRETE OUTLET STRUCTURE

875.1 DESCRIPTION—This work is construction of a permanent concrete outlet structure for a stormwater management facility and where applicable, the conversion to and from a temporary sediment trap or sediment basin.

875.2 MATERIAL—

(a) Inlet. Standard Box, with Type M Top Unit. Section 605.2 or Section 714

(b) Grate. Structural Steel for Top Indicated. Section 605.2

(c) Trash Rack.

- **Reinforcement.** Section 709.1
- **Steel Shapes.** Section 1105.02(a)2
- **Welding Material.** Steel Shapes - Section 1105.02(t). Reinforcement – AWS D1.4 Structural Welding Code, Reinforcing Steel.
- **Galvanizing.** Section 1105.02(s)
- **Anchors.** Section 516.2(k). Bolts to be stainless steel or galvanized.
- **Wire Mesh.** Steel Wire, No. 10 gage, with 1.5-inch square opening.

(d) Temporary Orifice Plate Cover. (Where indicated)

- **Plywood.** 3/4-inch thick, Alkaline Copper Quat (ACQ) Pressure Treated, Spruce/Pine/Fir. Certify as specified in Section 106.03(b)3.
- **Fasteners.** Of the type indicated. Certify as specified in Section 106.03(b)3.
- **Sealant.** Silicone. Section 705.4(a)

(e) Class A Cement Concrete. Section 704

(f) Mortar. Section 705.7

(g) Zinc Chromate Primer. Federal Specification TT-P-645. Certify as specified in Section 106.03(b)3.

875.3 CONSTRUCTION—As shown on the Standard Drawings, as indicated, and as follows:

- Cement Concrete Structures – As specified in the applicable parts of Section 1001.3.

Fabricate trash rack(s) and galvanize as indicated.
Excavate for concrete outlet structure as required.
Place concrete foundations and walls monolithically, except if otherwise indicated.
Construct new concrete outlet structure walls and bottoms to accommodate the dimensions of outlet pipes, weirs, and orifices. Form bottom of new concrete outlet structure with Class A Cement Concrete to channel the flow toward the outlet pipe as indicated.
Attach trash racks to concrete outlet structure as indicated.
Set frames and top units in full mortar beds.

Set pipes flush with the inside structure face.

When constructing concrete outlet structure(s) in conjunction with existing pipes, provide for satisfactory connections, as specified for new construction of a similar type.

Backfill excavated spaces around the structure with acceptable embankment material, as specified in Section 206.3(b)4, unless otherwise indicated. Satisfactorily dispose of unsuitable and surplus material.

Coat all aluminum surfaces to be embedded in concrete with one coat of zinc chromate primer, or a coat of asphalt paint. Allow to dry completely before placing concrete.

When concrete outlet structure is to be used for temporary sediment trap or sediment basin riser:

- Attach temporary orifice cover plates as indicated. Seal plate to concrete outlet structure such that it is leak tight.

- Do not install orifice trash racks until temporary orifice cover plates have been removed.

- Core/drill holes, of the diameter and spacing indicated, through concrete outlet structure and/or temporary orifice cover plate.

- When temporary orifice cover plate(s) are no longer required, satisfactorily remove plates, fasteners and clean exterior face of structure. Satisfactorily dispose of materials. Seal all holes in structure that were installed for temporary purposes with non-shrinking mortar and/or silicone sealant. Attach permanent trash racks as indicated.

875.4 MEASUREMENT AND PAYMENT—Each

SECTION 900
TRAFFIC ACCOMMODATION AND CONTROL

SECTION 901—MAINTENANCE AND PROTECTION OF TRAFFIC DURING CONSTRUCTION

901.1 DESCRIPTION—This work is the furnishing, installing, maintaining, and relocating of traffic control devices. This work may include flagging and pilot car operation for guidance of traffic through the temporary traffic control zone and dust control. All work shall be done as specified in these Specifications, the Publication 212, Publication 213, and the MUTCD, the Special Provisions, Standard Drawings, the approved Traffic Control Plans (TCP), and as directed.

901.2 MATERIAL—Furnish material and traffic control devices necessary for maintenance and protection of traffic, and conforming to the TCP, Publication 212, Publication 213, and the MUTCD, and as follows:

- Temporary Barrier—Section 627.2
- Temporary Concrete Barrier, Structure Mounted—Section 643.2
- Temporary Concrete Median Barrier, Structure Mounted—Section 643.2
- Temporary Concrete Glare Screen Median Barrier, Structure Mounted—Section 643.2
- Temporary Impact Attenuating Devices—Section 696.2
- Reset Temporary Barrier—Section 628.2
- Temporary Concrete Barrier, Structure Mounted, Reset—Section 644.2
- Temporary Concrete Median Barrier, Structure Mounted, Reset—Section 644.2
- Temporary Concrete Glare Screen Median Barrier, Structure Mounted, Reset—Section 644.2
- Reset Temporary Impact Attenuating Devices—Section 697.2
- Painting Traffic Lines and Markings—Section 962.2
- Asphalt Tack Coat—Section 460.2
- Superpave Asphalt Mixture Design, Asphalt Wearing Course 4.75 mm, SRL L—Section 413.2 and as follows: PG 64S-22, <0.3 million ESALs, or as indicated or directed.
- Shadow Vehicle—A truck equipped with a flashing or revolving yellow light and as specified in Publication 212, Publication 213, and the MUTCD.
- Truck Mounted Impact Attenuator and/or Arrow Panel—Installed on the shadow vehicle, as required in Publication 212, Publication 213, and the MUTCD.
- Adhesive—Section 966.2(c)
- Temporary Traffic Control Signals—Section 1124

- Temporary Traffic Control Signals, Reset—Section 1124

Provide traffic line paint and glass beads or pavement marking tape according to the requirements of Section 901.3(k). All temporary traffic control devices must be listed in Bulletin 15. Temporary Type III barricades must comply with Standard Drawings or be listed in Bulletin 15. Temporary portable 'H' base and 'X' base sign posts must comply with the Standard Drawings or be listed in Bulletin 15.

Certification Form CS-4171 is not required for temporary traffic control devices. However, temporary traffic control devices permanently incorporated as part of the project require Form CS-4171, unless otherwise specified in the contract.

901.3 CONSTRUCTION—

(a) General. Comply with Publication 212, Publication 213, and the MUTCD.

Install and maintain traffic control devices as indicated on the TCP, or an approved alternate plan submitted at the preconstruction conference. The Representative may revise the TCP in writing during construction. If unforeseen conditions arise or if revisions are made to the TCP by the Representative, install and maintain additional warning lights and traffic control signs on necessary mounting devices according to Publication 212, Publication 213, and the MUTCD, and at locations designated in writing by the Representative. Remove or cover existing traffic control devices that conflict with the TCP. When conflict no longer exists, erect or uncover them.

Temporarily remove or cover reduced regulatory speed limit signs when workers are not present, except as otherwise indicated on the TCP, approved alternate plan, or as directed.

Open any substantially completed section of roadway for the use and convenience of traffic, as directed, and as specified in Section 107.15. When work is completed, immediately remove temporary traffic control devices.

Maintain, clean, and properly operate the devices during the entire time they are in use. Traffic control devices must meet the acceptable or marginal standards shown in PennDOT Publication 213, Appendix C 'Quality Guidelines for Temporary Traffic Control Devices'. Where operations are performed in stages, keep only the necessary devices that apply to the present stage of construction in operation.

Cover or remove signs that do not apply to the existing conditions. Cover with rubber roofing material (EPDM) having a thickness of 0.045 inch (45 mils) or black vinyl coated polyester material having a minimum weight of 18 ounces per square yard and minimum thickness of 0.020 inch (20 mils). Cover the entire sign face including any supplemental plaques. All other materials, including burlap or open mesh materials, other signs, and trash bags are unacceptable. Covers with a color other than black are unacceptable. Stabilize and fasten this material to the sign with either plastic or wood to prevent any movement. Do not apply tape to face of sign. Do not deface or damage the sign face using this procedure.

Do not allow weeds, brush, trees, construction equipment, materials, and the like to obscure any traffic control device.

(b) Maintenance of Roadway and/or Structures. Continuously and effectively maintain existing roadways and/or structures within the limits of the project from the start of physical work until the date of project acceptance or until relieved of responsibility for further physical work and maintenance as specified in Section 110.08(a). Such maintenance includes, but is not limited to, the following:

- Picking up and disposing of trash and debris, including trash and debris not generated by construction activities. The Contractor is not responsible for picking up and disposing of dead animals;
- Keeping roadways clear of dust and soil, and cleaning up non-hazardous spills;
- Maintaining a safe and unobstructed passageway through or around the work zone for all traffic, including emergency pull-off areas at the edges of pavements;
- Maintaining surface drainage, including the removal of debris, ice, and snow from around inlets to ensure the drainage system is functioning as intended;
- Removal of ice and snow from bridge sidewalks and/or temporary walkways open to pedestrian traffic; and
- Maintaining access to devices associated with Intelligent Transportation Systems, including controllers and meter cabinets.

The Contractor is not responsible for the removal of ice and snow from roadways within sections of the project opened to traffic unless otherwise indicated.

Treat existing earth roads, or improved roads that have been graded, with calcium chloride or other approved dust control palliatives, as indicated or directed.

If the Contractor at any time fails to fully perform required maintenance, the Representative will provide immediate notification of the non-compliance and establish a date and time by which the maintenance work must be completed. If the Contractor fails to remediate the unsatisfactory maintenance condition within the established time frame, the Department will perform the required maintenance and deduct the cost of the work from money due or to become due the Contractor.

The Department reserves the right to enter upon a project and, at its own expense, perform routine maintenance of the existing roadway and/or structures. This maintenance will be during the life of the project, but will not include those items that are the Contractor's responsibility as specified herein, and in Section 105.13 for the contract work and Section 901.3(e) for the accommodation of local traffic. The Department does not assume responsibility in any way for the maintenance and protection of traffic as a consequence of performing this routine roadway and/or structure maintenance.

(c) Snow Removal and Anti-Skid Material. The Department reserves the right to enter upon a project and, at its own expense, remove snow and/or place anti-skid material, considered necessary for traffic protection. The Department does not assume responsibility in any way for maintenance of traffic as a consequence of removing snow or placing anti-skid material.

Remove the anti-skid material when necessary.

(d) Detours. For indicated detours, furnish, erect, maintain, and remove the detour signs, unless otherwise directed. Also, temporarily cover, revise, or remove existing permanent guide signs, in the vicinity of the construction site and along the detour route, if the messages on the guide signs conflict with the detour signs. Erect, maintain, and remove the detour signs and the modification of directional signs, as indicated, and as necessary for construction conditions. Restore original signs to their original state upon removal of the detour.

(e) Local Traffic Maintenance and Safety. Proceed with the work to ensure safety and the least inconvenience to local traffic. Maintain local traffic ingress and egress by use of existing or new roadways.

Provide and maintain local access to and from the nearest intersecting public road or street, unless otherwise directed. As directed, provide temporary approaches for local vehicular and pedestrian access to and from commuter service, residential, business, industrial, and other public and private facilities.

Also, provide and maintain adequate bridging over base and surface courses, trenches, or other construction, when directed.

(f) Equipment and Material Storage. According to Publication 213.

(g) Tubular Markers. When indicated, furnish and install tubular markers according to Standard Drawing TC-8604 and the MUTCD.

When directed, replace the complete tubular marker or the tubular marker post only, as the case may be.

Remove all tubular markers when no longer necessary for traffic control or as directed.

(h) Existing Department Signs. Remove existing warning, regulatory, guide, and directional signs as required to accommodate construction operations. Do not remove Stop or Yield signs unless an alternate type of traffic control is provided, such as flaggers, temporary traffic signals, etc. Continue the alternate traffic control until the Stop or Yield signs are replaced. Stake or mark sign locations or locate signs on construction drawings before removing any signs. Reinstall existing warning signs at appropriate locations within 4 hours of their removal. With the exception of Stop or Yield signs as herein noted, reinstall existing regulatory, guide and directional signs at appropriate locations within 24 hours of their removal.

Remove existing State Route and Segment markers that are likely to be damaged or disturbed as a result of construction operations. Provide survey ties for all such markers, before the removal, to facilitate replacement.

Replace all State Route and Segment markers that were removed, at their exact longitudinal locations, upon completion of the work.

(i) Not used

(j) Drop-offs. The following conditions and treatments apply only to continuous and intermittent drop-offs created by construction, maintenance, or permit/utility operations. If the treatments in this Section cannot be met due to constructability-related issues, obtain approval of an alternate drop-off treatment method, in writing, from the Bureau of Project Delivery before implementation.

1. **The following are not considered drop-offs:**

- Drainage ditches.
- Compacted earthen embankments tapered at 3:1 or flatter.
- Any area ≤ 2 inches below grade AND > 12 feet away from active travel lane.
- Any area behind guide rail, barrier, or curb.
- Any area outside right-of-way.
- Open areas where workers are present and while work is in active progress.

2. **General Conditions:**

- The duration of the drop-off condition starts at the end of the shift in which the drop-off condition was created.
- Place all channelizing devices at the same grade as the travel lane as close to the edge line as possible.
- As an option, an approved Type C steady burn light may be placed on each channelizing device throughout the drop-off condition unless otherwise specified in Condition 2.
- For intermittent drop-off conditions, place at least 3 channelizing devices or a Type III barricade transversely in front of each drop-off condition.
- When applicable, install Uneven Lane Signs (W8-11), Low Shoulder Signs (W8-9), or No Guide Rail Signs (W21-9A) at intervals not to exceed 1/2 mile throughout the drop-off condition.

Condition 1 – Drop-offs ≤ 2 inches below grade <u>AND</u> ≤ 12 feet away from active travel lane

Drop-off Location	Treatment
Between Active Travel Lane & Non-Active Travel Lane or Shoulder	• Place channelizing devices throughout drop-off condition. Space all channelizing devices at a maximum distance in feet, equal to two times the posted speed limit in miles per hour throughout a continuous or intermittent drop-off condition, unless otherwise directed.
Between Two Active Travel Lanes	• Install Longitudinal Notched Wedge Joint during paving operations in accordance with RC-28M and, during milling operations, mill a 3:1 wedge. For Temporary Overlay Transitions during paving and milling operations follow RC-28M except for the paving notch, and feather transition edge as much as mix will allow. **<u>OR</u>** End all lanes at the same grade longitudinally, install Temporary Overlay Transitions during paving and milling operations in accordance with RC-28M except for the paving notch, and feather transition edge as much as mix will allow.

Condition 2 – Drop-offs > 2 inches below grade

Distance From Active Travel Lane	Duration Condition Exists	Drop-off Height		
		> 2 inches to ≤ 4 inches	> 4 inches to ≤ 2 feet	> 2 feet

		Treatment		
≤ 4 feet Away	**≤ 48 Hours**	(A) OR (B)(D)	(A) OR (B)(E) OR (C)	(A) OR (C)
	> 48 Hours			
> 4 feet to ≤ 12 feet Away	**≤ 48 Hours**	(D)	(E)	(A) OR (B)(E)(F) OR (C)
	> 48 Hours	(A) OR (B)(D)	(A) OR (B)(E)	
> 12 feet	**≤ 48 Hours**	(D)	(E)	(E)(F)
	> 48 Hours			

Footnotes:

A. Place suitable material to grade and compact to non-movement.
B. Install a 3:1 slope with suitable material and compact to non-movement.
C. Install temporary barrier.
D. Place channelizing devices starting at 120 feet in advance of the drop-off condition. Space all channelizing devices at a maximum distance in feet, equal to two times the posted speed limit in miles per hour throughout a continuous or intermittent drop-off condition, unless otherwise directed.
E. Place channelizing devices starting at 120 feet in advance of the drop-off condition. Space all channelizing devices at a maximum distance in feet, equal to the posted speed limit in miles per hour throughout a continuous or intermittent drop-off condition, unless otherwise directed.
F. Place an approved Type C steady burn light on each channelizing device throughout drop-off condition.

(k) Work Area Pavement Markings. Unless otherwise indicated in the TCP, furnish all material and install reflectorized pavement markings in work areas for all base course, flexible pavement, and rigid pavement construction operations as follows:

- **All Operations Except Seal Coat/Surface Treatment (Oil & Chip), Skin Patching, Slurry Seal, Heat Scarification, and Microresurfacing Operations.** Before terminating work each day, replace all lane lines and centerlines covered or destroyed during the day's operations with applicable pavement marking pattern, shown in Standard Drawing TC-8600 and the MUTCD.

- **Seal Coat/Surface Treatment (Oil & Chip) and Skin Patching Operations.** If lane lines or centerlines are covered or destroyed during the day's operations, install "No Pavement Markings" signs (W21-16) throughout the affected area, at the beginning and at intervals not exceeding 1/2 mile, before terminating work each day. In not less than 7 days or more than 14 days after completion of the operation, remove signs and replace all lane lines and centerlines covered or destroyed during the operation with the applicable pavement marking pattern shown in Standard Drawing TC-8600 and the MUTCD.

- **Slurry Seal, Heat Scarification, and Microresurfacing Operations.** If lane lines or centerlines are covered or destroyed during the day's operations, install "No Pavement Markings" signs (W21-16) throughout the affected area, at the beginning and at intervals not exceeding 1/2 mile, before terminating work each day. In not less than 3 days or more than 7 days after completion of the operation, remove signs and replace all lane lines and centerlines covered or destroyed during the operation with applicable pavement marking pattern shown in Standard Drawing TC-8600 and the MUTCD.

For seal coat/surface treatment, skin patching, slurry seal, heat scarification, and microresurfacing operations, the Representative may waive the curing period specified in the above bulleted item for the asphalt paving material due

to traffic conditions or special circumstances. In these cases, install the applicable standard pavement marking pattern before terminating work each day and eliminate the requirement for installation of "No Pavement Markings" signs.

Apply work area pavement markings as specified in Section 962. For temporary pavement markings placed at the Department's direction and under conditions not meeting Section 962.3 (e), the requirements listed in Section 962.3 (i), (j), and (k) will be waived. Temporary pavement markings installed under this condition will be paid by the Department.

Pavement markings to consist of 4-inch wide lines; except, lane lines for all multilane roadways are to be 6 inches wide. As an alternate to paint and glass beads, provide standard pavement markings consisting of temporary pavement marking tape or use nonplowable raised pavement markers, when directed, except for final markings. Use traffic line paint and glass beads for pavement markings meeting requirements in Publication 212, Publication 213, and the MUTCD, or temporary pavement marking tape from a manufacturer listed in Bulletin 15.

Place standard pavement markings in the same location as covered or destroyed pavement markings, unless otherwise indicated in the TCP or directed.

Remove any pavement markings improperly placed and install in the correct location at no additional cost to the Department.

If the roadway is to be closed to traffic until completion of the project, and standard pavement markings will be in place when the roadway is opened to traffic, then work area pavement markings, as specified above, are not required.

(l) Not used

(m) Lateral Lane Restrictions. Provide, at the preconstruction conference, a written notification of construction activities that will create a physical lateral restriction to roadway width due to temporary barriers, barricades, drums, etc. Include a written schedule indicating the proposed times and widths of restrictions for the various phases of construction.

All restrictions are subject to Department approval.

Notify the Representative, in writing, at least 14 days before implementing or changing any lateral lane restriction, which provides less than 16 feet of pavement and shoulder in each direction for oversize vehicles. Notify the Representative, in writing, at least 7 days before removing the restriction.

(n) Temporary Highway Lighting. Provide temporary highway lighting as indicated on the TCP. Comply with local government, electric utility, and state codes or requirements; the electrical regulations of the Department of Labor and Industry; and applicable construction requirements of the NEC, NESC, and NBFU. Cooperate with electric utility company or agency furnishing power to the system and meet necessary service requirements.

Do not locate lighting fixtures to produce distracting or blinding glare for the driver.

Perform the Highway Illumination Test (Conv.) and record test data on Department Test Form CS-4225D. Correct any defects. Perform the test in the presence of an authorized representative of the Department.

Provide guide rail, crash cushions, or other devices, as indicated or directed, to protect vehicles from hitting poles or other temporary highway lighting appurtenances.

(o) Not used

(p) Surveillance and Review of Traffic Control. Designate personnel to be responsible for and to be on-call continuously over traffic control operations. This designee shall always be available to respond to calls involving damage to temporary traffic control devices from causes such as vandalism, traffic accident, or weather. Provide to the Representative during the preconstruction conference the name and phone number of the designee providing the surveillance.

The Representative and the Contractor's designee shall conduct periodic reviews of the traffic control devices throughout the duration of the project to ensure continuous compliance with the approved TCP. Conduct reviews during the day and night, adverse weather conditions, and active and inactive construction operations, as directed .

(q) Temporary Barrier. Blunt ends of temporary barrier or glare screen will not be allowed. Protect blunt ends by burying them in a cut slope or using an appropriate end treatment according to the pertinent parts of the following: Design Manual, Part 2, Section 696, and the Standard Drawings.

Provide, install, and maintain top-mounted and side-mounted delineators on temporary barriers, glare screen and bridge barrier as indicated on the TCP.

Clean or replace all delineators once per month or as directed. Clean in an approved method.

(r) Removal of Conflicting Traffic Lines and Markings. Remove conflicting pavement markings during any phase of construction and relocate as indicated. Remove as specified in Section 963.3. Do not remove traffic lines and markings without a paint truck present on the project site if repainting is required.

(s) Lifting of Construction Materials. Stop traffic during the placement or removal of any construction materials that are above open lanes of traffic, such as, but not limited to, lifting equipment, bridge components, signs, and overhead sign structure components as directed.

(t) Non-Compliance of Maintenance and Protection of Traffic. Work zone liquidated damages will be assessed in the event the Contractor neglects or refuses to correct a situation or condition of non-compliance with Maintenance and Protection of Traffic requirements (TCP, Publication 212, Publication 213, and the MUTCD, or other contract traffic control requirements).

When deficiencies are found, a copy of the Work Zone Traffic Control Compliance Checklist and Notification Form, CS-901, will be delivered to the Contractor to correct the deficiencies as soon as possible. After receiving this notification the Contractor may be assessed work zone liquidated damages if deficiencies are not corrected within the maximum time frames established below.

- Traffic control devices for short term operations – 2 hours
- Traffic control devices for long term operations – 24 hours, except for the following:
  Urgent
  - Three or more consecutive channelizing devices – 2 hours
  - Stop and Yield sign – 2 hours
  - Arrow panels – 2 hours
  - Attenuating devices – respond within 4 hours and complete repairs within 24 hours after notified the device is damaged

The base amount of work zone liquidated damages will be $1,000.00.

For long-term operations (as defined in Publication 213), an additional $100.00 assessment for each hour or portion thereof will be added to the $1000 base amount until the deficiency is corrected.

For short-term operations (as defined by Publication 213), an additional $100.00 for each hour or portion thereof will be added to the $1000 base amount until the deficiency is corrected.

Assessment of work zone liquidated damages will end when the Representative concurs that the deficiencies have been corrected.

If the Contractor remains in violation of the Maintenance and Protection of Traffic requirements, the District Executive will direct Department forces to correct the deficiencies and charge the Contractor for labor, equipment, and material costs incurred by the Department or suspend work in accordance with Section 105.01(b) until the deficiencies are corrected.

(u) Temporary Nonplowable Raised Pavement Markers. Furnish, install, and maintain yellow or white, one- or two-direction temporary nonplowable raised pavement markers according to the locations, spacings, and configurations indicated or directed.

Install the markers in compliance with the manufacturer's recommendations. Markers may be attached by epoxy when the marker does not have to be removed at a later date.

Maintain the nonplowable markers in place for the period indicated or directed, and remove them immediately thereafter. After removal, restore the pavement surface.

(v) Not used

(w) Portable Changeable Message Sign (PCMS). Furnish, operate, and maintain three-line or full matrix portable, trailer mounted, changeable message signs for traffic control as indicated or directed. Have all locations, messages, and times of operation approved by the District Traffic Engineer or authorized Representative according to PennDOT Publication 213 General Notes Section E.

For the duration of the project, provide a qualified technician familiar with the programming and operation of the changeable message sign. Designate the technician to be on call 24 hours a day, 7 days a week and to arrive on the project site within 3 hours of notification. Refer to Section 1231 for additional PCMS specifications.

(x) Temporary Traffic Signals. Furnish, install, maintain, and remove all items required to provide temporary signalization in accordance with the approved plans, specifications, and Section 1124.

(y) Flagger Training. Provide flaggers that successfully completed a flagger-training course within the last 3 years that complies with the Department's minimum flagger training guidelines described below. Assure that flaggers carry a valid wallet-sized training card containing the name of the flagger, training source, date of successful completion of training, and signature; or provide a roster of trained flaggers to the Representative before the start of flagging operations that contains the names of flaggers, training source, and date of successful completion of training. Minimum flagger training guidelines include the following:

1. Minimum Course Contents.

- Why flagging is important
- Fundamental principles of work zone traffic control

  - Component parts of the work zone
  - Channelization devices, spacing
  - Tapers
  - Buffer Space
  - Visibility to approaching drivers

- Human factors – driver attitude, expectation, reaction
- Qualifications of a flagger
- Clothing
- Flagger Operations

  - Setting up the flagger station
  - Signaling devices and when used
  - Hand signaling procedure
  - Communications
  - Two-flagger operations
  - Single flagger operations
  - Flagging in intersections
  - Nighttime flagging
  - Emergency situations

- Flagging in adverse weather conditions
- Sign requirements
- Practical exercise

2. Objectives. At the end of the course the student should be able to:

- Describe why flagging is important
- Describe flagger qualifications
- Ensure the flagger station complies with Publication 212, Publication 213, and the MUTCD
- Gather all necessary equipment
- Select the proper flagging station/position/location
- Control traffic using the stop/slow paddle
- Control traffic using the red flag
- Control two-way traffic in one lane of a highway
- Control traffic at an intersection
- Recognize and be able to control traffic in unique or special flagging situations
- Control traffic at night and recognize a safe nighttime flagging operation
- Communicate with co-workers and the public

3. Test. All students must take and pass a written, closed book, knowledge test consisting of a minimum of 20 questions. Passing is 70%.

4. Re-training. Re-training is required every 3 years.

(z) Shadow Vehicle. Load the truck according to the manufacturers recommendation.
Place the shadow vehicle upstream of the construction area at the distance specified in Publication 213 and the MUTCD, as directed.

(aa) Speed Display Signs. Furnish, place, maintain, and relocate a speed display sign that is a portable, trailer mounted, solar powered radar speed monitor unit. Use an approved system listed in Bulletin 15 for speed display signs.
Have all locations and times of operation approved by the District Traffic Engineer or authorized Representative. Trim trees and vegetation, and remove all obstructions at each placement site.
On interstate highway work zones with a project cost exceeding $300,000, use a speed display sign on each approach to the work zone.

(bb) Existing Traffic Signal Adjustments. In the event it becomes necessary to turn off any existing signalization, provide flaggers, or other approved means, to direct traffic within the intersection during any period when the signals are not operating.
Obtain the approval of the Representative, the municipality, and District Traffic Engineer for any changes to the existing signalization, including timing, phasing, and operation adjustments. Obtain approval for planned changes at least 7 days before implementation, unless directed otherwise.

(cc) Conflicting Overhead Signs. Furnish a Type VI orange retroreflective vinyl roll-up sheeting material to cover the entire sign. When the size of the sign requires multiple sheets of material to be sewn together, provide a 2 inch overlap with double stitching of heavy duty 5-Cord nylon thread. Provide retroreflective symbols, shields, and other legends as indicated. Provide approved, black nonreflective vinyl letter characters. Provide an additional 3 inch minimum of sheeting material to be folded around edge of the sign. Place aluminum grommets spaced a maximum of 48 inches on center around perimeter of the sheeting with one grommet no further than 2 inches from each corner.
Field verify the size of the sign to be fitted prior to fabrication. Adjust the dimensions as necessary. Secure sign in place as recommended by the manufacturer. Cover and uncover the signs as directed. Repair at no cost to the Department retroreflective sheeting damage on the existing sign, as a result of covering.

901.4 MEASUREMENT AND PAYMENT—

(a) Maintenance and Protection of Traffic During Construction. Lump Sum
The Department will measure and pay for this item in a proportionate manner based on current estimates.
With the exception of the separate pay items specified in Section 901.4(b), if an item or device is required for maintenance and protection of traffic, the cost of the item or device is incidental to Item 0901-0001.

(b) Separate Pay Items. The Department will separately measure and pay for the following items or devices, when indicated or required for maintenance and protection of traffic during construction:

- Arrow Panel—Each or Day
  Includes maintenance, fuel, and other operating costs for the payment indicated.
  If required by a figure in Publication 213 this work is incidental to Item 0901-0001

- Tubular Markers—Each

- Changeable Message Sign—Each
  Includes maintenance, fuel, telecommunication service and other operating costs, relocating to other locations, and programming of messages as directed by the District Traffic Engineer or authorized Representative.

- Temporary Traffic Control Signal—Each
- Temporary Traffic Control Signal, Reset—Each
- Floodlights—Each or Day
- Temporary Barrier—Section 627.4
- Temporary Concrete Barrier, Structure Mounted—Section 643.4
- Temporary Concrete Median Barrier, Structure Mounted—Section 643.4
- Temporary Concrete Glare Screen Median Barrier, Structure Mounted—Section 643.4
- Reset Temporary Barrier—Section 628.4
- Temporary Concrete Barrier, Structure Mounted, Reset─Section 644.4
- Temporary Concrete Median Barrier, Structure Mounted, Reset─Section 644.4
- Temporary Concrete Glare Screen Median Barrier, Structure Mounted, Reset─Section 644.4
- Painting Traffic Lines and Markings—Section 962.4
- Pavement Marking Removal—Section 963.4
- Temporary Nonplowable Raised Pavement Markers—Each
- Temporary Asphalt Rumble Strips—Square Yard
- Temporary Impact Attenuating Devices—Section 696.4
- Reset Temporary Impact Attenuating Devices—Section 697.4
- Standard Pavement Markings, Paint & Beads—Linear Foot
- Standard Pavement Markings, Tape—Linear Foot
- Additional Warning Lights—Day
  For the type indicated.
  Based on an accumulation of 24 hours when in place for one unit.
- Additional Traffic Control Signs—Square Foot
  Based on the minimum size sign for the necessary application as defined in Publication 212, Publication 213, and the MUTCD, unless otherwise directed.
- Temporary Highway Lighting—Lump Sum or Each
  As indicated.
- Shadow Vehicle—Each or Day
  Includes maintenance, fuel, relocations, and operating costs for the duration of the project.
  If required by a figure in Publication 213 this work is incidental to Item 0901-0001
- Speed Display Signs—Each or Day
  Includes maintenance, fuel and other operating costs, relocations, and programming.

- Roll-Up Vinyl Sign—Square Foot
  Based on the square foot of existing sign.
  Includes, mounting hardware and 3inches of material around perimeter of vinyl sign cover.

SECTION 902—MAINTENANCE AND PROTECTION DURING TEMPORARY SUSPENSION OF WORK

902.1 DESCRIPTION—This work is maintenance and protection of traffic on the project and the maintenance and protection of the project during a temporary work suspension.

902.2 MATERIAL—Section 901.2

902.3 CONSTRUCTION—Maintain and protect the project during suspension, as specified in Section 105.13(b), as directed, and as follows:

- Shape and maintain the existing roadway if existing roadway pavements are broken up and removed in advance of a reasonable paving schedule.
- Surface roadways, as directed, with acceptable commercial material or with acceptable local material secured beyond the project limits. If necessary, remove this material when project operation resumes.
- Apply a calcium chloride dust control solution or other approved dust control palliative in the manner and at the rate of application directed. If necessary, remove this material when project operations resume.
- Remove all protective signs and devices previously installed on the project.

If necessary, remove material placed by Department forces when operations resume.

Maintain and protect traffic during suspension, as specified in Section 901. The Department reserves the right to maintain traffic through the entire project or portions of the project and to perform necessary maintenance of traffic work. This Department work will be performed if agreement, as specified below, cannot be made upon a price, or if the Department work performed is in the interest of the State.

902.4 MEASUREMENT AND PAYMENT—

(a) Lump Sum Basis. Section 901.4

If this item is extra work, then the Department will pay for this item at a negotiated price as specified in Section 110.03(c).

(b) Acceptable Commercial and/or Local Material. Cubic Yard or Ton

If this material is extra work, then the Department will make payment as specified in Section 110.03(c).

(c) Calcium Chloride or Other Dust-Control Palliatives. Gallon or Ton

If these materials are extra work, then the Department will make payment as specified in Section 110.03(c).

(d) Removal of Material Placed by Department Forces. Cubic Yard

The Department will pay for this work as Class 1 Excavation.

SECTION 903—TEMPORARY BRIDGE AND APPROACHES

903.1 DESCRIPTION—This work is the design, furnishing, placement, maintenance, and removal of a temporary bridge and approaches of the type and method indicated, including required maintenance and protection of traffic.

903.2 MATERIAL—As indicated or as shown on the accepted detailed drawings.

903.3 CONSTRUCTION—

(a) Two-Lane Construction. If not otherwise indicated, design a temporary bridge and approaches to accommodate two lanes of traffic on a Department right of way or easement. Submit detailed drawings of the proposed bridge and approaches for the Representative's review and acceptance. Design the proposed temporary bridge for PHL-93 at the operating level, with a roadway width as indicated between curbs, guide rails, and with sidewalks, when directed. Conform to the alignment and grades indicated. If not indicated, submit a plan of a proposed alignment and grade.

Upon acceptance of the detailed drawings, construct the temporary bridge and grade, drain, and pave the approaches. Provide sidewalks and sidewalk protection when indicated.

If indicated, move the existing structure and use it as the temporary bridge. The method of moving, placing, and maintaining the structure will be subject to the Representative's review and acceptance.

When the temporary bridge and approaches are no longer needed, remove and dispose of them as directed. Grade and restore the entire disturbed area, as specified in Section 105.14.

(b) One-Lane Construction. Construct, as specified in Section 903.3(a), except:

Construct a one-lane temporary bridge having a roadway width between curbs of not less than 12 feet. Grade the one-lane approaches for a total width of not less than 18 feet and surface for a width of not less than 12 feet.

(c) Maintenance and Protection of Traffic. As specified in Section 901, maintain and protect traffic in the temporary area.

903.4 MEASUREMENT AND PAYMENT—

(a) Method 1. Lump Sum

(b) Method 2. Separate items, as follows:

- **Temporary Bridge and Approaches (Two-Lane or One-Lane).** Lump Sum
- **Maintenance and Protection of Traffic on Temporary Bridge and Approaches.** Lump Sum
- **Removal of Temporary Bridge and Approaches.** Lump Sum

SECTION 910—HIGHWAY LIGHTING

910.1 DESCRIPTION—This work is the furnishing, installation, erection, and wiring of the complete highway lighting system, including the electrical power supply and distribution system.

910.2 MATERIAL—

(a) Highway Lighting Material. Section 1101. Submit for approval, before purchase and at no cost to the Department, catalog cuts, certifications, photometric calculations, drawings, and manufacturer's specifications for all lighting material including lighting poles, luminaires, junction boxes, conduits, cables, and power supply components proposed for the project. Refer to the Project Office Manual for material information requirements.

(b) Other Material.

- Fine Aggregate, Type A or B—Section 703.1
- Coarse Aggregate, Type A or C—Section 703.2
- Class A Cement Concrete—Section 704
- Expansion Joint Filler—Section 705.1
- Reinforcement Bars—Section 709.1
- Nonshrink Epoxy Grout—Section 1080.2(g)
- Nonshrink Mortar—Section 1001.2(e)
- Caulking Compound—Section 705.8
- Precast Concrete Products—Section 714

(c) Certification and Warranties. Secure warranties or guarantees from the manufacturers for electrical and mechanical equipment. Submit these warranties or guarantees to the Department at project completion.

Submit material certification, as specified in Section 106.03(b)3.

For poles, submit a signed warranty from the manufacturer stating that specifications have been met.

910.3 CONSTRUCTION—As shown on the Standard Drawings, as indicated, and as follows:

(a) General. Comply with local government, electric utility company, and State codes or requirements; the electrical regulations of the Department of Labor and Industry; and the construction requirements of the NEC and NESC. Cooperate with the electric utility company or agency furnishing power to the system and meet the necessary service requirements. Acquire permits as specified in Section 107.02. Furnish certificates of approval from appropriate agencies when required. Upon work completion, submit to the Department five copies of "as-built" drawings, as directed, showing the date, any changes from the indicated system made during construction, and any revised circuit diagrams. Upon receipt, "as-built" drawing copies will be supplied to the agency maintaining the system. The acceptance of drawings will not relieve Contractor responsibility for erroneous or inconsistent dimensions, notations, or omissions or for the proper installation and operation of the electrical systems.

(b) Excavation for Pole Foundations. Before placing forms, each foundation excavation will be inspected for the actual soil conditions encountered. Do not proceed with work until the foundation excavation is accepted. The foundation design may need to be revised based on the actual conditions encountered as determined by the Representative.

Obtain approval of the completed foundation forms before concrete placement. Remove water from the foundation holes before concrete placement.

(c) Trench Excavation and Backfill. Remove and store topsoil encountered in the excavation. Excavate trenches for conduit runs parallel to the roadway, or as indicated. The preferred location is off of the shoulder. Provide a minimum 18 inch clearance from all underground utilities. Backfill the same day if possible. Remove rock within the excavation unless an alternate layout is authorized. Remove and dispose unsuitable material and excess excavation as directed.

Place plastic marking tape within the last layer of backfill material for the entire length of the trench.

Provide bedding soil for conduits as specified in Section 206.2(a)1.a. Backfill the remaining portion of the trenches with suitable on-site material to match existing conditions as shown on the Standard Drawings. Do not use coarse aggregate, except within the subbase area or as directed. Compact trench material as specified in Section 601.3(f).

Stake trench alignments for inspection and acceptance before excavating when they deviate from the indicated location. Submit the layout for review and acceptance before proceeding if the alignments extend the overall indicated circuit length by more than 5%.

(d) Pole Foundations. Construct of Class A cement concrete, as specified in the applicable parts of Section 1001.3.

Before erection of high mast poles, mix, cure, and test samples of the foundation concrete according to Department procedures. Verify the ground elevation at the foundation location for all high mast pole foundations.

Provide and place anchor bolts perpendicular to the top plane of the foundation. Use suitable templates or forms to hold the anchor bolts in position while placing concrete.

Clean the exposed portion of anchor bolts and associated hardware.

Install the necessary number of conduit sweep elbows and orient them inside the foundation to avoid unnecessary bends in the conduit runs. Fasten elbows securely to prevent movement while concrete is being placed.

For high mast pole foundations, install a 1 inch conduit for the grounding electrode conductor. For all other types of poles, install ground rod in pole foundation. Connect No. 4 AWG copper grounding electrode conductor to the ground rod with an exothermic weld or bronze connector, extend the other end through the center of the foundation, and leave 30 inches coiled above the foundation. Test the resistance to earth ground before placing concrete. Install additional ground rods (a minimum of 6 feet apart) if the measured resistance between the ground rod and earth is greater than 25 ohms.

(e) Lighting Poles and Accessories. Install poles plumb. For other than high-mast, use aluminum shims with aluminum bases; and use stainless steel shims with other bases. Place shims under no more than three bolts of any base. Do not use shims on bridges, use leveling nuts. Orient the handhole in the direction of traffic, unless otherwise indicated.

Plumb high-mast poles, using the leveling nuts supplied with the anchor bolts.

Unless otherwise indicated, install bracket arms at right angles to the pavement edge with arms securely fastened to the pole shafts. Install luminaires according to the manufacturer's instructions or as indicated.

Fasten an identification plate and a Lighting Management System (LMS) key plate with stainless steel rivets to the roadway side of the pole 8 feet above the foundation or as directed.

Select one or more poles for the static load test, as specified in Section 1101.02 before erecting the remainder of the poles.

Use similar pole types and similar materials within the same general area.

Field-assemble two-piece pole shafts by overlapping bolted sections.

Do not field weld poles or accessories.

(f) Supervision (High-Mast Installations). Ensure that a manufacturer's representative is on site to assist in supervising the field assembly and erection of high-mast poles and to instruct Department personnel in the proper procedures for raising and lowering the luminaire ring and in the recommended maintenance care of the poles.

Check the pole section mating and alignment before the erection of the pole.

Request the electric utility company to be present during erection of poles within 200 feet of their aerial electric lines.

(g) Conduits. Support conduits firmly and rigidly in place in a manner to prevent dislodging, while placing concrete or while performing other operations. If possible, install conduits under roadways before placing the pavement. If this is not possible, install a 3-inch diameter rigid steel conduit for a sleeve. Jack, auger, or bore under pavements, shoulders, sidewalks, railway tracks, and other indicated areas. Do not water bore. Extend this sleeve

under the roadway approximately 24 inches beyond the outside paved edge. Place the lighting conduit through this sleeve.

Grind the cut ends of metallic conduit to remove rough edges. Do not use defective conduit. Thread steel conduit for couplings and fittings. Coat the threads as specified in Section 910.3(r).

Weld plastic conduit joints with solvent, according to the conduit manufacturer's recommendations.

Make conduit bends and offsets, either in the shop or in the field. Do not damage the protective coating when making bends and offsets. Do not reduce the interior diameter of the bend. Form the bend on a radius at least twelve times the conduit diameter, but not less than 18 inches. Use manufactured sweep bends whenever possible.

Seal the ends of partially installed conduit runs if conduit work is temporarily suspended. If it is necessary to open the ends for cleaning or testing, reseal them upon completion. Seal the conduits in control cabinets.

Install conduit expansion and deflection joint fittings at each structure expansion joint as shown on Bridge Standard Drawings.

Ground steel conduit and provide electrical continuity on structures, as specified in Section 910.3(q), as soon as possible after installation, and before energizing the system. Connect fittings, junction boxes, and other appurtenances to the conduit on a structure so electrical continuity is maintained. Provide conduit expansion joints with an external bonding jumper. Size the bonding jumper to match the equipment grounding conductor installed in the conduit.

Coat underground steel galvanized conduit with asphalt paint or other approved coating if placed in a corrosive area. Use hot-dipped galvanized coating for other areas.

Clean conduit runs after installation by pulling a stiff wire brush, the size of the conduit, through the conduit. Then test the conduit by pulling a ball mandrel that has a diameter of at least 85% of the inside diameter of the conduit, through each conduit run. Where the mandrel fails to pass, either clean the conduit without injury to the conduit walls or replace the conduit.

Fasten conduits to electrical equipment using code-approved devices. Use watertight conduit fittings to connect to watertight enclosures.

Attach conduit to wood poles with 1/8-inch thick hot-dipped galvanized steel straps and galvanized lag screws. Provide 5 feet maximum spacing between straps.

Do not install pull wires in the conduit, unless indicated.

Provide a 2-inch minimum direct burial conduit for underground circuits.

(h) Cable Installation. Do not damage the cable insulation. Manually remove the cable from the drum or reel. Notify the Representative when cable is to be placed. Do not proceed without the Representative being present.

Use cable grips to install the cable in the conduit. Simultaneously pull cables within a single conduit, but do not damage the cable by overpulling. Use a dynamometer if pulling other than by hand. Use pulling lubricant of a type recommended by the cable manufacturer if necessary. Use extreme care when pulling cable through handholes in pole shafts. Place a pad of firm rubber or other similar material around the bottom edges of the opening to protect the cables.

Clearly locate underground conduits with aboveground markers if guide rail or other surface features are to be constructed in the immediate area.

Provide enough slack cable in junction boxes and light pole bases to allow exterior splicing. Neatly arrange the spliced cables or coil in junction box or pole base.

Prevent the entry of moisture into the cable at all times during installation. Seal the ends of cable until final splices are made.

Make splices above grade in pole base or transformer base with pre-molded disconnectable connector kits rated for 600 V. Provide splices with a minimum watertight or splash proof seal using weatherproof boots and tape as required by the manufacturer; and when placed in junction boxes or other potentially wet areas, provide splices that are waterproof and submersible. For in-ground junction boxes use non-fusible splices, unless indicated otherwise. Use only breakaway type connectors for connections where breakaway bases are used. Line splice only at pole bases or junction boxes. Do not splice cables inside conduits.

Use seven-strand No. 10 AWG insulated wire for the line taps from the feeder cable to the ballast or luminaire terminal block for the phase and neutral wires. Provide taps to the feeder cables as specified for line splicing. Do not use wire nuts for cable taps. Provide adequate size connectors for the wire sizes involved. Provide individual fusing for all conventional lighting. Fuse the tap with a 6A to 10A fuse, midget size, 250 V rating. Fuse the phase wire only. Connect the insulated equipment grounding conductor routed with the circuit conductors to the grounding electrode conductor (from the pole foundation ground rod) with a split bolt connector and then connect to ground lug welded to the pole base. Coat all grounding connections with an approved corrosion inhibitor. Attach the cable to the J hook at the pole top with a cable grip that supports the weight of the cable.

Furnish and install circuit-identifying tags on control and distribution circuit cables where they connect to

equipment located in service cabinets and vaults and on cables in junction boxes and pole shafts. Use fiber or other acceptable nonconducting tags, not less than 3/4 inch in diameter, and not less than 1/32 inch thick. Legibly stamp identification markings on the tags using small tool dies or permanent, waterproof marker. Securely tie each tag to the proper conductor, using plastic or nylon cord.

Use underground cable in direct burial conduit for all underground installations. The minimum underground wire size is No. 8 AWG copper cable.

(i) Cable Duct. Use only if indicated. Install similar to conduits as specified in Section 910.3(g), and according to the manufacturer's instructions.

(j) Luminaires. Check the luminaires for the proper lamp socket position, according to the lamp distribution indicated, before placing on the pole top or arms. Uniformly adjust and level luminaires. Install photocontrol or shorting cap according to the manufacturer’s instructions or as indicated.

Immediately before the illumination test, and after all dust-generating work has been completed, clean the light control surfaces according to the luminaire manufacturer's recommendations using a cleaner recommended by the manufacturer.

Provide luminaires with a weather resistant decal conforming to ANSI C136.15-2011 that shows the lamp wattage. Provide a decal that is visible from the ground.

(k) Service Pole Installation. Position the service pole inside the right of way, and where indicated. When required, mount a meter base on the pole according to the utility company's requirements. Coordinate the meter installation with the utility company.

Install poles, according to the current specifications and standards of NELA, EEI, and NESC. The minimum depth of holes for setting wood poles 30 feet to 40 feet in length is 6 feet measured from the low side on sloping ground. Dig holes with vertical sides and with a diameter large enough to permit use of a mechanical tamper around the pole. Ensure that each pole is inspected and accepted before backfilling. Deposit acceptable backfilling material around the poles and mechanically tamp in layers of not over 4 inches. Place backfill material around the pole to drain water away.

Guy service poles, if necessary. Install cone anchors 7 feet below ground level. After placing the anchor, backfill the hole with coarse aggregate for a depth of 24 inches above the anchor, then tamp during backfilling. Backfill the remaining hole with the excavated material, then thoroughly tamp. Obtain approval for the guys before the conductors are strung. Install a guy guard if the guy is adjacent to the roadway.

Install and tighten anchor bolts as specified in Section 948.

(m) Photoelectric Control Device. Use a plug-in device, for ease of replacement. Install the device with its detector area facing north.

(n) Enclosure Installation. Mount enclosures for housing the control equipment. Provide a separate service disconnect ahead of the control cabinet that is labeled ‘suitable for use as service equipment’. The disconnect can be provided integral to the control cabinet if the cabinet is dead front and labeled as ‘suitable for use as service equipment’. Padlock the enclosures. Key as directed. Provide enclosure ID tags as specified for pole ID tags. Provide the power supply number, the system voltage, and the LMS key number on the tags.

(p) Junction Boxes. Obtain acceptance of any change in box location before installation.

Excavate, then construct or install the box. Backfill around the box and dispose of excess or unsuitable material. Ground the junction box as required.

If using precast junction boxes with knockouts, remove the knockouts, then tightly grout the conduit or conduit sleeves in place with nonshrink mortar.

Ground exposed metal parts of junction boxes with a minimum No. 4 AWG grounding electrode conductor and a minimum 1/2-inch by 8-foot ground rod. Connect the grounding electrode conductor to the ground rod with either an exothermic weld or with a bronze connector clamp. Connection to an adjacent system ground rod is allowable.

(q) Grounding.

1. General. Install individual ground rods. Install additional ground rods a minimum of 6 feet apart as required if the measured resistance to earth is greater than 25 ohms. At the service entrance, install the first rod electrode (ground rod) inside a cast-in-place or precast junction box with lid and attach the ground rod to the grounding electrode

conductor with an exothermic weld or a bronze connector. Coat the connection(s) with approved corrosion inhibitor. Provide an equipment grounding conductor with all circuits. Do not connect the neutral to ground except at the service location. Provide an insulated equipment grounding conductor with the same insulation and size as specified for the circuit conductors.

2. Grounding on Structures. Ground lighting poles, underpass luminaires, and metal junction boxes on structures by the following methods:

- By connecting to the embedded or surface structure mounted steel conduit.
- By use of a continuous insulated equipment grounding conductor routed with the circuit conductors inside the conduit and connected to ground lugs installed inside the junction boxes.

If using embedded or surface structure mounted non-metallic conduit, use a continuous insulated equipment grounding conductor routed with the circuit conductors in the non-metallic conduit as the sole equipment grounding conductor for those portions of the circuit.

Provide one ground rod for structures up to 500 feet in length. Provide one ground rod at each end of structures over 500 feet in length. Provide a No. 4 AWG uninsulated copper grounding electrode conductor from the ground rod to the nearest structure-mounted junction box and attach to the ground lug inside the box. Attach the ground rod to the grounding electrode conductor with an exothermic weld or a bronze connector. Provide a separate insulated continuous equipment grounding conductor of the same size and material as routed with the circuit conductors for structures using either steel or non-metallic conduit.

(r) Galvanize Repair. Repair field damage to any galvanized finishes in accordance with ASTM A780.

(s) Power Supplies. Make arrangements with the local electric utility company for electrical service for the lighting system.

Furnish and install the specified number of wooden poles for the power supplies with the necessary auxiliary equipment (crossarms, brackets, meter base, transformers, cutouts, lightning arresters, conduit, insulators, switches, fuses, circuit breakers, lighting contactors, photoelectric controls, enclosures, weatherheads, service wire, guywire, and grounding) to provide complete electrical service for the entire lighting system.

(t) Buried Cable and Conduit Markers. Set the markers flush with the ground and directly over the trench. Place the marker directly under the guide rail when trench and guide rail cross.

(u) Tests. Perform the following tests as applicable and record the test data on the test forms. Use meters that bear a certification of calibration with the past year from a recognized testing laboratory. Provide the electrical energy and furnish personnel and equipment to complete the tests. Correct any defects disclosed by the tests and then retest the corrections. Perform the tests in the presence of an authorized representative of the Department.

Form	Title
CS-4225A	Ground Rod Test
CS-4225B	Conductor Insulation Resistance Test
CS-4225C	Circuit Performance Test
CS-4225D	Highway Illumination Test (Conventional)
CS-4225E	Sign Illumination Test
CS-4225F	High Mast Lighting Test
CS-4225G	Static Load Test (Conventional)

Satisfactorily demonstrate that circuits are continuous and free from short circuits and from unspecified grounds. Provide a resistance to earth-ground, for each ground rod location, of not more than 25 ohms. Supply and install additional ground rods, connected by a common grounding electrode conductor and installed a minimum of 6 feet apart, until this requirement is met or as directed.

The resistance to ground of conductors for underground cable is to be as shown in Table A at 60F, when measured with a 1000 V megger:

TABLE A
Insulation Resistance (Megohms- minimum, based on 1,000 feet)
Wire Size (AWG)

Cable Type	10-6	4-1	1/0-2/0
Cross-Linked Polyethylene RHW, RHH, USE	2,000	1,500	1,300
Cross-Linked Polyethylene XHHW	1,600	1,100	900
Rubber-Neoprene RHW	500	350	300
PVC THW	140	120	100

Take voltage readings, with load and without load, at the power supply side of the control cabinet main breaker. The readings with load must be within ±5% of nominal voltage (typically either 120 V or 240 V). Take voltage readings at the last light of each circuit. A voltage reading is acceptable if it is within 5% of the reading with load at the supply point.

Take current (ampere) readings with a full lighting load on the load side of each distribution breaker in the control cabinet. A current reading is acceptable if it does not exceed 75% of the breaker rating.

Energize and operate the lighting system, including automatic control(s), for 168 consecutive hours. At each control cabinet, supply a service voltage graphic record covering the test period, with the installed electrical equipment in normal operation (lights on at night and off in daytime).

After the lights have been energized for at least 100 hours burning time, and after dark, take horizontal footcandle readings at road level with the light meter leveled. Use a light meter conforming to the following:

- Lowest full scale not exceeding 2.0 footcandles or equivalent sensitivity.
- Cosine correction, filtered or adjusted to match the CIE response curve and calibrated for the light source.
- Accuracy: ±3% reading ±0.5% full-scale (< 929 footcandles)
- Resolution: 0.001 footcandles
- Calibrated within the last 12 months by an independent testing company.

Take footcandle readings, where directed. Give particular attention to points where low illumination is most likely to occur, usually midway between luminaires.

Complete the static load tests specified in Section 1101.02(a)1.

Lower and raise the ring assembly of all high mast poles to ensure proper operation.

(v) Data Gathering. Determine the GPS location and LMS keys for all existing and new highway lighting assets within the contract limits. Enter the data electronically in the Highway Lighting Asset Numbering spreadsheet and provide the updated spreadsheet electronically to the Bureau of Maintenance and Operations – Maintenance Technical Leadership Division (BOMO-MTLD) Highway Lighting group.

(w) Guarantee. Guarantee the in-service operation of all mechanical and electrical equipment, and related components of the entire lighting system including lamps, for a period of 180 days. The guarantee begins the day after the lighting system is fully operational, as determined by the Representative, after completion of all lighting system related work and completion of the 168-hour performance test specified in Section 910.3(u).

The energizing cost during the guarantee period will be borne by the owner, under the terms of the agreement (where agreements are applicable). Perform the following at the onset of and during the guarantee period:

- Execute the in-service guarantee notification Form CS-4225H, provided by the Department.

- Commence repairs within one calendar day following notification to the person designated on Form CS-4225H.

- Guarantee all repairs and material replacements for the balance of the guarantee period, or 30 days, whichever is the longer period.

- Repair work not performed within the guarantee period, or any extension periods, will be considered latent defects as specified in Section 107.16(b).

Repairs that are the direct result of external causes will be performed by others. Examples of external causes are lightning strikes, vehicular impact, objects driven through the underground circuit, trenching through installed circuits, etc.

Issuance of certificate of acceptance or final settlement of the contract is not consequential to the in-service guarantee period described herein. The guarantee period is not a part of the contract time.

910.4 MEASUREMENT AND PAYMENT—

(a) Junction Boxes. Each, for the type indicated.
The price includes the ground wire, ground rod, ground clamp, and necessary excavation and backfill.

(b) Poles (Conventional). Each, for the type and height indicated.
The price includes either frangible or breakaway base (when indicated) and arm.

(c) Poles (High-Mast). Each, for the height indicated.
The price includes the lowering device and wiring from the line splice to the luminaire ring.
The winch drive unit is incidental to the total number of poles constructed.

(d) Arms. Each, for the length indicated.
The price includes complete installation.

(e) Luminaires (Conventional). Each, for the wattage and mounting indicated.
The price includes integral ballast or driver and complete wiring from luminaire ballast or driver to line splice.

(f) Luminaires (High-Mast). Each, for the wattage indicated.
The price includes integral ballast or driver and complete wiring from the luminaire-ring terminal board to the luminaire ballast or driver.

(g) Luminaires (Underpass). Each, for the wattage and mounting indicated.
The price includes integral ballast or driver and complete wiring, conduit, and necessary mounting provisions from the line splice at the junction box to the luminaire.

(h) Ballast. Each, for the wattage indicated.
The price includes mounting and wiring, as directed.

(i) Pole Foundations. Each, for the type indicated.
The price includes excavation, concrete, anchor bolt assemblies, reinforcement bars, conduit, ground rod(s), ground rod clamp(s), grounding electrode conductor, backfilling, and satisfactory disposal of surplus material.

(j) Cable and Conduit Markers. Each
The price includes excavation, concrete, backfilling, and satisfactory disposal of surplus material.

(k) Conduit. Linear Foot
The price includes fittings, expansion/deflection fittings, joints, bends, grounds, protective coatings, and appurtenances. Does not include conduit in pole foundations.
Unless otherwise authorized, no allowance will be made for additional conduit lengths as a result of deviation from the indicated conduit location.

(m) Cable. Linear Foot
No allowance will be made for coiling or looping cable slack lengths inside pole bases or junction boxes, when additional lengths of cable are necessary for splicing. An allowance will be made for cable entry into each pole base from the trench to the handhole.

Unless otherwise authorized, no allowance will be made for additional cable lengths, or cable size, as a result of deviation from the indicated cable location.

The ground rods specified for structures are incidental to the circuit cables. Splices and fuses are incidental to the circuit cables.

(n) Trenches. Linear Foot

The price includes excavation, backfilling, temporary and permanent plastic trench markers, and surplus material disposal. No allowance will be made for rock excavation or for any other subsurface condition encountered.

Unless otherwise authorized, no allowance will be made for additional trench lengths as a result of deviation from the indicated trench locations.

(o) Complete Power Supply System. Each

The price includes service pole and all necessary power supply equipment.

(p) Testing of Entire Lighting System. Lump Sum

The price includes furnishing personnel, equipment, and electrical energy necessary for tests.

(q) Conduit Sleeve. Linear Foot

The price includes all work necessary to install the conduit sleeve as specified in Section 910.3(g). The price does not include circuit conduit passing through the sleeve.

(r) Asset Numbering System Update Effort. Lump Sum

The price includes furnishing personnel and equipment necessary to gather accurate information and to provide updated documentation in electronic spreadsheet format.

SECTION 920—SIGN LIGHTING

920.1 DESCRIPTION—This work is the furnishing and installation of a complete electrical distribution, control, and lighting system for the illumination of indicated signs.

920.2 MATERIAL—Section 1102. Certification and warranties, as specified in Section 910.2(c).

920.3 CONSTRUCTION—As shown on the Standard Drawings, as indicated, and as follows:

(a) General. Section 910.3(a) and as follows:
Do not alter sign structure members to attach electrical items, unless indicated. When necessary, drill during structural fabrication.

(b) Trench Excavation and Backfill. Section 910.3(c)

(c) Service Pole Installation. Section 910.3(k)

(d) Photoelectric Control Device. Section 910.3(m)

(e) Enclosure Installation. Section 910.3(n)

(f) Luminaires. Attach the luminaires to the supports. Install a lamp in each luminaire. Clean the luminaires as specified in Section 910.3(j). If the luminaire is provided with a remote ballast, mount the remote ballast over the shoulder. Submit mounting method and materials for approval.

(g) Junction Boxes. Section 910.3(p)

(h) Conduit Installation. Section 910.3(g) and as follows:
Unless another method is specified, attach exposed conduits to sign structures using galvanized or stainless steel supports and U-bolts or two-hole straps with spacers and expansion bolts, and attach the conduit to sign columns and shafts with clamping bands and bolts.

(i) Cable Installation. Section 910.3(h)
Deviation from the indicated layout may be allowed if it is necessary to overcome obstacles during construction, provided that drawings showing the deviations are submitted for approval.
Extend cables from the breakers of each sign structure mounted lighting panel to each ballast and sign lighting fixture.
Attach exposed cable runs to the structures using 1/2-inch stainless steel straps or black plastic tie straps, as directed, at intervals not exceeding 3 feet.

(j) Cable and Conduit Markers. Section 910.3(t)

(k) Grounding. Install grounding electrode conductors, ground rods, connectors insulated equipment grounding conductors, bonding jumpers, and necessary devices to limit the voltage to earth on the exposed normally non-current carrying metal parts of the entire electrical system and sign structure.
At the power supply, connect one end of the No. 4 AWG grounding electrode conductor to the breaker panel ground bus and the other end to the ground rod at the service pole.
At each sign structure install a ground rod and install a No. 6 AWG grounding electrode conductor through the sign column shaft and attach to the grounding lug accessible from the handhole. Connect the ground wire to the ground rod with an exothermic weld or a bronze clamp. Do not ground the system neutral conductor. Ground the equipment grounding conductor and enclosure using a connection on the grounding lug in the column shaft. Drive the ground rod vertically into the ground a horizontal distance of 1 foot from the foundation and opposite the roadway side of the shaft.

(m) Tests. Section 910.3(u), except as follows:

1. Circuit Tests. Make voltage readings at the power supply side of the service pole equipment or at the supply side of the highway sign lighting circuit, and make readings at ballasts. Provide a voltage drop not exceeding 5% of the rated voltage at the service point when under full load at the lamp ballast.

Take current readings on the load side of each main breaker and neutral circuit. Take current readings at nighttime and at daytime with the lighting systems in normal operation.

2. Performance Test. As directed, take footcandle readings at several points on the sign face.

(n) Guarantee. Section 910.3(w)

920.4 MEASUREMENT AND PAYMENT—Lump Sum

The price includes furnishing personnel, equipment, and the costs of electrical energy for the tests.

SECTION 930—POST MOUNTED SIGNS, TYPE A

930.1 DESCRIPTION—This work is furnishing and installation of fabricated aluminum signs of the type indicated on steel S or W beam posts and breakaway system.

930.2 MATERIAL—As shown on the Standard Drawings and as follows:

(a) Extruded Aluminum Channel Signs, Posts, and Miscellaneous Material.

- Extruded Aluminum Channel Signs—Section 1103.02
- Steel S or W Beam Posts and Breakaway System—Section 1103.07
- Galvanized Steel Hex Head Bolts, Nuts, Lock-Washers; Aluminum Post-Clips, Auxiliary Supports for Exit Panels, 1/8-inch Rivets—Section 1103.11

(b) Flat Sheet Aluminum Signs with Stiffeners, Posts, and Miscellaneous Material.

- Flat Sheet Aluminum Signs with Stiffeners—Section 1103.03
- Steel S or W Beam Posts and Breakaway System—Section 1103.07
- 1/8-inch and 3/16-inch Aluminum Rivets; Stainless Steel Bolts, Nuts, Washers, Post-Clips; Twist-In Toggle and Buckle Straps; Butting Plates; Auxiliary Supports for Exit Panels—Section 1103.11

(c) Foundations.

1. Cast-In-Place Foundation.

- Class A Cement Concrete—Section 704
- Reinforcement Bars—Section 709.1

2. Steel Finned-Pipe Foundation. From a manufacturer listed in Bulletin 15.

930.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) General. Erect posts plumb using a method that does not twist, bend, or otherwise deform the posts. Before erection, correct twisted, bent, or deformed posts. Erect signs by a method that does not twist, bend, or otherwise deform the signs. Level, correctly align, and then center signs on the posts and properly fasten. Exercise extreme care when using hoisting cables on the sign to avoid damage to the reflective sheeting. Repair or replace damaged posts and signs.

Fasten the signs to the posts with the necessary hardware as detailed in TC 8700 Standard Series.

(b) Location. The indicated location of sign installations is approximate with the exact location established at the site. Mark longitudinal and lateral location by stakes or paint marks with an identifying symbol.

On tangent sections of roadway, locate and erect posts to allow signs to face away from roadway at an angle of 93 degrees from the pavement edge. On curves, locate and erect the posts perpendicular to the sight line, where the sight line is an imaginary line connecting the center of the near traffic lane. The length in feet from the sign to the center of the near traffic lane is equal to 40 times the letter height of the smallest legend in inches, but not less than 300 feet. For example: 50-inch x 12-inch letter equals a 600-foot sight line.

(c) Removal of Existing Signs. Remove existing signs or sign installations as indicated. Existing signs or sign installations that are permanently removed shall become the property of the Contractor unless indicated otherwise. Remove foundations to a minimum 12 inches below final grade.

(d) Clearing and Grubbing. When directed, and as specified in Section 201.3, remove material, brush, trees, or branches, which obstruct the clear view of signs being placed.

(e) Restoration of Site. Restore the site to its original condition, including the disposal of excess or unsuitable materials.

(f) Motorist Service Signs. Provide and install symbols, legends, and borders, with the exception of business logo signs, as indicated.

(g) Posts and Foundations.

1. Posts. Submit a sketch for acceptance for each plan location before post fabrication, showing the following:

- location of sign by plan station;
- lateral offset from pavement edge to sign edge;
- sign size (width and height);
- exit panel sign size (width and height);
- number of post supports and sections;
- post heights, measured from bottom of post base plate to post top;
- measured distance from reference line elevation at pavement edge to foundation top;
- steel finned pipe foundation design; or
- footing base type design and reinforcing steel; and
- bracket identification number and quantity.

Replace galvanized parts or members damaged in transition or erection with new material having properly galvanized surfaces. Repair damage to galvanized surfaces that does not exceed 2% per linear foot of the total surface area according to ASTM A 780 and as specified in Section 910.3(r).

2. Foundations.

2.a Cast-in-Place Foundations. Excavate for the foundation, then position the posts and connections with the post flange faces aligned in the same plane. Place concrete against undisturbed earth, as specified in the applicable parts of Section 1001.3. Form the top 12 inches of foundations.

2.b Steel Finned-Pipe Foundations. Install foundation and provide installation report prepared by Technical Assistant, according to the drawing and manufacturer's recommendations.

- **Technical Assistant.** Provide a certified designer/installer to be present at the project site to assist the Contractor and Representative in the event that unusual problems or special circumstances arise. Furnish evidence of the designer/installer's certification from the steel finned-pipe foundation supplier to the Representative before the start of work.

(h) Erection. Install nuts on post clips with a torque wrench for extruded aluminum channels. Apply 225 inch-pounds of torque to each galvanized nut with the threads dry, clean, and unlubricated.

Attach the sign to posts with twist-in toggle and buckle straps or stainless steel post-clips for flat sheet aluminum. Apply 225 inch-pounds of torque to each stainless steel nut with the threads dry, clean, and unlubricated.

Clean signs after erection, removing any accumulation of oil, grease, dirt, or foreign material.

Brace the panel with one or more auxiliary supports if exit panels cannot be supported by two sign posts.

930.4 MEASUREMENT AND PAYMENT—

(a) Post Mounted Signs, Type A. Square Foot of sign

The unit price includes removal of existing signs, one breakaway system per post and erection of posts, but not furnishing and galvanizing posts.

(b) Steel S or W Beam Posts. Pound

(c) Breakaway System Replacement. Each

The price includes all breakaway hardware for a single post and all necessary machining.

SECTION 931—POST MOUNTED SIGNS, TYPE B

931.1 DESCRIPTION—This work is furnishing and installation of flat sheet signs on breakaway steel posts.

931.2 MATERIAL—As shown on the Standard Drawings and as follows:

- Flat Sheet Signs—Section 1103.04
- Breakaway Steel Posts—From a manufacturer listed in Bulletin 15, and as specified in Section 1103.08.
- Aluminum Bolts, Aluminum Nuts, and Anti-Theft Hardware—Section 1103.11
- Packaged Dry Concrete—Section 624.2(b)

931.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in Sections 930.3(a), (b), (d), and (e) and as follows:

(a) General. Drive anchors into undisturbed earth with anchor top a maximum of 4 inches above lower slope side.

Drill concrete if posts are to be located in concrete areas.

Drive square anchor into undisturbed earth and place concrete if square steel posts are used in concrete. Complete installation after concrete is cured a minimum of 72 hours.

Fasten STOP and YIELD signs, and other signs if indicated, to posts with anti-theft hardware.

Permanently scribe 1-inch numerals on back of sign indicating the month and year of installation.

(b) Removal of Existing Signs. Remove existing signs or sign installations, only when indicated or directed.

Return aluminum and steel removed from existing sign installations to the Department unless indicated otherwise. Sort and band removed items by type of material onto separate wooden pallets. Prevent additional damage or deterioration of the sign materials, particularly aluminum sign blanks, during storage, bundling, and delivery. Give 3 working days notice to arrange delivery to the Department as indicated.

931.4 MEASUREMENT AND PAYMENT—Square Foot of sign

The unit price includes removal of existing signs.

SECTION 932—POST MOUNTED SIGNS, TYPE C

932.1 DESCRIPTION—This work is the furnishing and installation of flat sheet signs on wood posts.

932.2 MATERIAL—As shown on the Standard Drawings and as follows:

(a) Signs, Posts, Supports, and Miscellaneous Material.

- Flat Sheet Signs—Section 1103.04
- Treated Wood Posts—Section 1103.09
- Aluminum Bolts, Aluminum Nuts, and Lag Screws—Section 1103.11
- Shims and Bars—Section 1105.02(a)2
- Brackets—Section 1105.02(f)2

(b) Foundations.

- Class A Cement Concrete—Section 704
- Sleeves—Section 1105.02(j)1

932.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in Sections 930.3(a), (b), (d), and (e), Section 931.3(b), and as follows:

Excavate for the post foundation. Place the post, with shim plates and bars attached, in the sleeve in the excavated foundation. Carefully set the sleeve, using the temporary framing to ensure proper location.

Place foundation concrete, as specified in the applicable parts of Section 1001.3, against undisturbed earth. Finish the foundation tops flush and in the same plane as the adjacent ground, except trowel the concrete surface and shape to prevent water standing against the posts.

Drill or form the hole if posts are to be located in concrete such as divisors or islands.

Limit field cutting of posts to a minimum. Field treat the cut area with the original post preservative.

Where multiple sign assemblies on the same installation require larger posts than shown on the Standard Drawings, refer to the Standard Drawings for post mounted signs, Type E.

Permanently scribe 1-inch numerals on back of sign indicating the month and year of installation.

932.4 MEASUREMENT AND PAYMENT—Square Foot of sign

The price includes removal of existing signs.

SECTION 933—POST MOUNTED SIGNS, TYPE D

933.1 DESCRIPTION—This work is the furnishing and installation of flat sheet aluminum signs with stiffeners on steel pipe supports, fastened to fabricated structural steel mounting brackets.

933.2 MATERIAL—As shown on the Standard Drawings and as follows:

- Flat Sheet Aluminum Signs with Stiffeners—Section 1103.03
- Twist-In Toggles and Buckle Straps; Anchors—Section 1103.11
- Steel Brackets, Bars, Pipes, Shapes, and Plates (Supports)—Section 1103.12

933.3 CONSTRUCTION—As shown on the Standard Drawings and as specified in Sections 930.3(a) and (b), and Section 931.3(b), except insert the word "support" for the word "post."

Permanently scribe 1-inch numerals on back of sign indicating the month and year of installation.

933.4 MEASUREMENT AND PAYMENT—Square Foot of sign

The unit price includes furnishing and erecting fabricated structural steel mounting brackets.

SECTION 934—POST MOUNTED SIGNS, TYPE E

934.1 DESCRIPTION—This work is the furnishing and installation of fabricated aluminum signs of type indicated on wood posts or composite posts, including the removal of existing signs.

934.2 MATERIAL—As shown on the Standard Drawings, and as follows:

(a) Extruded Aluminum Channel Signs, Posts, Supports, and Miscellaneous Material.

- Extruded Aluminum Channel Signs—Section 1103.02
- Treated Wood Posts—Section 1103.09(a)
- Composite Posts—Section 1103.09(b)
- Galvanized Steel Hex Head Bolts, Nuts, Lock-Washers; Aluminum Post-Clips, Auxiliary Supports for Exit Panels, Rivets—Section 1103.11
- Angles (Supports)—Section 1103.12(g)
- Shim Bars and Plates (Supports)—Section 1105.02(a)2

(b) Flat Sheet Aluminum Signs with Stiffeners, Posts, and Miscellaneous Material.

- Flat Sheet Aluminum Signs with Stiffeners—Section 1103.03
- Treated Wood Posts—Section 1103.09(a)
- Composite Posts—Section 1103.09(b)
- Rivets—Section 1103.11(e)
- Stainless Steel Bolts, Nuts, Washers, Post-Clips; Twist-In Toggles and Buckle Straps; Butting Plates; Auxiliary Supports for Exit Panels—Section 1103.11
- Angles (Support)—Section 1103.12(g)
- Shim Bars and Plates (Supports)—Section 1105.02(a)2

(c) Foundations.

- Class A Cement Concrete—Section 704
- Sleeves—Section 1105.02(j)1
- Steel Pipe—Section 1103.12(e)

934.3 CONSTRUCTION—If indicated, remove existing signs.

(a) Wood Posts. Section 932.3

(b) Composite Posts. As shown on the Standard Drawings, as specified in Sections 930.3(a), (b), and (e), Section 931.3(b), and as follows:

Excavate for the post foundation. Place the post in the sleeve in the excavated foundation. Set the sleeve, using the temporary framing to ensure proper location.

Place foundation concrete against undisturbed earth, as specified in the applicable parts of Section 1001.3. Finish the foundation tops flush and in the same plane as the adjacent ground, except trowel the concrete surface and shape to prevent water standing against the posts.

Drill or form the hole if posts are to be located in concrete such as divisors or islands.

Place protective plastic cap over top end of post.

Permanently scribe 1-inch numerals on back of sign indicating the month and year of installation.

934.4 MEASUREMENT AND PAYMENT—Square Foot of sign

The unit price includes removal of existing signs.

SECTION 935—POST MOUNTED SIGNS, TYPE F

935.1 DESCRIPTION—This work is the furnishing and installation of signs of the type indicated on existing posts or posts installed for other purposes.

935.2 MATERIAL—As shown on the Standard Drawing for the corresponding type post and as follows:

- Flat Sheet Signs—Section 1103.04
- Brackets and Bars (Supports)—Section 1103.12
- Extruded Aluminum Channel Signs—Section 1103.02
- Flat Sheet Aluminum Signs with Stiffeners—Section 1103.03
- Galvanized Steel Hex Head Bolts, Nuts, Lock-Washers; Aluminum Post-Clips; Lag Screws; Rivets; Anti-Theft Sign Hardware—Section 1103.11

935.3 CONSTRUCTION—Attach signs to supports, as shown on the Standard Drawings for post mounted signs, Type A, B, C, D, or E, as appropriate.

Band signs or brackets to signal poles, mast arm columns, or luminaire supports.

When mounting as a secondary sign below another sign, install sign at a minimum height of 5 feet on conventional highways in rural areas; at 7 feet on conventional highways, on business, commercial, and residential streets where parking or pedestrian movements are likely to occur, or where other obstructions exist; and at 5 feet on expressways and freeways. Height is measured as the difference in elevation between near roadway edge surface and sign bottom.

Erect the sign in a level position, correctly aligned on the posts, and firmly attached with the necessary mounting hardware.

Permanently scribe 1-inch numerals on the back of sign indicating the month and year of installation.

935.4 MEASUREMENT AND PAYMENT—Square Foot of sign

The unit price includes removal of existing sign(s), as necessary.

SECTION 936—STRUCTURE MOUNTED SIGNS

936.1 DESCRIPTION—This work is the furnishing and installation of signs of the type indicated, mounted on overhead structures.

936.2 MATERIAL—As shown on the Standard Drawings and as follows:

- Extruded Channel Signs and Miscellaneous Material—Section 930.2(a)
- Flat Sheet Aluminum Signs with Stiffeners and Miscellaneous Material—Section 930.2(b)
- Flat Sheet Signs—Section 1103.04
- Other Miscellaneous Material:
  Angles—Section 1103.12(g)
  Angles—Section 1105.02(a)2, galvanized as specified in Section 1105.02(s).
- Internally Illuminated Signs—Section 1103.03(g)
- School Zone Speed Limit Flashing Warning Signs – Sections 951.2, 952.2, 954.2, 955.2, and 1103.03(h) or otherwise indicated on the approved plans.
- Flashing Warning Signs - Sections 951.2, 952.2, 954.2, 955.2, 1103.03(h), and 1104 or otherwise indicated on the approved plans.
- LED Blank-Out Signs - Sections 951.2, 952.2, 954.2, 1103.03(h), and 1104, or otherwise indicated on the approved plans.

936.3 CONSTRUCTION—Section 930.3(h), as shown on the Standard Drawings, and as follows:

Remove existing signs only if indicated. Signs that are removed become property of Contractor unless otherwise indicated.

Submit to the Department all street name sign layout sheets for review and approval before fabrication.

Erect signs level, position correctly on sign brackets, and attach firmly with the necessary mounting hardware as shown in the Standard Drawings.

Erect signs by a method that does not twist, bend, or otherwise deform the signs. Repair or replace damaged signs.

Verify that the lowest point of any sign over the roadway is not less than 17 feet above the roadway surface unless otherwise specified on the approved plans.

Provide Internally Illuminated Signs from a manufacturer listed in Bulletin 15. Install in accordance with the approved plans.

Provide School Zone Speed Limit Flashing Warning Signs from a manufacturer listed in Bulletin 15. Install as indicated in Sections 951, 952, 954, 955, 1103, and 1104 or otherwise indicated on the approved plans.

Provide Flashing Warning Signs from a manufacturer listed in Bulletin 15. Install as indicated and in Sections 951, 952, 954, 955, 1103, and 1104 or otherwise indicated on the approved plans.

Provide LED Blank-Out Signs from a manufacturer listed in Bulletin 15 and in accordance with Publication 236M; the June 27, 2005 ITE Standard for "Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Circular Signal Supplement" (excluding Sections 6.3.2 and 6.4.2, "Maintained Minimum Luminous Intensity," 6.4.4.5 "Controller Assembly Compatibility," 6.4.4.5.1 "Load Switch Compatibility," and 6.4.4.5.2 "Signal Conflict Monitor Compatibility"). Install as indicated in Sections 951, 952, 954, 955, 1103, and 1104 or otherwise indicated on the approved plans.

936.4 MEASUREMENT AND PAYMENT—

(a) Structure Mounted Signs. Square Foot of sign.
The unit price includes removal of existing signs and mounting hardware.

(b) Internally Illuminated Sign. Each.

Includes all necessary connections, wiring, photoelectric cells, swing brackets, strapping, bolts, washers, and associated hardware to make the signs fully operational.

(c) School Zone Speed Limit Flashing Warning Signs. Each.
Includes Light Emitting Diode (LED) indications, controller assembly, solar components (if applicable), wiring, and associated hardware to make the sign fully operational.

(d) Flashing Warning Signs. Each.
Includes Light Emitting Diode (LED) indications, controller assembly, solar components (if applicable), wiring, and associated hardware to make the sign fully operational.

(e) LED Blank-Out Sign. Each.
Including all necessary connections, wiring, photoelectric cells, swing brackets, strapping, bolts, washers, and associated hardware to make the signs fully operational.

SECTION 937—DELINEATION DEVICES

937.1 DESCRIPTION—This work is the furnishing, installation, and removal of delineation devices of the type and color indicated.

937.2 MATERIAL—Provide delineation devices of the type and color indicated in the Standard Drawings and as listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3. Delineation devices are incidental for temporary barrier. Refer to Section 627.

(a) Barrier Mount. Provide delineation devices with an anchoring system of pressure-sensitive or epoxy adhesive as recommended by the manufacturer for anchoring the delineation device to the top or side of the barrier.

(b) Guide Rail Mount. Provide delineation devices with an anchoring system as recommended by the manufacturer for anchoring to the face or top of the strong or weak post guide rail.

(c) Post Mount. Provide delineation devices mounted on flexible posts meeting NCHRP 350 crash test criteria.

1. Ground Mount. Provide a ground mount anchoring system for installing flexible delineator posts in the ground or in proposed pavement, median or island.

2. Surface Mount. Provide a surface mount anchoring system for installing flexible delineator posts to existing pavements.

937.3 CONSTRUCTION—

(a) General. Locate delineation devices as indicated, by type and color. Remove and install devices as shown on the Standard Drawings. Verify that the reflective surface of all delineation devices is visible to approaching traffic.
Remove and dispose of delineators not being replaced, as indicated.

(b) Barrier Mount. Install barrier-mount delineators with a pressure-sensitive adhesive or epoxy as recommended by the manufacturer on a section of barrier that is clean and dry.

(c) Guide Rail Mount. Install guide rail mounted delineators as indicated for the particular type. Be certain the delineators are securely attached to the face of the guide rail or the top of the guide rail post as recommended by the manufacturer.

(d) Post Mounts. Check each post to be certain it is plumb.

1. Ground Mount. Drive flexible delineator post soil anchors until the top is flush with the ground. Place soil anchors in proposed pavement, median or island for in-pavement mount. Insert post and secure as recommended by the manufacturer.

2. Surface Mount. Install surface mount base anchors on the existing pavement and insert post and secure as recommended by the manufacturer.

937.4 MEASUREMENT AND PAYMENT (permanent barrier only) —

(a) Delineator. Each
The unit price includes removal of existing delineation devices.

(b) Delineator Removal. Each

SECTION 938—DISTANCE MARKERS

938.1 DESCRIPTION—This work is furnishing and installation of distance markers on breakaway steel posts or distance marker supports.

938.2 MATERIAL—As shown on the Standard Drawings and as follows:

- Aluminum Blanks—Section 1103.04(a)
- Breakaway Steel Posts—Section 1103.08
- Anti-Theft Hardware—Section 1103.11(j)
- Brackets, Bars, Clamps, Straps and Gussett Plates (Supports)—Section 1103.12(i)

938.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

The location of an initial marker will be established by the Representative.

Locate the markers in order along both main roadway sides, beginning as directed. Measure to accurately establish the marker locations, in 11-mile increments, along the outside pavement edge of the northbound or eastbound roadway only. Locate markers on the southbound or westbound roadway, opposite the marker locations established on the northbound or eastbound roadway.

Drive posts or erect supports, where necessary, and mount markers. After mounting markers, tighten anti-theft nuts and bolts to ensure a snug fit.

Erect markers facing traffic on distance marker brackets if a marker location is on a structure.

938.4 MEASUREMENT AND PAYMENT—Each

The price includes posts and supports.

SECTION 939—POST MOUNTED SIGNS, TYPE M

939.1 DESCRIPTION—This work is furnishing and installation of flat sheet signs on posts attached to concrete median barrier.

939.2 MATERIAL—As shown on the Standard Drawings, and as follows:

- Flat Sheet Signs—Section 1103.04
- Breakaway Steel Posts – From a manufacturer listed in Bulletin 15 and as specified in Section 1103.08.

939.3 CONSTRUCTION—As shown on the Standard Drawings and as specified in Section 930.3(a) and Section 931.3(b).

Permanently scribe 1-inch numerals on back of sign indicating the month and year of installation.

939.4 MEASUREMENT AND PAYMENT—Square Foot of sign

The unit price includes fabrication and installation of sign support, and removal of existing signs.

SECTION 940 – RESET POST MOUNTED SIGNS, TYPE A

940.1 DESCRIPTION—This work is the removal of existing extruded aluminum channel signs or flat sheet signs, posts, anchors, foundations, and associated hardware and resetting the existing signs as indicated with new posts, anchors, foundations, and associated hardware.

940.2 MATERIAL—Section 930.2(a), except delete the first bullet; Section 930.2(b), except delete the first bullet; and Section 930.2(c).

940.3 CONSTRUCTION—Section 930.3 and as follows:

Remove existing signs, posts, anchors, and associated hardware as indicated. Remove existing foundations to a minimum depth of 12 inches below final ground surface, and backfill any holes as specified in Section 206.3(b)4**.**

Stockpile signs for reuse. Dispose of existing anchors and associated hardware outside the right-of-way.

If specified or indicated, store existing posts for Department pickup. Otherwise, dispose of existing posts outside the right-of-way.

Provide new posts, anchors, foundations, and associated hardware to be set at the specified locations. Reset the existing signs.

Avoid damage to existing signs during the removal and stockpiling operations. Replace any sign lost or damaged as a result of any of the resetting operations, at no additional expense to the Department.

940.4 MEASUREMENT AND PAYMENT—Each

SECTION 941 – RESET POST MOUNTED SIGNS, TYPE B

941.1 DESCRIPTION—This work is the removal of existing flat sheet signs, posts, anchors, and associated hardware and resetting the existing flat sheet signs as indicated with new posts, anchors, and associated hardware.

941.2 MATERIAL—Section 931.2**,** except delete the first bullet.

941.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in Section 930.3(a), (b), (d), and (e), and as follows:

Remove existing signs, posts, anchors, and associated hardware as indicated.

Stockpile signs for reuse. Dispose of existing anchors and associated hardware outside the right-of-way.

If specified or indicated, store existing posts for Department pickup. Otherwise, dispose of existing posts outside the right-of-way.

Provide new breakaway steel posts, anchors, and associated hardware to be set at the specified locations. Reset the existing signs.

Avoid damage to existing signs during the removal and stockpiling operations. Replace any sign lost or damaged as a result of any of the resetting operations, at no additional expense to the Department.

941.4 MEASUREMENT AND PAYMENT—Each

SECTION 942 – RESET POST MOUNTED SIGNS, TYPE C

942.1 DESCRIPTION—This work is the removal of existing signs, wood posts, foundations, and associated hardware and resetting the existing signs as indicated with new wood posts, foundations, and associated hardware.

942.2 MATERIAL—Section 932.2(a), except delete the first bullet; Section 932.2(b).

942.3 CONSTRUCTION—Section 932.3 and as follows:

Remove existing signs, wood posts, foundations, and associated hardware as indicated. Backfill any holes as specified in Section 206.3(b)4**.**

Stockpile signs for reuse. Dispose of existing associated hardware outside the right-of-way.

If specified or indicated, store existing posts for Department pickup. Otherwise, dispose of existing posts outside the right-of-way.

Provide new treated wood posts, foundations, and/or associated hardware as directed to be set at the specified locations. Reset the existing signs.

Avoid damage to existing signs during the removal and stockpiling operations. Replace any sign lost or damaged as a result of any of the resetting operations, at no additional cost to the Department.

942.4 MEASUREMENT AND PAYMENT—Each

SECTION 943—RESET POST MOUNTED SIGNS, TYPE D

943.1 DESCRIPTION—This work is the removal of existing flat sheet aluminum signs with stiffeners, steel pipe supports, and associated hardware and resetting the existing flat sheet aluminum signs with stiffeners as indicated with new steel pipe supports, fastened to fabricated structural steel mounting brackets.

943.2 MATERIAL—As specified in Section 933.2, except delete the first bullet.

943.3 CONSTRUCTION—As shown on the Standard Drawings, as specified in Section 933.3, and as follows:

Remove existing signs, supports, anchors, and associated hardware as indicated.

Stockpile signs for reuse. Dispose of existing anchors and associated hardware outside the right-of-way.

If specified or indicated, store existing supports for Department pickup. Otherwise, dispose of existing supports outside the right of way.

Provide new steel pipe support, fasteners, and fabricated structural steel mounting brackets to be set at the specified locations. Reset the existing signs.

Avoid damage to existing signs during the removal and stockpiling operations. Replace signs lost or damaged as a result of the resetting operations, at no additional cost to the Department.

943.4 MEASUREMENT AND PAYMENT—Each

SECTION 944 – RESET POST MOUNTED SIGNS, TYPE E

944.1 DESCRIPTION—This work is the removal of existing signs, posts, foundations, and associated hardware and resetting the existing signs as indicated with new posts, foundations, and associated hardware.

944.2 MATERIAL—Section 934.2(a), except delete the first bullet; Section 934.2(b), except delete the first bullet.

944.3 CONSTRUCTION—Section 932.3 and as follows:

Remove existing signs, posts, foundations, and associated hardware as indicated. Backfill any holes as specified in Section 206.3(b)4**.**

Stockpile signs for reuse. Dispose of associated hardware outside the right-of-way.

If specified or indicated, store existing posts for Department pickup. Otherwise, dispose of existing posts outside the right-of-way.

Provide new posts, foundations, and/or associated hardware as directed to be set at the specified locations. Reset the existing signs.

Avoid damage to existing signs during the removal and stockpiling operations. Replace any sign lost or damaged as a result of any of the resetting operations, at no additional cost to the Department.

944.4 MEASUREMENT AND PAYMENT—Each

SECTION 945 – RESET POST MOUNTED SIGNS, TYPE F

945.1 DESCRIPTION – This work is the removal of existing signs and associated hardware and resetting the existing signs as indicated on existing posts or posts installed for other purposes.

945.2 MATERIAL – Section 935.2, except delete the first, third, and fourth bullets.

945.3 CONSTRUCTION –Section 935.3 and as follows:

Remove existing signs and associated hardware as indicated.

Stockpile signs for reuse. Dispose of existing associated hardware outside the right-of-way.

If specified or indicated, store existing posts for Department pickup. Otherwise, dispose of existing posts outside the right-of-way.

Reset the existing signs at the specified locations. Provide new associated hardware as directed.

Avoid damage to existing signs during the removal and stockpiling operations. Replace any sign lost or damaged as a result of any of the resetting operations, at no additional cost to the Department.

945.4 MEASUREMENT AND PAYMENT – Each

SECTION 948—STEEL SIGN STRUCTURE

948.1 DESCRIPTION—This work is the construction of overhead steel sign structures of the type indicated.

948.2 MATERIAL—

(a) Cantilever, Centermount, Monopipe, or Span with Single Plane Truss.

1. Pipe Columns, Struts, and Truss Chords. Provide supplemental CVN testing (Zone 2, non-fracture critical in accordance with AASHTO Specifications) for all pipe with nominal wall thicknesses greater than 1/2 inch.

The actual yield strength for all pipe, per mill test report, is not to exceed 65,000 pounds per square inch.

1.a ASTM A 53/A 53M, Grade B, Type E or S; or ASTM A 500, Grade B; or ASTM A 106, Grade B

1.b API 5L, Grades B, X42 or X52; PSL2 with the following characteristics:

- No jointers permitted
- Do not use thermomechanical rolled or thermomechanical formed (grade suffix M) pipe on monopipe structures.
- Process of manufacture: seamless, electric resistance welded, or longitudinal seam, submerged arc welded.

2. Truss Webs and Truss Verticals. As specified in Section 948.2(a)1 for tubular members; or Section 1105.02(a)2 for structural shapes.

3. Steel Angle, Shapes and Plates. Section 1105.02(a)2

4. Press-Break Columns. Section 1105.02(a)2, unless otherwise specifically approved by the Department.

Provide supplemental CVN testing (Zone2, non-fracture critical, in accordance with AASHTO Specifications) for columns with nominal wall plate thicknesses greater than 1/2 inch.

Provide a minimum internal surface (concave) bend radius at each press-break that is five times the wall thickness or 1 inch, whichever is larger. (Bends are parallel to direction of mill rolling).

The dimension across the flats on fabricated press-break columns may not vary by more than 2% from the specified dimension. The fabricator is responsible for all fabrication adjustments that may be necessary to accommodate any dimensional variation.

(b) Span with Tri-Chord or Box-Shaped Truss. As specified in Sections 948.2(a)1 through 948.2(a)4.

(c) Tapered Tube Structures.

1. Chord and Column Members. Section 1105.02(a)2. Provide supplemental CVN testing (Zone 2, non-fracture critical, in accordance with AASHTO Specifications) for tube wall thickness greater than 1/2 inch. If press-break columns are used, provide a minimum internal (concave) surface bend radius that is five times the wall thickness or 1 inch, whichever is larger. (Bends re parallel to direction of mill rolling).

2. Steel Angles, Shapes, and Plates. Section 1105.02(a)2

(d) Fabricated Structural Steel. Section 1105, except identify on the shop drawings weld locations, type, size, process, and nondestructive testing. Shielded Metal Arc Welding (SMAW), Submerged Arc Welding (SAW), Gas Metal Arc Welding (GMAW), and gas-shielded Flux Cored Arc Welding (FCAW) are approved. Galvanize as specified in Section 1105.02(s). If necessary, perform one time weld repair of column to base plate, column to splice plate, chord to splice plate, and/or circumferential butt welds in chords and columns. If the initial repair fails, seek

approval of the Chief Structural Materials Engineer before making any further repairs at the previously repaired location. Column base plates must meet a Class C flatness tolerance, as specified in Section 1111, for structures erected directly on a pre-finished concrete foundation using bridge shoe bedding material. Perform and evaluate all non-destructive testing according to cyclically loaded non-tubular tension criteria.

1. Perform the following minimum ultrasonic testing of Complete Joint Penetration (CJP) groove welds:

1.a On monopipe structures, 100% of the length of all CJP groove welds; on other structures, 25% of the length of the length of each weld connecting columns to base plates, cords to splice plates connection plates to columns and chords, welds on truss seat plates, and longitudinal seam welds on cantilever and center-mount sleeves.

- If a rejectable defect is found on a partially tested weld, then test 100% of the CJP weld length on that plate or sleeve.

1.b 100% of the groove weld length on at least 25% of the number of similar type connections of web members to the truss chords.

- If any rejectable defect is found, double the testing frequency until no rejectable defects are discovered.

2. Perform the following minimum magnetic particle inspection (MT) of fillet welds and Partial Joint Penetration (PJP) groove welds.

2.a Intermediate member connections: MT 100% of the weldment length on at least 25% of the total number of connections on trusses and towers, respectively.

- If any rejectable defect is found, double the testing frequency until no rejectable defects are discovered.

2.b Welds on truss seat plates, base plates, cantilever and center-mount sleeves, and alternate press-break members and fillet welds connecting backing rings to base plates and flange splice plates: MT a minimum of 25% of the total length of each weld.

- If a rejectable defect is found, then test 100% of the weld on that element.

2.c Welds attaching handhole frames to columns: MT 100% of the length of each weld.

2.d All other connections: MT 100% of the weldments on at least 10% of the total number of connections

- If any rejectable defect is found, double the testing frequency until no rejectable defects are discovered.

3. Perform 100% radiographic inspection of complete penetration longitudinal seam welds on tapered tube structures and on all press-break columns.

4. The Department's plant inspector will select weld locations and weldments to be tested when less than 100% of weld length is required to be tested.

5. Backing rings for full penetration welds must be continuous or butt welded with a full penetration weld. Perform 100% ultrasonic inspection (UT) of butt welds in rings 5/16-inch and thicker. Perform 100% MT on rings less than 5/16-inch thick.

(e) Anchor Bolts, Nuts, and Washers. Section 1105.02(c)3, except anchor bolts shall conform to Grade 55 only.

(f) Class A Cement Concrete. Section 704

(g) Mortar. Section 1001.2(d), with a 1-day compressive strength equal to or greater than 3,750 pounds per square

inch.

(h) Reinforcement Bars. Section 709.1

(i) Stainless Steel U-Bolts and Washers. ASTM A 276, Type 304. Maximum allowable diameter for stainless steel U-bolts is 3/4 inch Condition B.

(j) Stainless Steel Nuts. ASTM F 594, Alloy Group 1

(k) High Strength Bolts. Section 1105.02(d)

- Furnish bolts, nuts, and washers for testing purposes and test as specified in Section 1050.3(c)7.b.
- U-bolts, other than stainless steel, shall conform to ASTM A 449.
- Stainless Steel U-bolts as specified in Section 948.2(i) may be substituted for ASTM A 449 U-bolts for bolt diameters of 3/4 inch and smaller.

(m) Bedding Material for Bridge Shoes. Section 1113.03(h)

(n) Pre-Assembly of Field Connections. Before galvanizing, preassemble field connections of chord trusses and chord sections to verify geometry and camber. If distortion occurs after galvanizing, re-verify.

(o) Certification. Section 106.03(b)3

948.3 CONSTRUCTION—As indicated, as shown on the Standard Drawings, and as follows:

(a) General. Submit detailed shop drawings for review and acceptance. Submit erection drawings as directed by the Structure Control Engineer conforming to Section 105.02. Material and workmanship not previously inspected will be inspected on the work site. Remove rejected material from the work site. Restore the site to its original condition, including the disposal of excess or unsuitable material.

(b) Foundations. Excavate and construct the foundations of Class A cement concrete, as specified in the applicable parts of Section 1001.3.

Use steel templates provided by the fabricator to accurately set tower base anchor bolts to the correct elevation and alignment. Securely brace the bolts against displacement before concrete is placed. Provide conduit sweeps when required.

After constructing the concrete foundations, backfill the excavation around the foundation using acceptable material, in uniform loose layers, not exceeding 4 inches in depth. Compact to the necessary density by means of mechanical tampers.

(c) Bearing Areas. Construct the column base bearing areas of concrete pedestals, in a true and level position. Provide full bearing under bases. Place bedding material for bridge shoes, if indicated.

(d) Cantilever and Centermount Structures. Adjust cantilever and centermount structures, after the sign panels and lighting are installed, to make the signs level.

(e) Column Installation and Anchor Bolt Pretensioning. Install sign structure columns, and pretension the anchor bolts in strict conformance with the following procedure:

1. Remove all dirt or other foreign material from the top of the concrete pedestals or caissons. Clean top and bottom surfaces of column base plates to the satisfaction of the Representative; remove any burrs or excessive surface galvanizing in the area of the anchor bolt holes that would prevent proper seating of the washers in the snug tightened condition.

2. Verify that a test nut can be turned onto each anchor bolt to a point below the elevation corresponding

to the bottom of each in-place leveling nut, and can then be backed off the bolt by the effort of one person using a 12-inch long wrench or equivalent without employing a pipe extension on the wrench.

3. Clean and lubricate the exposed threads of all anchor bolts. Clean and lubricate the threads and bearing surfaces of all nuts. Re-lubricate the anchor bolts and the nuts if more than 24 hours has elapsed since earlier lubrication, or if the bolts or nuts have become wet since they were first lubricated.

4. Turn the leveling nuts onto the anchor bolts and align the nuts to their approximate final elevation. Place one hardened washer on top of each leveling nut.

5. Install column. Column must fit freely over the anchor bolts; do not force column onto anchor bolts. Support the column with the crane as necessary, and adjust leveling nuts to align the column into its proper upright position. Bring all leveling nut washers into contact with the bottom of the base plate.

NOTE: Upon subsequent completion of any column installation and the tightening of all nuts, the clear dimension between the bottom of each leveling nut and the top of the concrete pedestal or caisson shall not exceed approximately 1 inch as shown on the Standard Drawings. In no case shall this clear dimension ever exceed the diameter of the anchor bolt unless substantiated by design bending calculations for the bolts.

6. Place one hardened washer onto each anchor bolt on top of the base plate, and turn the top nuts onto the anchor bolts and into contact with the washers on the base plate.

NOTE: If for any reason, the slope of an anchor bolt from vertical, or the slope of the base plate from horizontal, results in a deviation of greater than a 1:40 slope at the bolt/plate intersection, or if a nut cannot be brought into full contact with the base plate after final tightening, a fabricated-to-fit beveled washer must be used in place of a flat washer under each nut at that location.

7. Tighten the top nuts to a snug-tight condition using a star tightening pattern. Snug-tight is defined as the maximum nut rotation resulting from the full effort of one person using a 12-inch long wrench or equivalent (no pipe extensions). A star tightening pattern is one in which the nuts on opposite or near opposite sides of the bolt circle are successively tightened in a pattern resembling a star.

8. Tighten the leveling nuts to a snug-tight condition using a star tightening pattern as stipulated for top nuts. At this point, verify that the clear distance between the bottom of each leveling nut and the top of the concrete is compliant with maximum allowable requirements.

9. Before final turn-of-nut tightening of the top nuts, mark the reference position of each top nut in its snug-tight condition with a suitable marking on one flat, and a corresponding reference mark on the base plate at the same location. Then, using a star tightening pattern and at least two tightening cycles (passes), incrementally turn the top nuts until achieving the total required nut rotation as specified in the table below. After tightening is completed, verify proper rotation at each nut by observing the reference marks, and verify that the nut and washer are in full contact with the top surface of the base plate.

Top Nut Rotation Beyond Snug Tight	
Anchor Bolt Diam. (in.)	F1554 Grade 55
≤ 1 1/2	1/3 Turn
> 1 1/2	1/6 Turn
Note: The top nut rotation tolerance is -0, +20 degrees (1/18 turn) from the specified value.	

10. Install jam nuts to a snug-tight condition, and burr the threads of each anchor bolt immediately above the jam nut.

11. Install the rodent screen on the base plate.

12. Verify bolt/nut tensioning no sooner than 48 hours, and no later than 7 days after final/complete

installation, as follows:

a. Remove the rodent screen.

b. Using a 12-inch long wrench, apply a snug-tight force to each top nut (not jam nut) and then to each leveling nut as stipulated in Paragraphs 7 and 8 above. If any nut rotates by any amount, carefully document the location and approximate degree of rotation of that nut, in writing, and report the information to the Chief Structural Materials Engineer as soon as possible upon completion of the verification.

c. Apply a snug-tight force to each jam nut, and replace the rodent screen.

(f) Expansion. Provide a 1 1/4-inch clearance for expansion of structures mounted between concrete walls. Hand-tighten the nuts on the U-bolts at expansion points on such structures, and then install jam nuts.

(g) Connections Using High-Strength Bolts. Section 1050.3(c)7

948.4 MEASUREMENT AND PAYMENT—

(a) Steel Sign Structures. Lump Sum
The price includes removal of existing signs.

(b) Class 3 Excavation. Cubic Yard

(c) Class A Cement Concrete. Cubic Yard

(d) Reinforcement Bars. Pound

SECTION 951—TRAFFIC SIGNAL SUPPORTS

951.1 DESCRIPTION—This work is the furnishing and installation of complete and operational traffic signal supports for the mounting of traffic control devices and luminaires.

951.2 MATERIAL— Sections 1104.01 and 1104.02 and as follows:

- Reinforcement Steel—Section 709.1
- Conduit—Section 1104.05(a)
- Class A Cement Concrete—Section 704
- Ground Rod—Section 1101.11(j)
- Nonshrink Mortar—Section 1001.2(e)
- Metal screening—Section 1101.02
- Premolded Expansion Joint Filler—Section 705.1

951.3 CONSTRUCTION— Sections 1104.01 and 1104.02, as shown on the Standard Drawings, and as follows:

(a) Excavation. Before forming and placing concrete, each foundation excavation will be inspected for the actual soil conditions encountered. Do not proceed with the work until the excavation is accepted. If necessary, revise the foundation design based on the soil conditions encountered. Before submitting the revised design for approval, obtain the signature and seal of a Professional Engineer registered in the State. Foundation locations may be changed to avoid underground obstructions, with written permission of the Representative.

(b) Foundations. Install reinforcement steel, anchor bolts, conduit sweeps, and ground rods with ground wire clamps. Orient the anchor bolt template to obtain the proper angle of the mast arm. Place concrete as specified in the applicable parts of Section 1001.3.

Backfill around the foundation in 6-inch layers with selected on-site material, then compact mechanically to the density of the undisturbed earth. Dispose of excess or unsuitable material. Place 1/2-inch premolded, expansion joint filler between the foundation and existing concrete sidewalks and pavements.

After placing concrete, do not install supports for a minimum of 72 hours.

(c) Traffic Signal Supports. Install supports, of the type indicated, on the foundation. Use leveling nuts on the anchor bolts to adjust the support shaft rake to provide a vertical set when the load is added.

Connect the ground wire to the grounding lug.

Install span and tether wires on strain poles. Allow enough span wire and tether wire length to fasten wire and for sag adjustment. After installing signal cable, signal heads, and signs, adjust sag of the span wire.

Install mast arm to column using high-strength bolts. Threaded plate traffic signal support connections are not allowed. Check for vertical alignment of the shaft and for alignment of the mast arm after signals, brackets, signs, luminaires, and signal cable are in place. Adjust to the correct alignment.

Tighten anchor nuts, as specified in Section 1105.03.

Place nonshrink mortar or metal screening, providing drain hole in the mortar or screening. Place mortar or screening vertically at the outside edge of the base plate.

951.4 MEASUREMENT AND PAYMENT—Each and as specified in Section 1104

SECTION 952—CONTROLLER ASSEMBLY

952.1 DESCRIPTION—This work is the furnishing and installation of a traffic signal controller assembly of the type indicated.

952.2 MATERIAL— Sections 953.2, 954.2, 955.2, 1104.01, and 1104.03 and as follows:

- Class A Cement Concrete—Section 704
- Caulking Compound—Section 705.8(b)

952.3 CONSTRUCTION— Sections 953.3 and 1104.01,, as shown on the Standard Drawings, and as follows:

(a) Controller Assembly. Install the controller assembly with internal time-base coordination, as indicated. For base-mounted controller assemblies, construct the foundation as specified in Sections 951.3(a) and (b). Connect field wiring for signals, interconnect, and preemption. Connect service to the input/output terminals of the controller assembly. Connect to the equipment safety ground.

When the signal controller becomes operational, and during initial turn-on, demonstrate that all functions are operating in accordance to all the design documents and the applicable standards for the installed unit. Conduct the demonstration, as directed, in the presence of the Representative. Upon successful demonstration that all functions are operating properly the controller will be subject to a 30-day system test. If a fault occurs during the 30-day test period correct the problem and restart the test. Once the 30-day period has expired with no recordable system faults and meets the approval of the Representative the system will be considered for final acceptance.

Connect the conflict monitor or malfunction management unit to function as specified in Section 1104.03(b). When the controller assembly becomes operational, and during initial turn-on, demonstrate that the conflict monitor or malfunction management unit will cause transfer of the signals to flashing operation upon sensing all possible conflicting signal indications. Conduct the demonstration, as directed, in the presence of the Representative. The 30-day system test shall not begin until the conflict monitor or malfunction management unit is functioning properly.

Before or during the initial turn-on, connect output from shutdown relay to the output and power input of the signal load switches. Connect relay to controller assembly to provide flashing operation with the traffic signal controller unit installed or removed. Provide activation of the shutdown relay from any of the following sources:

- Removal of controller voltage, when indicated
- Police panel switch
- Output from conflict monitor or Malfunction Management Unit

Connect systems and communication control equipment as indicated. Before the 30-day system test, field test for the indicated operation as specified in Section 953.3(b).

(b) Time Clock. Install the time clock, when indicated. Connect to input/output terminals of the control equipment. Connect to the equipment safety ground. Field test for indicated operation.

(c) Connector Harness. Provide a separate harness and connector that meets NEMA Standards and is wired for the maximum phase capability of the controller unit.

(d) Cable Connections (NEMA TS-1 & TS-2), Type 170-Advanced Traffic Controller (ATC), and Type 2070-ATC).

1. Copper Cables. Connect the traffic signal cable and interconnection cable to the proper color coded controller terminals as directed by the Representative. Crimp-type connectors are not to be used for traffic control cable or interconnection cable. All wiring and cable connections are to be neat and with all such cables tie-wrapped. Spare conductors of signal cable and interconnection cable are to be neatly wrapped in the cabinet and of the same length as the active conductors. Connect all communication cable conductors to the terminal block. Mount on the inside of the lower left cabinet wall a communication cable terminal block. The terminal block is to have a sufficient number of connections to splice two 12-pair communication cables together. If applicable, mount on this

panel an RS-232 interface for connecting a portable PC to the 170/2070 Microcomputer. The RS-232 interface is to consist of a shielded cable with a DB9 connector at one end, and a 170/2070 C2 type connector at the other. Plug the DB9 connector into the C2 port of the 170/2070 controller.

2. Fiber Optics. Route all fiber optic cables entering the controller cabinet through a 1 1/4 inch internal diameter conduit as specified in Section 954. Run a continuous conduit segment from the base of the pole, through the bottom entry hub of the junction box, and into entry hub in the bottom of the Controller Cabinet. Place conduit to maintain the minimum bend radius of fiber optic cable. The conduit from the cabinet to the closest junction box or manhole is incidental to this item.

The cabinet is to have the means to hold service loops, each 8 feet in length, of each of the jacketed fiber optic cables entering and leaving the cabinet. Secure each service loop to the bottom of the lowest rack in the cabinet in such a way as to ensure the minimum bend radius of the cable(s), and prevent interference of any kind. However, the service loops are to be easily removed and reattached during fiber maintenance. Carefully route the fiber optic cable(s) to the patch panel for termination.

The cabinet is to have a patch panel, mounted on an easily removable aluminum panel, to house all internal fiber splices; mount the aluminum panel in an appropriate location inside the cabinet. Secure the fiber optic cable(s) to the panel before entering the patch panel. Terminate all field fibers in the cabinet. If applicable, mount on this panel an RS-232 interface for connecting a portable computer to the 170/2070 microcomputer. The RS-232 interface is to consist of a shielded cable with DB9 connect at one end, and a 170/2070 C2 type connector at the other. Mount the DB9 connector on the panel for easy access, and the C2 type connector plugged into the C2 port of the 170/2070 controller.

952.4 MEASUREMENT AND PAYMENT— Each and as specified in Sections 1104.01 and 1104.03 for the type indicated:

(a) Controller Assembly. Each

The price includes required controller assembly with Buss Interface Unit (BIU) and detector card rack assembly, conflict monitor or malfunction management unit, flasher unit, load switches or switch packs, cabinet, relays, cable terminal/harness assembly, electric load center, generator adapter kit, police panel, and time clock.

SECTION 953—TRAFFIC SIGNAL SYSTEMS AND COMMUNICATIONS

953.1 DESCRIPTION—This work is the furnishing and installation of the system equipment for the control of traffic signals and the furnishing and installation of equipment necessary to provide communication between controller and assemblies and other components that form a system, as indicated on the approved plans.

953.2 MATERIAL—Sections 1104.01 and 1104.04 and as follows:

- Class A Cement Concrete—Section 704
- Caulking Compound—Section 705.8(b)

953.3 CONSTRUCTION—Sections 1104.01 and 954.3, as shown on the Standard Drawings and as follows:

(a) Time Based Coordinator Unit. Section 952.3

(b) Master Controller Assembly. Section 952.3

(c) Coordination Unit. Section 952.3

(d) Closed Loop Signal System.

1. Software. Install two licensed versions of closed loop system software, one on a Municipality designated computer and the other on a designated Department computer. Provide software upgrades, as released by the manufacturer, at no additional cost. Provide necessary connections to facilitate communications with the on-street master and local controllers through the software.

Software versions to be input with project specific data, i.e. intersection data, intersection graphics with real-time displays, overall system map graphics.

2. Testing. Conduct a 30-day systems test after the completion of all individual intersections' 30-day tests. System test will include but not be limited to the following:

- Communication test from the systems computers to intersection controllers and vice versa
- Monitor detector status
- Provide real time intersection display
- Log system events
- Upload and download system and intersection databases
- Review system status reports
- View system displays
- Test system security codes
- Automatic adjustments for daylight savings time (DST)
- Emergency Preemption logs

Provide 180 days of support after the successful completion of the systems test. Support includes correcting software deficiencies that may be discovered through sustained operation, and addressing any system related problems within 48 hours of notification. Supply support contact information to the Municipality and the Representative.

3. Training. Provide two separate, 8-hour training sessions on the system software for a maximum of ten people. Hold the sessions at the municipality after the successful completion of the systems test. Provide appropriate handouts to each attendee on the system software. Cover the following:

- basic system architecture,
- the operation of the closed loop system software,

- revising system parameters,
- the purpose and operation of each data screen,
- backing up the software and data,
- the addition of new intersections to the system,
- understanding and responding to alarms and failure modes,
- prevention of unauthorized access to the system,
- printing system reports,
- and any trouble shooting procedures.

(e) Radio Communications System: Furnish all necessary antennas, cables, jumpers, and lightning protection as necessary to provide a complete and functioning wireless interconnect system to include but not be limited to the following:

- One radio unit at the master controller location and at each local controller location as indicated on the approved plans.
- Communication cable from the controller to the radio unit.
- Omni and directional antennas as directed on the approved plans.
- Coaxial cable assembly with length and size as shown on the approved plans.
- Coaxial lightning suppressors at all locations and grounded to the grounding electrode system.
- Supply antenna grounding kits at all locations and connected to the grounding electrode system.
- Provide each radio unit with repeater capabilities.
- Provide all product information and warranties for all equipment.

Neatly install all equipment meeting all FCC, TIA/EIA requirements and all state and local codes.

Upon completion of the radio system installation conduct the following tests in the presence of the Representative to ensure the installation is functioning adequately.

- Perform cable frequency sweep testing with appropriate test equipment. Test cables and connectors over cable manufacturer's entire certified frequency range.
- Report cable VSWR performance in graphical format.
- Perform TDR testing to identify point faults. Report in graphical format.
- Test all ground system interconnections. Report impedance measurements.
- Repair or replace any cables and connectors that do not meet manufacturer's published performance standards. Retest any such cables.
- Tune and configure system to maximize performance of radio link.
- Report actual VSWR, RSSI, and S/N ratio.
- Utilize radio manufacturer's diagnostic system software to assist in analysis and configuration.
- Log and submit printed diagnostic software results.
- Visually inspect all installed system components. Restore or replace all components found to be in less than perfect condition.
- Adjust ERIP to within FCC allowable limits.

Upon successful completion of the testing requirements the Representative will provide the contractor with final approval that the system is complete.

(g) Cable. Install instrument, control, and communication cables and hardware as required. Do not splice cables, except at terminal strips. Test the cables, as specified in Section 954.3(j), as applicable.

(h) Cellular Communications System: Cellular communication system consisting of a cellular modem, communication cables, antenna, and surge protection. Furnish all necessary materials necessary to provide a complete and functioning cellular interconnect system including but not limited to the following requirements:

- One cellular modem is provided at the master controller location and at each local controller location as indicated on the approved plans.
- Communication cables from the controller to the cellular modem.
- Omni antennas as directed per the approved plans. Size the antenna to match the cellular modem used and the strength of the cellular signal for each location.

- Provide surge protection for the cellular modem at all locations and connect to the grounding electrode system.
- Provide all product information and warranties for all equipment.

Neatly install all equipment meeting all FCC requirements and all state and local codes. Facilitate the cellular modem authorizations with the Service Representative and ensure that all cellular contracts are turned over to the proper responsible parties.

Upon completion of the cellular system installation, demonstrate to the Representative that the installation is functioning properly and according to the approved plans.

(i) Telephone Dialup Communications System: Telephone dialup communication system consisting of a dialup modem, communication cables, and surge protection. Furnish all necessary materials necessary to provide a complete and functioning dialup interconnect system including but not limited to the following requirements:

- One dialup modem is provided at location as indicated on the approved plans.
- Communication cables from the controller to the dialup modem.
- Provide surge protection for the dialup modem at all locations and connect to the grounding electrode system.
- Provide all product information and warranties for all equipment.

Install all equipment in a neat and professional manner meeting contract requirements and all state and local codes. Facilitate the telephone connections with the Service Representative and coordinate with the Representative to ensure that all telephone lines are turned over to the proper responsible parties.

Upon completion of the dialup system installation, demonstrate to the Representative that the installation is functioning properly and according to the approved plans.

(j) Fiber Optic Communications System: Fiber optic communication system consisting of a fiber optic (FO) network switch, patch panel, communication cables, and surge protection. Furnish all necessary materials necessary to provide a complete and functioning FO interconnect system including but not limited to the following requirements:

- One FO network switch is provided at the master controller location and at each local controller location as indicated on the approved plans.
- Communication cables from the controller to the FO network switch.
- Provide FO cable between each location as indicated on the approved plans.
- Provide FO patch panel for terminating each FO cable at an enclosure.
- Provide inner duct in all underground conduit installations in accordance with Section 954.3(a), (b), (c).
- Provide all product information and warranties for all equipment.

Standards: Unless specified otherwise provide all FO cables and installation methods meeting the following standards:

- EIA FOTP-25 for requirements on impact resistance of FO cable
- EIA FOTP-33 for requirements on tensile resistance of FO cable
- EIA FOTP-41 for requirements on crush resistance of FO cable
- EIA FOTP-892 for requirements on moisture resistance of FO cable
- EIA FOTP-104 for requirements on flexibility of FO cable

Provide multi-fiber optic cables over 60 feet long with minimum 12 fiber count, except where indicated otherwise on the approved plans and specifications. Terminate all spare fibers with ST type connectors and connect the patch panel.

Provide FO patch cords exceeding 60 feet long with minimum 4 spare fibers or 20% of used fiber count (whichever is the greatest), except where indicated on the approved plans.

Install each FO cable run as one continuous length; no splicing in the conduit system is allowed; fusion splicing for FO lines longer than 1,000 feet is allowed but only in designated splice trays inside designated splice enclosures. Test all fiber strands including spare fibers for continuity and submit documentation.

Ensure that pulling strength of the cable is not exceeded during installation.

Ensure that the minimum bend radius of the cable is not exceeded during installation.

Install aerial FO cables in accordance with the manufactures recommended installation methods and components

and be loose tube design.

Ensure that the maximum installation tension (Span Tensioning) is not exceeded during the installation of aerial FO cables.

Do not exceed 0.75 dB insertion loss per mated connector pair. Where the installed FO connector assembly to terminate onto a connector at a FO device and the said mating device connector is not separable from the device, then the insertion loss of the single installed FO connector assembly will be less than 0.35dB.

Perform optical power tests before and after splice for attenuation on the spliced FO line longer than 1,000 feet. Do not exceed 0.3dB insertion loss for each splice. Document results and submit to the Representative.

Use "ST" type connector for a FO strand. In cases where "ST" type connector is not available for the related device, obtain written permission for the use of manufacturer's standard connector type before finalizing procurement/supply of affected item(s). Fabrication tolerances and quality of the connector shall be such that the limitation on installed insertion loss of the connector is achievable.

Provide FO patch cables as indicated on the approved plans. FO patch cables must be provided from the connectors on the FO cross patch panel to the connectors on the FO network switch.

Provide single mode fibers consisting of (single-mode, 8.3-10/125 µm) cable, 900 µm loose tube gel-filled with fibers, aramid yarn strength members, yellow flexible flame retardant jacket, round duplex configuration, UL type OFNR. Provide a cable with a maximum attenuation of 0.5 dB/km @ 1310 nm and 0.4 dB/km @ 1550 nm.

Install all equipment in a neat and professional manner meeting all installation requirements and all state and local codes. Install all conduit and trenches in accordance with Sections 954.3(a), (b), (c). For aerial FO installations, coordinate any utility pole attachments or provide service poles for attachment if indicated on the approved plans. Provide service poles in accordance with Section 1101.11(a).

Upon completion of the FO system installation, demonstrate to the Representative that the installation meets the operational limits and Section 952. Demonstrate to the Representative that the installation is according to the approved plans.

(k) Traffic Signal System Testing. Unless otherwise indicated in Section 953.3(d)(2) for a closed loop system. Conduct a separate 30-day operations test on the system and communications. Test the entire system for the indicated operation, including proper operation and communication between local controller assemblies, master controller assemblies, and other necessary remote control or monitoring equipment. System test includes hardware and software used for control, communication, or monitoring. Change inputs, outputs, and programming controls, and adjust or revise initial signal timing parameters, as directed.

(l) Traffic Signal System Training. Unless otherwise indicated in Section 953.3(d)(3) for a closed loop system.

Provide initial system training during the first week of the 30-day system test lasting a minimum of 5 calendar days. Trainees include both local municipalities and Department staff as directed by the Representative.

953.4 MEASUREMENT AND PAYMENT—Section 1104.01 and as follows:

(a) Master Controller Assembly. Each

For the type indicated.

(b) Closed Loop Signal System. Lump Sum

- 50% to be paid on installation.
- 50% to be paid on completion of the 30 day systems test.

(c) Radio Communications System. Lump Sum

Includes all antennas, cable, transmitter/receivers, protective devices, mounting hardware, and testing and diagnostic work for a complete system.

(d) Cellular Communications System. Each

Includes all antennas, cable, modems, mounting hardware, and protective devices, to make a complete and functional cellular communications system.

(e) Telephone Dialup Communications System. Each

Includes all cable, modems, and protective devices, to make a complete and functional telecommunications system.

(d) Fiber Optic Communications System. Each

Includes all cable, modems, mounting hardware, and protective devices, to make a complete and functional fiber optic communications system.

(g) System Training. Lump Sum

Of the type indicated.

SECTION 954—ELECTRICAL DISTRIBUTION

954.1 DESCRIPTION—This work is the furnishing and installation of the electrical distribution for the control and illumination of traffic signals.

954.2 MATERIAL—Sections 1101.02, 1104.01, and 1104.05

954.3 CONSTRUCTION—Sections 910.3(a) and 1104.01, as shown on the Standard Drawings, and as follows:

(a) Conduit Trench and Backfill. Excavate and backfill as specified in the applicable parts of Section 910.3(c). Cut existing pavement only when indicated. If applicable for Type II trench and backfill, require full slab sidewalk replacement as specified in Section 676.3.

Restore existing pavement. For flexible pavement, use asphalt material of a type equal to the existing pavement, as determined by the Representative. For rigid pavement, use High Early Strength Cement Concrete as specified in Section 704.1.

(b) Directional Boring. Install and maintain all erosion and sediment pollution control measures, as indicated on plans, before the start of directional boring. The depth of directional borings should be below the existing roadway subgrade. Do not deform the pavement. Guide the boring. Pneumatic hammers are not allowed. Keep boring pits at least 2 feet from the edge of pavement unless otherwise authorized in writing. Do not use water or drilling fluids to the extent that the pavement might be undermined or subgrade softened. Maintain drilling fluid in bore hole to increase stability of the surrounding soil. Angle the entry/exit holes so that the curvature of the entry/exit holes does not exceed the allowable bending radius of the traffic signal conduit. Cover the boring pits with adequate planking if the drilling operation must be left overnight. Refill and compact boring as specified in Section 206.3(b).

(c) Conduit. Install as specified in the applicable parts of Section 910.3(g) and as follows:

If allowed by the Representative, indicated conduit runs may be changed to avoid underground obstructions.

Install conduit as indicated. Maintain at least a 12-inch separation between conduit and other underground utilities. Install high-impact, plastic spacers a maximum of 8 feet on center, if more than two rigid, nonmetallic conduits are to be installed in a common trench. For conduits within junction boxes and foundations, ends of the conduit should be restricted with a rodent-proof filler.

(d) Bonding and Grounding. Bond and ground all electrical equipment as indicated, as shown on the Standard Drawings, as specified in the applicable parts of Section 910.3(q), and as follows:

Provide a continuous mechanical and electrical grounding system from the controller assembly through the electrical distribution system.

Bridge grounding bushings on rigid metallic conduit.

Thread bonding bushings on the free ends and lock in place with stainless steel set screws, lug mountings, and binding screws.

(e) Signal Cable and Wire.

1. General. Install indicated cable to form a continuous circuit between the proper equipment terminals. Install cables inside supports and brackets.

Insert cable in conduit using lubricant. If new cable is to be installed in conduit with existing conductors, remove the existing cable, clean the conduit, as specified in Section 910.3(g), and then insert both old and new cable into the conduit as a unit. Replace existing cable damaged during removal as directed.

Use insulated, locking, spade terminals for conductor terminations. Neatly arrange conductors and tie with cable ties within fixtures. Attach cable tags at splices, indicating phase and function, within all junction boxes, pole bases, and cabinets.

Terminate all spare signal conductors collectively with a pressure-type mechanical lug and cover with electrical tape. Ground spare conductors.

Attach conductor terminations in controller cabinets to barrier-type terminal blocks with no more than one conductor per screw, otherwise use pressure-type mechanical lugs to accommodate the number of conductors being

terminated. Identify and mark blocks.

Terminate on grounding bus and identify spare and reserved conductors.

Provide enough slack cable in pole bases, controller cabinets, and junction boxes to allow for proper wiring connections. For pole mounted signals and pedestrian pushbuttons, install signal cable inside pole to the terminal block of the signal or pushbutton.

For span wire installations, lash cable to the span wire, or secure using cable rings and saddles.

Provide drip loops at wire entrances to poles and signal heads. Secure drip loops with outdoor-type, self-locking cable ties.

2. Conductor Color Codes.

2.a Pedestrian Pushbutton.

Cable	1 Black	—Spare*
	2 White	—Logic Ground
	3 Red	—Pedestrian Call Detector

2.b Pedestrian Signal.

5/C Cable	1 Black	—Walking Person (Walk)
	2 White	—Neutral
	3 Red	—Upraised Hand (Don't Walk)
	4 Green	—Reserved
	5 Orange	—Spare*
7/C Cable	1 Black	—Walking Person (Walk 1)
	2 White	—Neutral 1 and 2
	3 Red	—Upraised Hand (Don't Walk 1)
	4 Green	—Reserved
	5 Orange	—Walking Person (Walk 2)
	6 Blue	—Upraised Hand (Don't Walk 2)
	7 White/Tracer	—Spare*

2.c Vehicular Signal.

5/C Cable	1 Black	—Green Ball/Arrow
	2 White	—Neutral
	3 Red	—Red Ball
	4 Green	—Reserved
	5 Orange	—Yellow Ball/Arrow
7/C Cable	1 Black	—Green Ball
	2 White	—Neutral
	3 Red	—Red Ball
	4 Green	—Reserved
	5 Orange	—Yellow Ball
	6 Blue	—Green Arrow
	7 White/Tracer	—Yellow Arrow/Spare*

* Or as indicated.

(f) Electrical Service. Install the conduit and service wire where indicated and consistent with the service type. Perform necessary circuit connections to complete service to the controller assembly as shown on the Standard Drawings.

Install power service outlets in cabinet as specified in Section 1104.05(j) and the NEC.

Install service pole as specified in Section 910.3(k) and as shown on the Standard Drawings.

Verify with the utility company the location of the service conduit on the service pole or to the service manhole.

Notify the utility company of service requirements. Ensure that service is inspected as required by the utility.

(g) Splicing. Splice wires and cables only at the following locations:

- ground wires within junction boxes;
- signal wires and cables in pole bases; and
- places, where indicated, if existing traffic signals are being modified.

When splicing signal cables within pole bases, use wire nuts sealed with waterproof resin.

(h) Junction Box. Section 910.3(p)

(i) Ground Rods. Install ground rods and ground wire clamps as shown on the Standard Drawings.

(j) Testing and Commissioning. Test traffic signal power and control wiring circuits after installation of the electrical distribution system, before connecting to operating equipment, and in the presence of the Service Representative. Complete testing as follows:

- No electrical energy is to be applied to any equipment or components before system testing. The Contractor's service engineer must initiate operation of the equipment.
- All grounding electrodes are adequately installed and measure 8 ohms or less to earth.
- The Contractor’s Representative must verify that instruments, have been properly installed, configured, and meet the manufacturer's qualifications for warranty.
- Submit a certificate from the manufacturer, or from the Service Representative, stating that the installed equipment has been inspected, adjusted, approved, and certified to be satisfactory before field testing.
- Correct and recheck any equipment not functioning correctly. Provide corrective measures to remove any ground loops found during start-up.
- Immediately correct any defects and malfunctions with approved methods and materials.
- Include in the testing, but not limited to, taking all variables to their limits (simulated or actual process) to verify all alarms, failure interlocks and/or transfers, and operational interlocks.

(k) Submittals. Submit 4 copies of documentation to the Representative for all components. Include the following information on the documentation as a minimum:

- Product Data: For each component, include manufacturers descriptive literature; product specifications; published details; technical bulletins; performance and capacity rating curves, charts, and schedules; catalogue data sheets; and other submittal materials as required to verify that the proposed products conform to the quality and functionality as required for the installation.
- Identification: Clearly indicate by an arrow on submissions covering more than one product type or style exactly which product is being submitted for approval.
- Equipment Characteristics: Size, location, weight, and electrical requirements.
- Manufacturer: Include the catalogue name, company name, address, and telephone number for each product submitted.
- Arrangement Drawings: Provide Arrangement Drawing for all signal controller cabinets showing the

external front panel, and internal side and rear mounting sub-panels.

Provide Bill of Materials, on Arrangement Drawing, identifying equipment shown and all software.

- Reference equipment by a numerical item number. Include the following information:
  - Item
  - Identity
  - Quantity
  - Description
  - Manufacturer
  - Catalog Number

- Provide wiring diagrams for each signal controller cabinet illustrating the power connections to each internal device and all field connections. Display all wiring in a ladder diagram format.

(**l) Generator Adaptor Kit.** Submit shop drawings/catalog cuts of the kit conforming to Section 1104.05(h) before installation. Provide and attach to the signal controller cabinet after approval.

(m) Uninterruptible Power Supply (UPS). As specified in Section 1104.05(i) and as follows:

- Provide true-online double conversion
- Initiate a 30-day test only after the total system is running and functional.
- Install and test the UPS in accordance with the manufacturer's specifications.

954.4 MEASUREMENT AND PAYMENT—Section 1104.05 and as follows:

(a) Conduit. Linear Foot
For the type indicated.

(b) Trench and Backfill. Linear Foot
For the type indicated.

(c) Directional Boring. Linear Foot
For the type indicated.

(d) Signal Cable. Linear Foot
The unit price includes cable, identification tags, and cable lashing.

(e) Junction Box. Each
For the type indicated.

(f) Electrical Service. Each
For the type indicated.
The price includes service pole, service head, meter socket, service disconnect, power line surge protector, exposed conduit, conduit fittings, service wire, generator adaptor kit, ground rod, and ground wire.

(g) Signal Controller Cabinet. Each
For the type indicated.
The price includes enclosure, internal cabinet power supply system, generator adaptor kit, terminal blocks, mounting hardware, breakers, fuse holders, internal wiring, equipment and communication surge protection, displays, programming hardware, relays, receptacles, light, and heater.

(h) Uninterruptible Power Supply (UPS). Each

(i) Cement Concrete Sidewalks. Section 676.4

SECTION 955—SIGNAL HEADS

955.1 DESCRIPTION—This work is the furnishing and installation of assemblies for the control and illumination of vehicular traffic signals, pedestrian signals, or lane control signals, which includes the appropriate housing and mounting hardware.

955.2 MATERIAL—Sections 1104.01 and 1104.06.

955.3 CONSTRUCTION—Section 1104.01, as shown on the Standard Drawings, and as follows:

(a) General. Arrange and display traffic signal heads in accordance with the approved plans. Variations to the permit should not be completed without approval of the District Traffic Engineer.

Securely mount signal heads, using signal mounting brackets, where indicated, and according to the regulations.

Install signal heads over roadways with the top of the housings at the same elevation and as shown on the Standard Drawings. Where vehicular and pedestrian signals are to be installed on the same support, separate the assemblies. Aim vehicular signal heads, as directed, toward a point approximately 150 feet in advance of the stop line and in the center of the traveled traffic approach. Install louvers where it is necessary to restrict the view of the signal indications from an adjacent approach as specified in Section 955.3(c). Aim pedestrian signals to the far side of the crosswalk they are to control.

Install backplates as specified in Section 1104.06 and install visors as directed on the approved plans.

Securely cover signals with an opaque material that covers and hides signal indicators from the view of traffic until the signal is put into operation. Use material that is sufficiently opaque to hide any lighted signal face indication. Burlap may be used as a hood material if the signal indications are not lighted and will not be until the hood is removed. Maintain the hood and replace or repair the hood if it becomes loose, torn, or removed.

(b) Light Emitting Diode (LED) Modules. Install, or retrofit into existing signal heads, according to manufacturer’s instructions.

(c) Optically Programmed Signals. According to the manufacturer's instructions, program each signal head to restrict signal visibility to the area indicated.

955.4 MEASUREMENT AND PAYMENT—

(a) Vehicular Signal Heads. Each

For the type indicated.

The price includes, when indicated, traffic signal housing, louvers, backplates, and mounting hardware.

(b) Optically Programmed Signal Heads. Each

For the type indicated.

The price includes, when indicated, traffic signal housing, tunnel visors, louvers, backplates, and mounting hardware.

(c) Pedestrian Signal Heads. Each

For the type indicated.

The price includes, when indicated, traffic signal housing, louvers, and mounting hardware.

(d) Lane-Use Traffic Control Signal Heads. Each

(e) Programmable Louvered Head. Each

SECTION 956—DETECTORS

956.1 DESCRIPTION—This work is the furnishing and installation of devices to sense the presence or passage of vehicles or pedestrians.

956.2 MATERIAL—Sections 1104.01 and 1104.07

956.3 CONSTRUCTION—Section 1104.01, as shown on the Standard Drawings, and as follows:

(a) Vehicular Detection.

1. Loop Detector. Saw cut slots in the pavement for the sensor, as indicated. Rotary drill a hole for the conduit at curb. Ensure the slot and hole are free of moisture and debris. Install the conduit. Install the number of sensor turns to obtain the inductance required by the manufacturer to achieve proper operation, without splices, kinks, or curls, and without straining or stretching around the corners of the slot. Install a minimum of two turns of wire for each loop detector. Use a blunt nonmetallic tool to seat the sensor in the bottom of the slot. Check for slack, raised portions, and tightness. Correct if necessary. Insert the two leads from the loop, twisted together a minimum of 3 turns per foot, in the conduit leading to the junction box. Test leakage resistance, series resistance, and inductance before sealing the sawcut slot. Leakage resistance greater than 10 megohms is necessary when tested at 375 V(dc) minimum. Series resistance is not to exceed 2.6 ohms per 1,000 feet. Inductance is to be between 50 microhenries and 700 microhenries. Seal the conduit with duct seal. Seal the hole and slots with sealant, according to the manufacturer's instructions. Do not apply the sealant if the air temperature is below 32F, unless otherwise specified by manufacturer, or during precipitation. Fill the slot to within 1/8 inch of the pavement surface and ensure that there are no voids. Do not allow traffic on the slot until the sealant is cured. Remove excess sealant from adjacent road surfaces, but do not use solvents.

When resurfacing occurs over any area of loop sensor, install the sensor in the existing pavement structure or in the binder course before placement of the wearing course. Do not install the top course of pavement before the sealant is cured.

Splice the sensor wires to the lead-in cable as shown on the Standard Drawings. Encapsulate the splice with sealant to prevent water from penetrating the splice. Connect the sensor to each lead-in pair, as indicated. Band all excess loop sensor/lead-in cable in the junction box to prevent movement resulting in false calls. Extend the lead-in cable to the terminal strip in the controller cabinet, without splices. Measure inductance of loop and lead-in. Inductance is to be between 50 microhenries and 700 microhenries. Place a record of the inductance readings in the controller cabinet. Connect to the loop detector amplifier. Adjust the amplifier, according to the manufacturer's instructions, to obtain the necessary sensitivity. Provide field validation that the detector equipment is properly working.

2. Video Detector. Install and mount according to the manufacturer’s instructions to provide area of detection and operation as indicated without detecting conflicting movements. Secure detectors using appropriate mounting brackets as required by the manufacturer. Adjust and realign video detector as necessary to obtain optimal detection zone. Draw appropriate detection zones as indicated on the approved plans.

For applications that require remote monitoring of the traffic signal video provide a reduced frame rate connection. Do not transmit remote monitoring of the video over the traffic signal controller interconnect communications system. Equip intersection with a remote connection as indicated on the plans. Compress images before transmitting and adjust frame rates to meet the bandwidth requirements. Provide all material, support, and coordination necessary to ensure the remote video access is functioning properly. Provide field validation that the detector equipment is properly working.

3. Radar Detector. Install and mount according to the manufacturer’s instructions to provide area of detection and operation as indicated without detecting conflicting movements. Secure sensors using appropriate mounting brackets as required by the manufacturer. Provide field validation that the detector equipment is properly working.

4. Radar Detection System. Install intersection detection control utilizing above ground techniques. Mount the sensor(s) directly to a pole or mast arm and provide cable as required and recommended by the manufacturer. Provide field validation that the detector equipment is properly working.

5. Magnetometer Detector. Before installation, conduct the manufacturer's test to determine if the earth's magnetic flux at the point of installation is sufficient for the detector to operate. Rotary drill a hole in the pavement for the sensor. Saw cut slots for the lead, as indicated. Rotary drill a hole for the conduit at curb. Ensure the holes and slot are free of moisture and debris. Install the conduit. Insert the sensor vertically in the hole. Then insert the lead wire in the slot and in the conduit leading to the junction box. Use a blunt nonmetallic tool to seat the wires in the bottom of the slot. Test leakage resistance and series resistance. Leakage resistance greater than 10 megohms is necessary. Series resistance is not to exceed 2.6 ohms per 1,000 feet. Backfill the sensor hole, then seal the holes and slot with sealant, according to the manufacturer's instructions. Do not apply the sealant if the air temperature is below 32F, or during precipitation.

Complete the installation for the magnetometer detector, as specified in Section 956.3(a)1.

6. Magnetic Detector. Bore a tunnel, with boring pit as necessary, without disturbing the pavement, from the junction box to a point approximately 2 feet beyond the centerline of the detection zone. Bore a diameter only large enough to insert the conduit. Repair any damage to the roadway or pavement base drain caused by boring. Insert the capped, rigid, nonmetallic conduit in the tunnel, using a proper lubricant if necessary. Insert the sensor within the conduit. Test leakage resistance and series resistance. Leakage resistance greater than 10 megohms is necessary. Series resistance is not to exceed more than 2.6 ohms per 1,000 feet.

Complete the magnetic detector installation, as specified in Section 956.3(a)1. Adjust the location of the sensor to obtain proper operation.

(b) Pedestrian Detection.

1. Pushbuttons. Install the pedestrian pushbutton and indicated sign, using stainless steel vandal-resistant, machine screws, rivets, or stainless steel banding taking care not to impair the message on the sign. Install in accordance with Publications 13M, 148, and 149 and the approved plans. Ensure that the pushbutton and sign is right side up. Drill and tap mounting holes of the size and pattern specified by the manufacturer. Drill and deburr the cable entrance hole. Connect the pushbutton according to the manufacturer's instructions, as indicated, and as shown on the Standard Drawings. Provide sealant above pushbutton where it abuts connecting support.

Field-test the operation by activating the pushbutton and performing a visual check of the controller indicator lights and a timing check of the pedestrian phase or phase extension.

2. Accessible Pedestrian Signals (APS). Sections 956.3(b)1, 1104.01, and 1104.07, the Standard Drawings, the MUTCD, and as follows:

Install the APS pushbutton, speaker and vibrotactile device, and any applicable pushbutton sign within 10 feet of the extension of a crosswalk line, and reachable from the level landing of the curb ramp. Orient the arrow parallel to the direction of the crosswalk.

Attach any external speakers directly to the traffic signal supports and not to pedestrian signal heads. Adjust volumes of the pushbutton locator tone and WALK indication emitting from the pushbutton housing to a maximum of 2 to 5 dBA louder than ambient sound, except when audible beaconing is provided in response to an extended pushbutton press.

Field-test the operation by activating the pushbutton and performing a visual check of the controller indicator lights and a timing check of the pedestrian phase or phase extension.

(c) Preemption Systems. In accordance with the MUTCD, approved plans, and as follows:

Install in accordance with the manufacturer's and supplier's specifications to provide for a complete and operational system. Review each detector location in the field with a Service Representative and a representative of the District Traffic Unit before installation in order to provide optimum operation.

Test complete system at the intersection with an emergency vehicle.

956.4 MEASUREMENT AND PAYMENT—Sections 1104.01 and 1104.07 and as follows:

(a) Detector Lead-In Cable. Linear Foot

(b) Detector Card Rack Assembly. Each

Unless provided as part of new controller assembly.

(c) Detector Card. Each
Unless provided as part of new controller assembly.

(d) Loop Sensors. Linear Foot
Measured along sawcut to where it enters conduit.
The sensor in conduit is incidental to the payment for conduit.

(e) Loop Amplifiers. Each
For the type indicated.

(f) Video Detector. Each
The price includes cable, controller interface, video monitor for setting up detection zone, mounting hardware, and all software for complete installation.

(g) Radar Detector. Each
The price includes radar detector for setting up detection zone(s), mounting brackets, cables, and connections tested and accepted.

(h) Radar Detection System. Each
The price includes cable, communication interface, interface, radar detectors for setting up detection zone(s), mounting hardware and all software for complete installation.

(i) Magnetometer Sensor. Each

(j) Magnetometer Amplifiers. Each
For the type indicated.

(k) Magnetic Sensors. Each

(l) Magnetic Amplifiers. Each
For the type indicated.

(m) Pedestrian Pushbuttons. Each
The price includes signs and mounting hardware.

(n) Accessible Pedestrian Signal. Each
The price includes signs and mounting hardware.

(o) Preemption System. Each
For the type indicated.
Includes all material required for the installation of an intersection emergency preemption system including detector units, preemption cable, and failsafe lamps.

SECTION 960—HOT THERMOPLASTIC PAVEMENT MARKINGS

960.1 DESCRIPTION—This work is the furnishing and installation of hot thermoplastic pavement markings, of the indicated type and color with a surface application of glass beads.

960.2 MATERIAL—

(a) General. Provide materials from a source listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

(b) Thermoplastic. AASHTO M 249. Provide a material listed in Bulletin 15.

(c) Glass Beads. Section 1103.14, Type A

1. Intermix. Provide sufficient uncoated glass beads to comprise 40% of the marking material by weight.

2. Surface-applied. Moisture resistant coated with a maximum of 5% passing the No. 80 sieve and a minimum of 70% rounds per sieve and a minimum or 80% rounds overall.

960.3 CONSTRUCTION—

(a) General. For proper adhesion, perform surface preparation of the road surface and provide the pretreatment according to Bulletin 15 or recommended by the manufacturer. Clean the roadway surface where the hot thermoplastic pavement markings will be applied. Remove all surface treatment, laitance, curing compound, or any contaminants that would hinder adhesion. Clear any loose dirt and other debris from the application area. Surface preparation is incidental to the application of hot thermoplastic pavement markings, except for the removal of pavement markings which is performed and paid for under Section 963. Identify the location of the final pavement markings by applying spots on the pavement at 40-foot intervals. The Inspector-in-Charge will approve the locations. Apply on dry pavement when the air and roadway temperatures are between 50F and 90F and when the wind speed is less than 20 miles per hour.

(b) Application. Uniformly apply the markings at a minimum thickness of 90 mils ± 3 mils. A tolerance of ± 1/4 inch from the specified width will be allowed provided the variation is gradual and does not detract from the general appearance. For skip line patterns maintain a tolerance of ± 6 inches for each 40-foot cycle and ± 3 inches for each 10-foot skip line.

(c) Glass Beads. Apply glass beads immediately after application of the markings at a minimum rate of 10 pounds per 100 square feet of markings. Uniformly distribute glass beads on the surface. Provide markings with an average minimum initial retroreflectivity of 300 mcd/m^2/lux for white and 250 mcd/m^2/lux for yellow. Under the direction and supervision of the Representative, measure retroreflectivity with a 30-meter geometry retroreflectometer, conforming to ASTM E 1710 within 21 days after installation in accordance with PTM No. 431.

(d) Defective Markings. Remove any markings placed incorrectly and replace them. Repair those markings, which after application and drying, are determined to be defective by the Inspector-in-Charge. Complete this work at no additional cost to the Department. Major problem areas and method of repair include the following:

- Insufficient thickness or line width, uneven cross-section─Prepare defective material by grinding or blast cleaning to remove a substantial amount of beads and the marking surface is roughened. Remove loose particles and debris with compressed air. Restripe the cleaned surface as specified in Sections 960.3(b) and (c).

- Inadequate retroreflectivity, glass bead coverage or retention─Remove defective markings and clean pavement surface, including 1 foot beyond each end of the affected area. Remove loose particles and

debris with compressed air. Restripe the marking on the cleaned surface as specified in Sections 960.3(b) and (c).

(e) Guarantee. Where directed, remove and replace material that has not remained within close conformity to location or has not remained effective in performing useful service in accordance with Section 107.16(b) for a period of 180 days from the date of acceptance. The minimum acceptable service is as follows:

- **Longitudinal Markings.** 90% of material remains in each 1,000-foot section of marking where the intersection unit is defined as material on an approach leg within 160 feet of the intersection.

- **Transverse Markings, Legends, and Symbols.** 90% of material remains for each individual legend, symbol, crosswalk, or stop line.

960.4 MEASUREMENT AND PAYMENT—

(a) Line. Linear Foot

(b) Legend. Each

SECTION 961—COLD PLASTIC PAVEMENT MARKINGS OR LEGENDS

961.1 DESCRIPTION—This work is the furnishing and installation of plastic pavement markings or legends, of the type indicated.

961.2 MATERIAL—ASTM D 4505. When required, provide compatible "adhesive activator" or "primer sealer," as listed in Bulletin 15 or as recommended by the manufacturer.

961.3 CONSTRUCTION—

(a) General. For proper adhesion, perform surface preparation of the road surface and provide the pretreatment according to Bulletin 15 or recommended by the manufacturer. Clean the roadway surface where the cold plastic pavement markings or legends will be applied. Remove all surface treatment, laitance, curing compound, or any contaminants that would hinder adhesion. Clear any loose dirt and other debris from the application area. Use a cleaning method that, as a last operation, provides a dust-free surface over the application area. Surface preparation is incidental to the application of cold plastic pavement markings or legends, except for the removal of pavement markings which is performed and paid for under Section 963. Identify the location of the final pavement markings. The Inspector-in-Charge will approve the locations. Apply on dry pavement when the roadway temperature is greater than or equal to 60F, unless, unless otherwise directed.

Apply according to the manufacturer's instructions.

Provide applicator units, manual or automatic, that are capable of applying two parallel lines simultaneously with a 6-inch space between the lines.

(b) Retroreflectivity. Provide markings with an average minimum initial retroreflectivity of 250 mcd/m²/lux for white and 200 mcd/m²/lux for yellow. Under the direction and supervision of the Representative, measure with a 30-meter geometry retroreflectometer conforming to ASTM E 1710 within 21 days after installation in accordance with PTM No. 431.

(c) Inlaid. Applied as part of an asphalt resurfacing project. Place the material, with a thickness of 60 mils ± 2 mils to 90 mils ± 3 mils, on the pavement before final compaction and within the temperature range specified by the manufacturer. Roll the material into the new surface to achieve a flush finished surface.

(d) Surface Applied. Apply the material with a thickness of 60 mils ± 2 mils, onto the existing, cleaned surface of concrete or asphalt roadways.

(e) Guarantee. Where directed, remove or replace material as specified in Section 107.16(b) has not remained within close conformity to location or has not remained effective in performing useful service for a period of 180 days from the date of acceptance. The minimum acceptable service is as follows:

- **Longitudinal Markings.** 90% of material remains in each 1,000-foot section of marking where the intersection unit is defined as material on an approach leg within 160 feet of the intersection.

- **Transverse Markings, Legends, and Symbols.** 90% of material remaining for each individual legend, symbol, crosswalk, or stop line.

961.4 MEASUREMENT AND PAYMENT—

(a) Line. Linear Foot

(b) Plastic Legend. Each

SECTION 962—WATERBORNE PAVEMENT MARKINGS

962.1 DESCRIPTION—This work is the furnishing and application of waterborne pavement markings, of the type and color indicated.

962.2 MATERIAL—

(a) General. Provide materials from a source listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

(b) Paint. Provide waterborne traffic paints listed in Bulletin 15.

(c) Glass Beads. Section 1103.14, furnish Type A glass beads unless otherwise specified.

962.3 CONSTRUCTION—

(a) General. At least 5 days before beginning work, provide the Inspector-in-Charge with a schedule of operations. In addition, provide the Inspector-in-Charge with the manufacturer's instruction for the installation of the materials, application temperatures, proper mixing techniques, and any other data to ensure the material is being properly installed.

(b) Equipment.

1. Line Application. Use a machine that is:

- Capable of simultaneously applying two parallel lines of the width indicated in solid or broken patterns or various combinations thereof;
- Capable of automatically dispensing glass beads onto the painted surface, at the required application rate, by the pressurized gun method; and
- Equipped with a measuring device, which automatically and continuously measures the length of each line placed, to the nearest foot.

2. Legend Application. Include crosswalks, symbols, legends, stop lines, and other miscellaneous items. Do not apply with hand brushes or rollers. Glass beads may be hand-applied.

(c) Application Rates.

1. Paint. Dispense at a wet-film thickness of 15 mils ± 1 mil for all markings, except edge line markings are 12 mils ± 1 mil.

2. Glass Beads. Apply at a rate of 7 pounds per gallon of paint.

3. Calibration. Use a machine calibrated as follows:

- **Line Measuring Device .** Calibrate automatic line length gauges to maintain a tolerance of ± 25 feet per mile.
- **Cycle Length/Line Timer .** Calibrate cycle length in a tolerance of 6 inches per 40 feet; calibrate line length to maintain a tolerance of 3 inches per 10 feet.
- **Bead Guns .** Calibrate to dispense glass beads at the specified rate. Check by dispensing glass

beads into a gallon container for a predetermined fixed period of time. Verify the weight of glass beads.

- **Paint Guns .** Calibrate to simultaneously apply the paint at the uniform rates specified with an allowable tolerance of 1 mil and with an allowable width tolerance of 1/4 inch.

(d) Surface Preparation. Clean the roadway surface where the waterborne pavement markings will be applied. Remove all surface treatment, laitance, curing compound, or any contaminants that would hinder adhesion. Clear any loose dirt and other debris from the area to be painted with compressed air. Surface preparation is incidental to the application of waterborne pavement markings, except for the removal of pavement markings which is performed and paid for under Section 963. Identify the location of the final pavement markings by applying spots on the pavement at 40-foot intervals. The Inspector-in-Charge will approve the locations.

(e) Temperature Restriction. Apply on a dry pavement with minimum ambient and pavement temperatures of 50F and a maximum relative humidity of 80%. Confirm the proper atmospheric and pavement surface conditions with the Inspector-in-Charge.

(f) Protection of Painted Surfaces. Provide protection to allow adequate time for the markings to dry and be track-free from vehicular traffic. Follow the manufacturer's recommendations or use a minimum of 30 minutes. Use barrier cones to protect markings that do not dry in less than 2 minutes on a roadway where traffic is maintained. Repaint marked or damaged areas, as directed.

(g) Centerline Application. Locate and place as indicated and as follows:

Avoid placing markings on longitudinal pavement joints and seams. Where existing centerlines are visible and properly located, apply directly over the existing pattern.

Where centerlines do not exist or existing centerlines are improperly located, apply at the correct location, as determined by the Inspector-in-Charge. Remove the improperly located existing markings, as specified in Section 963.3.

Divide the roadway on two-lane roadways. However, if a portion of the roadway on either or both sides is to be used for parking, then divide the traveled way.

(h) Edgeline Application. Do not place markings on joints or seams between the traveled way and shoulder.

(i) Retroreflectivity. Provide markings with an average minimum initial retroreflectivity of 250 mcd/m^2/lux for white and 165 mcd/m^2/lux for yellow. Under the direction and supervision of the Representative, measure with a 30-meter geometry retroreflectometer conforming to ASTM E 1710 within 21 days after installation in accordance with PTM No. 431.

(j) Defective Work. Remove and replace any markings placed incorrectly. Repair those markings, which after application and drying, the Inspector-in-Charge determines to be defective. Complete this work at no additional cost to the Department. Major types of defective work and method of repair include the following:

- **Inadequate retroreflectivity, glass bead coverage or retention .** Restripe over defective marking.

- **Insufficient thickness or line width, uneven cross-section, poor adhesion, or delaminating.** Remove defective markings as specified in Section 963.3 and clean pavement surface, including 1 foot beyond each end of the affected area. Remove loose particles and debris with compressed air. Restripe the marking on the cleaned surface as specified in this specification.

(k) Guarantee. Guarantee pavement marking material against failure due to premature wear or poor adhesion resulting from defective materials or method of application in accordance with Section 107.16(b) for a period of 90 days from the date of acceptance.

962.4 MEASUREMENT AND PAYMENT—

(a) Line. Linear Foot

(b) Legend. Each

(c) Pavement Marking Removal. Section 963.4

SECTION 963—PAVEMENT MARKING REMOVAL

963.1 DESCRIPTION—This work is the removal of pavement markings and legends.

963.3 CONSTRUCTION—Remove existing pavement markings, as indicated, immediately before any change in traffic patterns or before the application of final markings. Remove markings that conflict with revised traffic patterns and may confuse motorists. Do not paint over existing lines with black paint.

Remove markings for restriping to the extent that 90% of the material is removed without materially damaging or grooving the pavement surface more than 1/32 inch. For all other marking removal, eliminate the markings to the extent that the marking is not visible to motorists when viewed from a distance of 50 feet. Grinding is acceptable only for the removal of thermoplastic, cold plastic, or epoxy marking materials. Obtain approval from the Representative for the proposed removal method before beginning work.

Vacuum or collect residue, including sand, dust, and marking material, concurrently with the removal operation unless alternate procedure is submitted and accepted. Clean the area to completely remove loose debris. Perform this work only in the area where the markings are to be applied. Do not allow sand, dust, or other residual material, which may interfere with drainage or constitute a traffic hazard, to accumulate. Dispose of all residue in an acceptable manner.

Repair any pavement or surface damage caused during the removal process.

Prevent damage to transverse and longitudinal joint sealers, and repair any damage as specified in Section 513.

963.4 MEASUREMENT AND PAYMENT—

(a) Lines.

1. Linear Foot

2. Square Foot

(b) Legends.

1. Each

2. Square Foot

SECTION 964—EPOXY PAVEMENT MARKINGS

964.1 DESCRIPTION—This work is the furnishing and installation of reflectorized, two-component epoxy resin pavement markings of the color indicated, with glass beads, at the locations indicated.

964.2 MATERIAL—

(a) General. Provide materials approved by the Department, from a source listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

(b) Epoxy Resin. Provide only those epoxy materials listed in Bulletin 15. Do not use polluting solvents or fillers.

1. Color. Furnish white and yellow pavement markings that satisfy the following chromaticity coordinates:

	1		2		3		4	
	x	y	x	y	x	y	x	y
White	0.330	0.370	0.355	0.345	0.310	0.300	0.285	0.325
Yellow	0.515	0.465	0.505	0.430	0.440	0.415	0.420	0.443

Furnish black epoxy that satisfies color chip 37038 of Federal Standard 595B and is equal to the quality of the white epoxy being used.

2. No Track Time. Dry to a no-track condition in 10 minutes or less when tested according to ASTM D 711 at a temperature of 75F ± 2F at a thickness of 20 mils ±1 mil with glass beads applied at a rate of 20 pounds per gallon of epoxy.

(c) Glass Beads. Section 1103.14.

(d) Black Aggregate. Furnish with the following gradations:

Sieve Size	Retained (%)
No. 20	17-37
No. 30	45-65
No. 40	14-25

964.3 CONSTRUCTION—

(a) Equipment. Provide application equipment with a system capable of:

- Spraying epoxy material mixed in the proper formulation conforming to manufacturer's requirements.
- Applying symbol markings and longitudinal lines with the specified glass bead application.
- Heating Epoxy Part A to satisfy manufacturer's recommendations.
- Heating Epoxy Part B to satisfy manufacturer's recommendations.
- Mixing Part A with Part B according to manufacturer's recommendations.
- Applying glass beads using the double drop method.

Provide an operator for the equipment who is fully knowledgeable of all equipment operations and application techniques. Provide a pressure gauge on each proportioning pump to verify pressures. Position these gauges to be easily visible to the operator of the equipment and the Inspector-in-Charge.

Obtain from the manufacturer of the epoxy material being used, specifications for the proper mix ratios of the epoxy component, proper temperatures, proper mixing techniques, and any other data to ensure that the epoxy material is being properly installed. Furnish this information to the Inspector-in-Charge at least 5 days before beginning work.

(b) Procedures.

1. For proper adhesion, perform surface preparation of the road surface and provide the pretreatment according to Bulletin 15 or recommended by the manufacturer. Clean the roadway surface where the epoxy pavement markings will be applied. Remove all surface treatment, laitance, curing compound, or any contaminants that would hinder adhesion. Clear any loose dirt and other debris from the application area. Surface preparation is incidental to the application of epoxy pavement markings, except for the removal of pavement markings which is performed and paid for under Section 963. Identify the location of the final pavement markings by applying spots on the pavement at 40-foot intervals. The Inspector-in-Charge will approve the locations.

2. Before starting work, furnish four sample plates of each color of materials used. Prepare two plates with and two plates without glass beads or aggregate.

3. Uniformly apply the epoxy markings at a wet thickness of 20 mils ± 1 mil. A tolerance of 1/4 inch from the indicated width will be allowed provided the variation is gradual and does not detract from the general appearance. For skip line patterns maintain a tolerance of ±6 inches for each 40-foot cycle and ±3 inches for each 10 foot skip line.

4. Apply glass beads immediately after application of the epoxy markings. Use the double drop method with a minimum rate of 10 pounds per gallon for Type A beads and 10 pounds per gallon for Type B beads for a total minimum of 20 pounds per gallon of epoxy. Uniformly distribute glass beads on the surface. Provide markings with an average minimum initial retroreflectivity of 250 mcd/m^2/lux for white and 200 mcd/m^2/lux for yellow. Under the direction and supervision of the Representative measure retroreflectivity with a 30-meter geometry retroreflectometer conforming to ASTM E 1710 within 21 days after installation in accordance with PTM No. 431.

5. After the application of epoxy material and glass beads, protect the markings from traffic for a minimum period of 30 minutes or until the epoxy has dried sufficiently to prevent dirt pickup or tracking.

6. Apply black epoxy markings on cement concrete roadways. Place the black markings, flooded with black aggregate, immediately after all white skip line patterns. Use the same line dimensions for both colors.

7. Install epoxy on dry pavement only if the road surface and ambient temperatures are 40F or higher unless otherwise approved by the Inspector-in-Charge and acceptable to the manufacturer.

(c) Defective Markings. Remove and replace any markings placed incorrectly. Repair those markings, which after application and drying, the Inspector-in-Charge determines to be defective. Complete this work at no additional cost to the Department. Major types of defective work and method of repair include the following:

- **Insufficient thickness or line width, uneven cross-section .** Grind or blast clean defective material to remove a substantial amount of beads and to roughen the marking surface. Remove loose particles and debris with compressed air. Restripe the cleaned surface as specified in this specification.

- **Inadequate retroreflectivity, glass bead coverage or retention .** Restripe over defective Marking.

- **Poor Adhesion, Delaminating.** Remove defective markings as specified in Section 963.3 and clean pavement surface, including 1 foot beyond each end of the affected area. Remove loose particles and debris with compressed air. Restripe the marking on the cleaned surface as specified in this specification.

(d) Guarantee. Guarantee 90% of the pavement marking material against failure due premature wear or poor adhesion resulting from defective materials or method of application as specified in Section 107.16(b) for a period of

180 days from the date of acceptance.

The Representative will identify material to be repaired or replaced.

Begin all repair or replacement work within 30 days of notification by the Representative and perform as specified in these specifications.

964.4 MEASUREMENT AND PAYMENT—

(a) Line. Linear Foot

(b) Legend. Each

SECTION 965—PREFORMED THERMOPLASTIC PAVEMENT MARKINGS

965.1 DESCRIPTION—This work is the furnishing and installation of preformed thermoplastic pavement markings, of the type and color indicated.

965.2 MATERIAL—

(a) General. Provide materials from a source listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

(b) Thermoplastic. AASHTO M 249, Type 1, except that the material is in a preformed state. Provide a material listed in Bulletin 15. Furnish a material with a minimum initial skid resistance of 50 British Pendulum Number (BPN) for all crosswalks, stop lines, legends, or where indicated.

(c) Glass Beads. Section 1103.14, Type A.

1. Intermix. Provide sufficient uncoated glass beads to comprise 30% of the marking material by weight and have a minimum of 80% rounds overall.

2. Surface-Applied. Moisture resistant coated with a maximum of 5% passing the No. 80 sieve and a minimum of 70% rounds per sieve and a minimum or 80% rounds overall.

965.3 CONSTRUCTION—

(a) General. At least 5 days before beginning work, provide the Inspector-in-Charge with a schedule of operations. In addition, provide the Inspector-in-Charge with the manufacturer's instructions for the installation of the materials, application temperatures, proper mixing techniques, and any other data to ensure the material is being properly installed.

(b) Pretreatment. For proper adhesion, perform surface preparation of the road surface and provide the pretreatment according to Bulletin 15 or recommended by the manufacturer. Clean the roadway surface where the preformed thermoplastic pavement markings will be applied. Remove all surface treatment, laitance, curing compound, or any contaminants that would hinder adhesion. Clear any loose dirt and other debris from the application area. Surface preparation is incidental to the application of preformed thermoplastic pavement markings, except for the removal of pavement markings which is performed and paid for under Section 963. Identify the location of the final pavement markings by applying spots on the pavement at 40-foot intervals. The Inspector-in-Charge will approve the locations. Apply on dry pavement when the air and roadway temperatures are within the manufacturer's recommendations and when the wind speed is less than 20 miles per hours. If recommended by the manufacturer, preheat the surface to remove any moisture.

(c) Application. Apply markings, which have a minimum thickness of 125 mils ± 4 mils. A tolerance of ± 1/4 inch from the indicated width will be allowed provided the variation is gradual and does not detract from the general appearance. Use a heat gun to fuse the material to the pavement. Heat the material as recommended by the manufacturer.

(d) Glass Beads. Surface apply glass beads as recommended by the manufacturer immediately after application of the markings. Uniformly distribute glass beads on the surface. Provide markings with an average minimum initial retroreflectivity of 300 mcd/m^2/lux for white and 250 mcd/m^2/lux for yellow. Under the direction and supervision of the Representative measure retroreflectivity with a 30-meter geometry retroreflectometer conforming to ASTM E1710 within 21 days after installation in accordance with PTM No. 431.

(e) Defective Markings. Remove any markings placed incorrectly and replace them. Repair those markings, which after application and drying, are determined to be defective by the Inspector-in-Charge. Complete this work at no additional cost to the Department. Major problem areas and method of repair include the following:

- Insufficient thickness or line width, uneven cross-section─Prepare defective material by grinding or blast cleaning to remove a substantial amount of beads and the marking surface is roughened. Remove loose particles and debris with compressed air. Restripe the cleaned surface as specified in this specification.

- Inadequate retroreflectivity, glass bead coverage or retention─Remove defective markings and clean pavement surface, including 1 foot beyond each end of the affected area. Remove loose particles and debris with compressed air. Restripe the marking on the cleaned surface as specified in this specification.

(f) Guarantee. Where directed, remove and replace material that has not remained within close conformity to location or has not remained effective in performing useful service as specified in Section 107.16(b) for a period of 180 days from the date of acceptance. The minimum acceptable service is as follows:

- **Longitudinal Markings.** 90% of material remains in each 1,000-foot section of marking where the intersection unit is defined as material on an approach leg within 160 feet of the intersection.

- **Transverse Markings, Legends, and Symbols.** 90% of material remains for each individual legend, symbol, crosswalk, or stop line.

965.4 MEASUREMENT AND PAYMENT—

(a) Line. Linear Foot

(b) Legend. Each

(c) Decorative Crosswalk. Square Foot

SECTION 966—SNOWPLOWABLE RAISED PAVEMENT MARKERS

966.1 DESCRIPTION—This work is the furnishing, installation, replacement, and removal of snowplowable, retroreflective, raised pavement markers of the type indicated.

966.2 MATERIAL—

(a) General. Provide materials listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

(b) Snowplowable Raised Pavement Markers. ASTM D 4383

(c) Adhesive. Two-component epoxy adhesive that conforms to AASHTO M 237 and is classified as Type IV according to manufacturer's recommendations for bonding the reflectors or holders to the pavement or the reflectors to the holders.

(d) Concrete Material. Section 525.2

(e) Asphalt Material. Section 413.2

966.3 CONSTRUCTION—As shown on the Standard Drawings, recommended by the manufacturer, and as follows:

(a) Layout. Before installing, lay out the pavement marker locations.

Do not place devices on pavement surfaces that show visible evidence of pavement cracking, checking, spalling, or failure of underlying base material. Do not place devices within 4 inches of a pavement joint. During the pre-installation layout, if it is determined that a device would be placed at a point where any of the above conditions exists, relocate it longitudinally to the directed location.

(b) Sawing. Cut the depression in the pavement.

(c) Installation. Install within 7 days of making the saw cuts. Before applying the adhesive, vacuum or blow the depression to remove loose material, then clean and dry the depression with compressed air. Apply the adhesive and place the unit into the depression. Be certain that markers are properly seated with the leading edges below the roadway surface or reflectors are placed as shown on the Standard Drawings. Secure in place until adhesive is set.

At the time of installation, be sure that devices are free of dirt, dust, oil, grease, rust, moisture, or any foreign matter that impairs adhesion to the pavement.

Do not apply devices if the pavement surface temperature and the air temperature at the time of application are less than 50F or as recommended by the manufacturer. Do not install markers if the pavement surface is moist or wet.

(d) Replacement. Use the following procedures for the replacement of the holders or reflectors:

- Cut a new depression when required.
- Ensure the attachment area is smooth and clean.
- Apply adhesive and install the new holder or reflector as indicated above.

(e) Removal. Remove and dispose of existing pavement markers before paving or milling operations.

Remove by method that will cause the least damage to pavement structure and is approved by the Department. Satisfactorily repair any pavement damage caused by the removal methods.

When pavement markers are removed from an asphalt pavement, prepare the existing surface voids as specified in Section 413.3(g). Fill voids in pavement with asphalt wearing course or approved equal.

When pavement markers are removed from a cement concrete pavement, clean void areas from all loose and foreign material. Fill voids as specified in Section 525.3 or approved epoxy that is used in the installation of the holders.

(f) Guarantee. Within 30 calendar days of notification, replace defective holders and/or reflectors if any of the following unsatisfactory conditions exist:

- The holder does not remain in place or does not resist deformation for 180 days after acceptance; has not remained in the exact location and alignment as originally placed; is deformed, cracked or otherwise not able to provide useful service; or shows visible signs of bond failure between the holder and the adhesive.

- Reflectors are missing or do not provide full service for a period of 180 days after acceptance.

- Reflectors fail between the date of notification and the replacement date.

966.4 MEASUREMENT AND PAYMENT—

(a) Raised Pavement Marker. Each
Includes removal and disposal of existing pavement markers and filling of pavement voids.

(b) Reflector Replacement. Each
Includes removal and disposal of existing reflectors.

(c) Raised Pavement Marker Removal Without Replacement. Each
As indicated for the existing pavement type. Includes filling of pavement voids.

SECTION 970—REMOVE POST MOUNTED SIGNS, TYPE A

970.1 DESCRIPTION—This work is the removal and disposal of existing signs of the type specified as indicated and directed.

970.3 CONSTRUCTION—Remove and dispose of existing signs and posts, and backfill any holes as specified in Section 206.3(b)4 as indicated and directed.

Remove existing foundations to a minimum depth of 12 inches below the final ground surface, and backfill any holes as specified in Section 206.3(b)4.

970.4 MEASUREMENT AND PAYMENT—Each

SECTION 971—REMOVE POST MOUNTED SIGNS, TYPE B

971.1 DESCRIPTION—This work is the removal of existing signs of the type specified as indicated and directed.

971.3 CONSTRUCTION—Remove existing signs and posts and backfill any holes as specified in Section 206.3(b)4 as indicated and directed.

Do not damage signs during removal. Salvage all aluminum signs, and dispose of other materials. Deliver aluminum signs to the Project Field Office and place in neat piles for pickup by the Department's maintenance forces.

971.4 MEASUREMENT AND PAYMENT—Each

SECTION 972—REMOVE POST MOUNTED SIGNS, TYPE C

972.1 DESCRIPTION—This work is the removal of existing signs of the type specified as indicated and directed.

972.3 CONSTRUCTION—Remove existing signs, posts, and foundations and backfill any holes as specified in Section 206.3(b)4 as indicated and directed.

Do not damage signs during removal. Salvage all aluminum signs, and dispose of other materials. Deliver aluminum signs to the Project Field Office and place in neat piles for pickup by the Department's maintenance forces.

972.4 MEASUREMENT AND PAYMENT—Each

SECTION 973—REMOVE POST MOUNTED SIGNS, TYPE D

973.1 DESCRIPTION—This work is the removal of existing signs of the type specified as indicated and directed.

973.3 CONSTRUCTION—Remove existing signs, supports, mounting brackets, and associated hardware as indicated.

Burn off bolts to 1 inch below concrete surfaces. Patch hole with non-shrink grout.

Salvage all aluminum signs and dispose of other materials. Do not damage signs during removal. Deliver aluminum signs to the Project Field Office and place in neat piles for pickup by the Department's maintenance forces.

973.4 MEASUREMENT AND PAYMENT—Each

SECTION 974—REMOVE POST MOUNTED SIGNS, TYPE E

974.1 DESCRIPTION—This work is the removal and disposal of existing signs of the type specified as indicated and directed.

974.3 CONSTRUCTION—Remove and dispose of existing signs, posts, and associated hardware as indicated and directed.

Remove existing foundations to a minimum depth of 12 inches below the final ground surface, and backfill any holes as specified in Section 206.3(b)4.

974.4 MEASUREMENT AND PAYMENT—Each

SECTION 975—REMOVE POST MOUNTED SIGNS, TYPE F

975.1 DESCRIPTION—This work is the removal of existing signs of the type specified as indicated and directed.

975.3 CONSTRUCTION—Remove existing signs and associated hardware as indicated and directed.

Salvage all aluminum signs, and dispose of other materials. Do not damage signs during removal. Deliver aluminum signs to the Project Field Office and place in neat piles for pickup by the Department's maintenance forces.

975.4 MEASUREMENT AND PAYMENT—Each

SECTION 1000
STRUCTURES

SECTION 1001—CEMENT CONCRETE STRUCTURES

1001.1 DESCRIPTION—This work is construction of bridges, arches, culverts, and other cement concrete work.

1001.2 MATERIAL—

(a) Cement Concrete. Section 704. Do not use High Early Strength (HES), as specified in Section 704, Table A in bridge decks.

1. Barrier.

1.a Fixed Form Bridge Barrier. Class AA Cement Concrete – Section 704, except use No. 8 coarse aggregate.

1.b. Slip-Formed Bridge Barrier. Class AA Cement Concrete – Section 704, except, use No. 8, No. 67, or No. 57 coarse aggregate. Mixes using No. 8 coarse aggregate must contain No. 57 or No. 67 or both coarse aggregate.

(b) Concrete Curing Material and Admixtures.

- Curing and Protecting Covers—Section 711.1
- Curing Compounds—Section 711.2(a) (white only) and 711.2(c)
- Concrete Admixtures—Section 711.3. Do not use admixtures containing chloride salts in bridge-deck concrete.

(c) Structure Foundation Drains. Section 610.2 and Section 615.2

(d) Nonstaining, Nonshrinking Grout. Use for minor patching of concrete surfaces. Mix one part cement, two parts fine aggregate, and enough water to provide a consistency stiff enough to place by either manual or mechanical tamping. Do not use more than 4 1/2 gallons of water per bag of cement. Mix for 60 seconds, cover to prevent loss of moisture, and allow to stand for 45 minutes. Remix for 60 seconds without further addition of water, then place within 30 minutes after completion of mixing. Use material as follows:

- Cement, Type IP, IS, IL or II—Section 701
- Fine Aggregate, Type A or C—Section 703.1
- Water—Section 720.1

The Contractor may use premixed grout. Obtain from a manufacturer listed in Bulletin 15. Mix according to the manufacturer's instructions. Certify as specified in Section 106.03(b)3.

(e) Nonshrink Grout for Studs, Dowels, and Anchor Bolts. Section 1080.2(c), except use Type C fine aggregate. The Contractor may use premixed nonshrink grout. Obtain a grout, which passes a No. 8 sieve, from a manufacturer listed in Bulletin 15. Mix according to the manufacturer's instructions. Certify as specified in Section 106.03(b)3.

(f) Asphalt Tack Coat (for Bridge Decks). Section 460.2

(g) Lighting Pole Anchorage. Provide as shown on the Standard Drawings and as follows:

- Anchor Bolts, Nuts, and Washers—Section 1105.02(c)2 (metallic coated)
- Steel Angle—Section 1105.02(a)2
- Conduit—Section 1101.09(b)
- Junction Box—Section 1101.10

(h) Forms.

1. Temporary. Use plywood at least 5/8 inch thick or other accepted material made for form work. For final exposed concrete surfaces, use smooth material, free of knots, holes, bulges, and depressions.

2. Metal Bridge Deck Forms. Use permanent forms, fabricated from steel conforming to ASTM A924/A924M and ASTM A653/A653M (Structural Quality (SQ) excluding Grade 50 Class 3), with a coating designation of G165, and a minimum thickness of 22 gage. Coat fasteners, if used, either by galvanizing according to ASTM A153 or ASTM B633, Thickness Class Fe/Zn 12; or cadmium plating, according to ASTM B766, Class 12.

An alternate form system may be used, if indicated or if accepted in writing by the Chief Bridge Engineer. Submit material details and erection methods of the alternate form system for review and acceptance.

Certify as specified in Section 106.03(b)3.

(i) Other Material.

- Premolded Expansion Joint Filler—Section 705.1
- Closed Cell Neoprene Sponge—Section 1107.02(p)1
- Joint Sealing Material—Section 705.4(b), (c), or (d)
- Waterstops—Section 705.5
- Caulking Compound—Section 705.8
- Reinforcement—Section 1002.2
- Steel Welded Wire Fabric—Section 709.3
- Deformed and Plain Bar Dowels—Section 709.1
- Structural Steel—Section 1105
- Waterproofing—Section 680.2
- Coarse Aggregate, No. 57—Section 703.2
- Conduits and Conduit Protective Coating—Sections 1101.09(b) and (d)
- Selected Borrow Excavation—Structure Backfill, Section 205 and as shown on the Standard Drawings.
- Anchor Bolts—Section 1105.02(c)2
- Asphalt Material, Class RC-250—Section 702

- Geotextiles, Class 1—Section 735
- Polyethylene Sheeting—Section 505.2
- Asphalt Impregnated Paper—Section 727
- Asphalt Cement, PG 64S-22—Section 702
- Epoxy Binder Resin—Bulletin 15 approved epoxy based surface treatment for bridge decks, epoxy binder resin component only.
- Epoxy Bonding Compound—Section 706.1.

(j) Tremie Cement Concrete. Use Class A cement concrete as specified in Section 704, modified as follows:

- Cement Factor (Min.) — 7.0 bags per cubic yard
- Slump—7 inches ± 1 inch
- Compressive Strength at 7 Days—2,000 pounds per square inch

Provide admixtures that retard concrete set 5 feet above and below the tremie pipe outlet, are compatible with the air entrainment agents, and do not allow excessive segregation of the aggregate.

(k) Concrete Bonding Compound. Section 706

(l) Anti-washout Admixture. Section 711.3(f) from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

1001.3 CONSTRUCTION—Construct as shown on the Standard Drawings and as follows:

(a) Forms and Centering.

1. General. Support forms so that deflection does not exceed 1/2 inch under plastic concrete. Before using forms, clean them and obtain approval for use. Use forms that are strong and firm; securely braced; tied together, if required, by means of form ties, tight enough to prevent the leakage of mortar; and strong enough to withstand the action of mechanical vibrators, if used.

Remove dirt, chips, sawdust, and other foreign materials before placing concrete. Except for stay-in-place forms, before placing reinforcing steel, thoroughly coat forms with a release agent. Coat forms for exposed surfaces with a nonstaining release agent.

Adequately brace forms. If forms are insufficiently braced or unsatisfactorily built, the work will be halted, either before or during concrete placement, until such defects have been satisfactorily corrected. Chamfer the edges as indicated. Do not leave wood separators in the completed work.

Do not use form support systems that will cause unacceptable overstress or deformation to permanent bridge members.

Use ties that are adjustable in length, to allow tightening of forms. Use ties that leave no metal in the concrete within 1 1/2 inches of the exposed surface. Do not fit ties with lugs, cones, washers, or other devices to act as spreaders within the form, or devices that leave depressions in back of the exposed surface of the concrete. Flat bands may be used, if the bands conform to the following:

- Not less than 3/4 inch wide.
- Not less than 14 gage thick.
- Placed on edge.

- Protected by adequate spreaders to prevent twisting during construction.

Do not use wire ties or thin, narrow, flat bands, except in the construction of endwalls, inlets, and manholes. Where necessary, coat the form ties with a release agent to facilitate removal. Do not damage the concrete on the exposed surface when removing forms and ties. Do not cut ties back from the concrete face.

Before starting construction, obtain acceptance of working drawings required for centering and falsework, as specified in Section 105.02(c). Before placing concrete, obtain acceptance of in-place forms. Camber the centering to compensate for dead-load deflection and settlement of centering. Provide for gradual and uniform lowering.

Where required, drench the inside of forms with water immediately before placing concrete.

2. Metal Bridge Deck Forms (Permanent). When portions of a bridge deck are constructed adjacent to each other and divided by an open or a preformed joint, do not use metal forms in the cantilever area on either side of the joint, except with prior written permission of the Chief Bridge Engineer.

Submit shop drawings of the forms as specified in Section 105.02(d) for review and acceptance. Include the following on the shop drawings:

- Grade of steel.
- Physical and section properties for permanent metal bridge deck form sheets.
- Methods of attachment.
- Locations where the forms are supported by steel beam flanges, subject to tensile stresses.

Prepare the drawings, conforming to the details and design shown on the Standard Drawings.

Before installing forms, submit for acceptance top of beam elevations in tenth points with tables showing beam haunches and deck elevations. For bridge deck replacements, before removing the existing deck, survey existing deck above beams at tenth points to determine deflection. If an asphalt overlay is present, remove before surveying. Tenth point surveys are incidental to the deck placement.

Before welding in a tension zone, make a test installation on a sample of a simulated flange, using the same welding procedure, materials, and fit-up that are to be used in the tension zone. Allow no burn-through of the parts being welded or fusion to the flange. Do not weld to flanges in tension zones. When this welding procedure has been satisfactorily demonstrated, do not deviate from that used in the test during welding in the tension zone.

Perform field cutting of forms, supports, and closures using saws, shears, or other acceptable methods. Do not cut by burning or melting. Make the attachments concrete tight. A fastening system, using a low-velocity, powder-actuated piston tool to attach forms to support angles, may be used. Thoroughly clean and wire brush form metal where galvanized coating has been damaged. Paint with two coats, no color added, according to ASTM A780. Areas of welds and of weld burns need not be touched up. Uncoated edges, resulting from shearing or punching, are acceptable.

(b) Reinforcement.

1. Reinforcement Bars. Section 1002.3. For bridge decks, also comply with the following:

Place bars as indicated. Use reinforcement chairs, spaced not greater than 3 feet apart, to maintain the position of bottom and top bars. Tie down the top bar mat as specified in Section 1002.3(d). Tie the top bar mat to the lower bar mat, forms or form straps, or studs or chairs tied to the lower mat, at sufficient locations to hold the reinforcement in the proper position. Provide beam haunch reinforcement as indicated and as shown on the Standard Drawings.

Use galvanized chairs with ASTM A641, Class 3 coating, or use stainless steel, plastic-coated or epoxy-coated steel chairs. Use chairs with exposed cut-ends coated or turned up.

Place reinforcement so the indicated cover clearance does not deviate from position by more than ±1/4 inch.

Do not place concrete until the reinforcing placement is accepted.

2. Steel Welded Wire Fabric. Place as indicated. Lap ends and sides 12 inches. Fasten with annealed iron wire or metal clips.

(c) Weep Holes. Construct holes as indicated or directed. Place geotextiles, Class 1, as specified in Section 212.3. Then place approximately 1/2 cubic yard of No. 57 coarse aggregate within the geotextiles at the inlet end.

(d) Structure Foundation Drains. Construct as indicated. Place within geotextiles, Class 1, as specified in Section 212.3.

(e) Pipes and Conduits. Place pipes and conduits in the structure concrete as indicated, including pipes and conduits supplied by others. Maintain existing pipes and conduits, where indicated. If indicated, wrap pipes with asphalt impregnated paper.

(f) Placing Anchor Bolts and Expansion Plates. Place expansion plates, anchor bolts, pier nosing angles, and other material as indicated. Place anchor bolts as indicated or directed. Inspect and repair galvanizing on the projecting portions of anchor bolts as specified in Section 1105.02(s)2 as soon as practical after the anchor bolts have been set, but not until the surrounding concrete or grout has cured. Coat threads with grease.

If the bridge substructure and superstructure are built under separate contracts, proceed as specified in Section 1050.3(c)4.g.

(g) Placing Lighting Pole Anchorage. Construct the lighting pole anchorages as an integral part of the structure. Where indicated, install anchor bolts, nuts, and washers, as specified in Section 1105.02(c)2, 1 1/4-inch conduit, junction box, drain pipe, steel angles, and the required fittings. Cap the conduit with a cap or plug to prevent entry of foreign material and moisture.

For future lighting, protect the anchor bolts using a painted hardwood block.

(h) Consistency of Concrete at the Time of Placement. Do not add water to concrete in the field, unless authorized in writing by the District Executive. If written authorization is obtained, the quantity of water may be increased by a maximum of 1 gallon per cubic yard not to exceed maximum water cement ratio. Immediately remove free water, soft concrete, or mortar that appears on the surface of the concrete, and correct the cause of this condition.

For bridge decks, do not add water to concrete in the field. Adjustment of slump may be allowed by adding water reducer at the job site if a comprehensive procedure detailed in the QC plan has been submitted and accepted by the DME/DMM for this purpose.

(i) Mixing Conditions. Section 704.1(f)

(j) Proportioning and Mixing Concrete. Section 704

(k) Placing and Finishing Concrete.

1. General Requirements. At least 15 days before the element of work is started, submit, for review and acceptance, a QC Plan showing the methods, sequence, and schedule for placing concrete. Maintain material on hand and in place, if necessary, for curing and protecting the concrete. Before placing foundation concrete, ensure that the bearing area is firm, reasonably dry, and free of water. The Representative will inspect the foundation area for bearing capacity before placement. If directed, drill or drive a bar into the material below the foundation or footing bottom to a depth sufficient to determine the suitability of the material. Place concrete without segregation. Remove and discard any concrete that is segregated, too wet for use, or not of uniform consistency. Do not drop the concrete mixture a distance greater than 5 feet. Do not allow concrete to come in contact with aluminum, unless the aluminum is coated with an accepted coating.

Do not place consecutive batches adjacent to each other at concrete temperatures differing by more than 20F. Do not place concrete upon frozen foundation material, in forms containing frost, around frosted reinforcement, or in pile shells surrounded by ice or frozen earth.

For succeeding batches, place concrete in the forms within 30 minutes. Place concrete in horizontal layers no more than 15 inches in depth. Fill each part of the form by depositing the concrete as close to its final position as possible. Do not work or flow concrete along the forms from the point of deposit. Work the concrete without displacing the reinforcement. Place concrete so that the upper surface of the concrete is at the indicated elevation after it has been struck off and after initial shrinkage has taken place.

Finish exposed concrete surfaces accurately and evenly, free from open and rough areas, and free from depressions and projections. In bridge seats and walls, place concrete to the required elevation. Strike off with a

straightedge and float to the correct elevation. Do not add water or curing agent to the concrete surface to assist in finishing.

Finish bearing areas of substructures, as specified in Section 1001.3(k)9.

In areas where reinforcement extends through a construction joint, do not place concrete adjacent to previously placed concrete until at least 24 hours has elapsed.

2. Use of Vibrating Equipment. Keep sufficient vibration equipment in reserve to guard against a work shutdown, caused by the failure of the equipment in operation.

Use an acceptable mechanical vibrator. Do not attach it to the forms or reinforcement. Use a vibrator capable of transmitting vibration to the concrete with a frequency of not less than 100 impulses per second. Determine the vibrator size by the reinforcement spacing.

When sufficient concrete has been deposited, spade and manipulate it to fill the form. Apply the vibrator to the concrete, at intervals not exceeding 3 feet, immediately after the concrete has been deposited. Move the vibrator throughout the mass, completely working the concrete around the reinforcement and other embedded fixtures, and into the corners and angles of the forms. Correct any reinforcement displacement caused by the vibrator before continuing vibration. Move the vibrator slowly to prevent segregation. Do not use vibrators to spread concrete.

Remove and discard concrete segregated by the vibrating operation. Ensure that the vibrator does not penetrate or disturb partially hardened layers. Reinforcement in freshly placed concrete may be vibrated for short durations to ensure proper reinforcement embedment.

3. Placing Concrete in Water.

3.a General. When the depth of water in the foundation area is less than 1 inch, no adjustments to the specified class of concrete are required. When there is greater than 1 inch of water in the foundation, utilize an anti-washout admixture (AWA) as specified below unless otherwise approved by the DME/DMM based on a case specific justification. If use of the AWA is waived by the Representative, provide concrete with a 2.5 inch maximum slump and add 25% more cement than the quantity specified for the concrete class being used, as specified in Section 704.1(h).

Drilled shafts and caissons are exempt from this requirement. Do not deposit concrete in water having a temperature below 40F.

Utilize a mix design using an AWA to achieve a loss no more than 8.0% as determined by PTM No. 641.

If concrete with an AWA is placed below the frost line no air entrainment is required in the concrete mix design.

When concrete is placed above the frost line, design concrete to have an air content of 6.0%. Accept concrete at point of placement with an air content between 4.5% and 7.5%.

Limit the slump at point of placement to no more than 8.0 inches.

Hold a concrete placement meeting and present details of the placement to the Representative. Do not begin concrete placement until the placement procedures, concrete mix design, inspection procedures, and concrete sampling procedures have been accepted by the Representative.

If the tremie method is selected for placing concrete, submit a concrete placement procedure plan for approval at least 21 calendar days before performing the work, and include the following:

- Concrete mix design.
- Available concrete production capability.
- Availability and capacity of equipment to be used to transfer concrete to the tremie.
- The total volume of concrete to be placed.
- The various placement schemes available.
- Tremie locations.
- Maximum flow distance of concrete.

- Any restrictions to flow, such as reinforcing steel, piles, and internal form bracing.
- The method of sealing the tremies and the emergency restart procedure if the seal is broken.
- An inspection plan detailing sounding locations and the frequency of soundings. Take soundings over the entire placement area on, at least, an hourly basis.
- A concrete sampling and testing plan.

3.b Water Under 2 feet Deep. If placing concrete in water 2 feet deep or less, build the concrete above the water level in one end of the form, then place the concrete on top of the concrete above water, and gradually work ahead so that the smallest possible area of fresh concrete is exposed to the water.

3.c Water Over 2 feet Deep. If concrete is placed in water deeper than 2 feet, place in approximately horizontal layers, in a consolidated mass in its final position, using the tremie method or other acceptable method, and do not disturb after placing. Do not place concrete with bottom-dump buckets.

Use tight forms, constructed to retain concrete under water, and maintain still water within the forms. Regulate the consistency of the concrete to prevent segregation of the material.

Before placing tremie concrete, ensure the foundation area is level, and forms and surfaces are free of mud and silt.

Use a tremie with a smooth interior face; and watertight discharge tube at least 10 inches in diameter, long enough to reach the bottom of the placement, and marked in 1-foot increments. Provide a valve or similar device, including various types of plugs, at the lower end of the discharge tube that closes tightly while the tremie is being charged and lowered into position, and that can be fully opened in the lowered position. Attach tremie tube to a funnel or hopper of at least 1/2-cubic yard capacity to facilitate transfer of concrete to the tremie. Do not use tremie tubes fabricated from aluminum. Furnish at least two tremie tubes to ensure continuous concrete placement. Do not place tremie concrete by pumping directly to the bottom of placement. Place tremie concrete only in the presence of the Representative.

Maneuver the tremie tube by using an accurately controlled crane or hoist that allows free vertical movement of the discharge end of the tube. Keep the concrete level in the tremie tube stable. Maintain the equilibrium level. Keep the discharge end of the tremie tube fully submerged in the freshly deposited concrete. Keep the tremie tube relatively motionless. Do not move the tremie laterally during concrete placement.

Place tremie concrete in one continuous operation. Place concrete at a rate that prevents aggregate segregation and allows flow over the entire placement area. Keep the top surface of concrete as level as possible. Maintain balanced hydrostatic pressures to prevent form failure and movement of water through the plastic concrete.

When the tremie concrete has reached a minimum compressive strength of 2,000 pounds per square inch, proceed with dewatering of forms. Upon completion of dewatering, and in the presence of the Representative, thoroughly inspect the hardened tremie concrete. Remove laitance and other undesirable material by chipping, scraping, or other means that are not detrimental to the sound concrete. Visually inspect tremie slabs 3 feet or less in thickness, and if any areas of the concrete are suspect, drill cores as directed. For slabs greater than 3 feet in thickness, verify concrete integrity by drilling four 2-inch diameter cores, or one 2-inch core for every 100 square feet of slab area, whichever is greater. Drill additional cores as directed. Use a double tube core barrel with a diamond bit to obtain the cores. Do not exceed 5 feet for individual core runs. Drill cores from the top of the tremie slab to within 12 inches of the bottom. Operate drilling equipment at speeds and pressures that ensure satisfactory core recovery. Pull the core at the end of each run. Identify and store to preserve the integrity of the cores. Record the existence of any void areas or other concrete deficiencies. If defective concrete areas or voids are found, fill with pressure grout or Class A cement concrete as directed. Completely fill core holes as specified in Section 1001.3(k)11. Upon completion of the project, dispose of cores in a satisfactory manner.

4. Pumping Concrete.

4.a Concrete Pump and Reduction Device. Provide a concrete pump with a flexible end section at least 10 feet long equipped with a reduction device or combination of devices to provide a steady and continous discharge. Devices that may be used include, but are not limited to, a combination of 90 degree angles, a tapered reduction hose, a slide gate, a 6-foot diameter loop in rubber hose, or a finger reducer. Pump and waste enough material through the pump to insure that the grout used to prime the pump has been discharged from the system.

4.b Determining QC and Acceptance Testing Location. The location of the QC sampling and acceptance sampling will be determined daily on the first load of concrete and for every 200 cubic yard therafter, by the following procedure:

- Provide a concrete mixture in conformance with specification requirements in Section 704 for slump, air content, and temperature before placement into the pump.
- Obtain a sample of concrete before placement in the pump and perform slump and air content tests.
- Position the pump into the most severe vertical drop boom configuration, or, when pumping from the same elevation as the placement, at the longest horizontal section configuration that will occur during placement.
- Obtain a sample of conrete at the discharge end of the pump and perform slump and air content tests.
- The air content must conform to the requirements as specified in Section 704.1(c)3.

If the test results for slump and air content taken at the discharge end of the pump are within ± 1.0 inch of the slump and ± 1.0% of the air content taken before placement into the pump, QC and acceptance testing may be performed before placement into the pump. If the test results are not within these tolerances, acceptance testing will be performed at the discharge end of the pump.

The Representative may require acceptance testing and QC testing to be performed at the point of placement at any time the quality of the material comes into question.

If more than one pump is utilized during a placement, each pump must comply with the above procedure.

5. Superstructures. When constructing superstructures, place the concrete in one continuous operation, unless otherwise indicated, specified, or directed.

Before constructing spandrel walls, barriers, or other concrete construction placed on concrete slab, T-beam, rigid frame superstructures, or open or closed spandrel arches, relieve the supporting centering of falsework to allow the superstructures to take part of the permanent deflection.

Do not place barriers for concrete rigid frame structures until after completing the backfilling and the embankment adjacent to the structures.

6. Bridge Decks. Follow the procedure as specified below:

6.a Pre-Placement Meeting. At least 2 weeks before concrete deck placement, schedule a deck pre-placement meeting to review the specification, method and sequence of placing deck concrete, quality control testing, and method of protective measures, to control the concrete evaporation rate.

6.b Ambient Conditions During Placement. Place concrete at a concrete temperature between 50F and 80F. Do not proceed with mixing and placement operations if the forecasted ambient temperature is expected to reach 80F within the scheduled placement time or if the evaporation rate will exceed 0.06 pounds per square foot per hour. Unless otherwise authorized in writing by the District Executive, do not start the placement operation unless the ambient air temperature is a minimum of 40F and rising and is predicted to stay above 40F throughout the placement operation. Do not proceed with placement operations if the temperature of the concrete and surfaces to be in contact with concrete differ by more than 22F.

Provide the necessary equipment and determine the evaporation rate before starting deck placement and every hour during the placement. Do not exceed an evaporation rate of 0.06 pounds per square foot per hour.

6.c Finishing Equipment. Have readily available at the bridge deck placement site, remediation equipment and procedures as submitted, accepted, and demonstrated during the dry run before starting the placement. If the evaporation rate in Section 1001.3(k)6.b is exceeded, stop concrete placement until protective measures are taken to reduce the values to an acceptable level.

Fog cure misting is an acceptable method to mitigate an excessive evaporation rate. Use high or low pressure equipment equipped with nozzles that atomize droplets and can keep a large surface damp without causing water deposits.

Apply the fog over the entire placement area behind the finishing operation, not covered by wet burlap when the evaporation rate in Section 1001.3(k)6.b is exceeded. Do not leave concrete exposed for an extended duration.

Place concrete no greater than 5 feet ahead of finishing machine to prevent any premature drying, unless concrete will be finished within 15 minutes.

Use self-propelled, motorized, mechanical finishing equipment capable of applying vibration to the plastic deck surface through the use of a separate attachment from the machine manufacturer or by other approved means. Use a finishing machine capable of forward and reverse movement under positive control. Make provision for raising screeds to clear the surface when traveling in reverse. Submit a sketch to the Inspector-in-Charge, describing the equipment and showing complete details of supports for the equipment. Vibrating screeds may be used, with the written permission of the District Executive. Vibrating screeds are to be power-vibrated and moved by means of a positive, power-operated apparatus, but are not to be a substitute for high-frequency vibrators. Hand-finishing methods will be allowed outside mechanically screeded areas and to a placed bulkhead in cases of power equipment failures. Use strike-off finishing machines or screeds large enough to finish the full width of deck between curbs or between longitudinal construction joints, or between both.

When strike-off finishing machines are used, support the wheels above the pavement surface on temporary rails, supported on non-deflecting forms or other horizontal structural devices. When vibrating air screeds are allowed, provide a temporary rail system that is supported above the concrete deck surface.Support vibrating screeds on temporary pipe guides or on-grade angles. Use adjustable finishing machine supports or vertical supports for screed guides. Fix supports during finishing, at intervals to limit deflection to not more than 1/8 inch in 10 feet. Do not place supports where concrete is to be placed unless allowed in writing by the District Executive. If allowed, use supports that are removable to at least 2 inches below the surface with a minimum disturbance of concrete. Fill voids left upon removal of screed guides and supports with nonstaining, nonshrinking mortar, after the deck concrete has reached its initial set.

6.d Concrete Placement and Finishing. For rigid frame decks, place the concrete from the center of the span toward each leg or abutment simultaneously. Continuously check falsework or supporting beams so the concrete, as placed, meets the lines and grades indicated. Keep wedges and blocking tight during placement of the concrete.

Use a placing sequence as indicated in the contract drawings or as accepted by the Structure Control Engineer.

Unless allowed in writing by the District Executive, do not allow truck mixers, truck agitators, or other heavy motorized equipment on the deck spans in which concrete is being placed.

Provide sufficient materials at the work site, during concrete deck placement, to protect the bridge deck concrete against rain before initial set. If rain begins, stop placement operations and immediately cover the concrete with protective materials.

If it is necessary to stop operations, due to weather or operational conditions, provide full depth bulkheads at the work site, and place them as directed. Remove bulkheads before resuming concrete placement operations.

Obtain acceptance of changes or additions to indicated construction joints, before incorporating into the work.

Adjust the deck openings at expansion joints and at expansion dams at the time concrete is placed to provide the openings indicated at 68F under full dead load.

Do not allow screed or runway supports to bear on the forms, unless direct undersupport is provided to prevent form damage or deflection. Do not discharge concrete near side laps or at midspan of the corrugated sheets, to a depth greater than 10 inches above the top of the forms. Do not discharge concrete in a manner that causes excessive concentrated construction loads.

Place concrete, at a minimum rate of 20 linear feet of deck per hour, in a longitudinal direction, except for reinforced concrete slabs and rigid frames.

Vibrate the concrete to prevent honeycombing and voids, especially at construction joints, expansion joints, valleys, and ends of form sheets. Obtain acceptance of placing sequences, procedures, and mixes before placing concrete.

Repair or replace damaged material.

Conduct final finishing operations immediately behind the finishing machines or screeds from work bridges of rigid construction, not in contact with the surface of the concrete, set on rails, and easily moved. Finish with a 10-foot, long-handled straightedge to achieve a smooth surface. Make one pass of the float if the concrete surface remains open after the finishing machine operations. Do not overfinish concrete. Use of steel trowels and fresno floats are prohibited.

Perform straightedge testing and surface correction as specified in Section 501.3(k)3 while the concrete is workable. After completing the straightedge testing and surface corrections, before the concrete becomes nonplastic, manually texture/tine the surface as specified in Section 501.3(k)4. Immediately after texturing/tining operations are completed, perform intermediate curing as specified in Section 1001.3(p)3.c.

When mechanical texturing is indicated, immediately after straightedge testing and surface correction, provide initial texturing with a burlap drag or broom device to produce striations parallel with centerline. Provide a drag that

produces a uniform surface of gritty texture without blemishes, marks, tears and scratches deeper than 1/16 inch. Replace the drag as necessary to produce the desired finish. Water cure as specified in Section 1001.3(p)3.b.2 after the initial texturing operation.

6.e Concrete Curing and Testing. Cure the deck as specified in Section 1001.3(p)3.b.2. Maintain wet burlap application within 15 feet behind the finishing equipment. Minimal marking of the concrete is allowed. Following cure, test the surface again, as specified in Section 501.3(o). If directed to facilitate inspection, remove at least one section of permanent forms, at a location directed, for each span of every bridge in the project. After the deck concrete has been in place for a minimum period of 2 days, test the concrete by sounding with a hammer, where directed. If unsound or unconsolidated areas are found, or full depth cracking is visible, remove the forms as directed for inspection after the concrete has attained adequate strength. The forms need not be replaced. Repair the adjacent metal forms and supports in order to present a neat appearance. Remove or repair unsatisfactory concrete. Provide facilities for the safe and convenient conduct of the inspection.

6.f Mechanical Texturing. Provide mechanical texturing for bridge decks and approach slabs when indicated.

Do not begin grooving operations until directed and live loads can be applied as specified in Section 1001.3(q)2.2c.

Do not begin grooving operations until the surface tolerance has been checked and any high points are removed as specified in Section 501.3(o).

Terminate grooves 12 inches from gutter lines and scuppers.

Terminate grooves within 5 inches, but no closer than 3 inches of bridge joints. Use smaller grooving machine or hand held circular saw with diamond blade and guide to control depth of grooves at skewed joints or low spots missed with larger equipment to provide a uniformly grooved bridge deck where grooves terminate within 5 inches, but no closer than 3 inches of skewed joints.

Do not overlap sawed grooves or leave more than 1 inch of the surface without sawed grooves between passes or where a single pass of the grooving machine cannot be made.

Remove and collect debris and slurry resulting from the grooving operations concurrently with the grooving operations. Surfaces are to be immediately left in a washed and clean condition, free from slurry and debris.

Do not open to traffic until mechanical texturing is complete.

6.f.1 Test Area. Do not begin production grooving operations until the test area is accepted.

- **Transverse Sawed Grooves.** Perform a test pass of the grooving equipment. The test area is the width of a single pass of production grooving equipment by a length of one lane width. Check groove widths, depths and spacing to ensure conformance to requirements specified in Section 1001.3(k)6.f.2.

- **Longitudinal Sawed Grooves.** Perform a test pass of the grooving equipment. The test area is the width of a single pass of production grooving equipment by a length of ten feet longitudinally in one lane. Check groove widths, depths and spacing to ensure conformance to requirements specified in Section 1001.3(k)6.f.3.

6.f.2 Mechanical Texturing with Transverse Sawed Grooves. Texture the deck surface with transverse sawed grooves with the following characteristics:

- Perpendicular with centerline
- Rectangular in shape
- 1/8 inch (± 1/32 inch) in width
- 1/8 inch to 3/16 inch in depth
- Random groove pattern of 1.5 inches, 1.75 inches and 2 inches nominal center-to-center sawed groove spacing

6.f.3 Mechanical Texturing with Longitudinal Sawed Grooves. Texture the deck surface with longitudinal sawed grooves with the following characteristics:

- Parallel with centerline

- Rectangular in shape for straight bridge decks, sawed along the curve for curved bridge decks
- 1/8 inch (± 1/32 inch) in width
- 1/8 inch to 3/16 inch in depth
- 3/4 inch nominal center-to-center sawed groove spacing

7. Reinforced Concrete Arches. Place the concrete symmetrically on each side of the span and progress uniformly from the spring line to the crown.

8. Reinforced Concrete Box Culverts. Place concrete in the base slab with horizontal construction joints formed in the sidewalls as indicated. Form horizontal construction joints to provide keys, as shown on the Standard Drawings.

When the concrete has reached the top of the sidewall, stop the concrete operation for 2 hours to allow for settlement of the wall concrete before placing the top slab.

9. Bearing Areas of Substructures. As indicated, construct concrete bearing areas of substructures upon which neoprene pads, masonry plates, shoes, pedestals, column bases, or other metallic bearing devices are to be placed. Slope areas between and surrounding bearings to drain so no water accumulates or stands at any point. After curing, grind the defined bearing area to the indicated elevations, as necessary, according to the following tolerances:

- Deviation from specified elevations:
  - For steel beam superstructures, ±0.01 feet, except do not exceed a 0.01 feet difference between specified elevations of bearing areas of adjacent beams measured at the centerline of beams and centerline of bearings.
  - For prestressed concrete beam superstructures, ±0.02 feet
- Having no projecting irregularities exceeding 1/16 inch
- Variations in flatness:
  - For neoprene pads, ±1/16 inch
  - For metal bearings and high load multi-rotational bearings:
    - Bearing seats up to 30 inches long, ±1/16 inch
    - Bearing seats over 30 inches but less than 45 inches long, ±3/32 inch
    - Bearing seats over 45 inches long, ±1/8 inch
- Variation in slope between specified elevations for each beam seat:
  - For neoprene pads, 300:1
  - For metal bearing and high load multi-rotational bearings, 200:1

Submit as-built beam seat elevations for review and acceptance. Provide drawings and/or spreadsheets stamped by a professional land surveyor registered in the State. Do not set beams until accepted. For beam seat elevations that do not meet the tolerances above, submit a corrective action plan for review and acceptance. Do not set beams until the corrective action plan is accepted.

When using neoprene pads, provide a bearing surface with a rough texture.

For metal and high-load multi-rotational bearings, fill minor depressions caused by finishing, bush hammering, or grinding with a low-viscosity epoxy applied with a squeegee.

10. Final Finishes.

10.a Conventional Finish. Do not brush or bag finish, or paint with grout or neat cement. After the forms are removed, correct irregularities in the exposed concrete surfaces. Exposed surfaces are surfaces above normal ground level or water level, when applicable, and surfaces that will not be concealed by other construction. Irregularities include fins, protrusions, individual holes larger than 1 inch in any dimension, and clusters of smaller holes.

10.b Tooled Finish. Tool finish surfaces as indicated by cutting into the body of the concrete with a pointed tool or bush hammer until the concrete surface shows a grouping of broken aggregate particles in a matrix of mortar.

10.c Other Finishes. Finish surfaces by other methods as indicated.

11. Patching. Saturate holes with water and, immediately, completely fill the holes with nonstaining, nonshrinking mortar. For holes passing entirely through walls, use a plunger-type caulking gun or other device to force the mortar through the wall starting at the back face. Hold a piece of burlap or canvas over the hole on the front face. Then, when the hole is completely filled, strike off the excess mortar until the mortar is flush with the surface. Completely fill holes not passing entirely through the wall by ramming the mortar in place with a suitable tool. Strike off the excess material until the material is flush with the wall surface.

For minor patching, treat concrete surfaces to be patched with a paint coat mixture of neat cement and water. Tamp mortar into place manually, preferably to at least 1/2 inch depth. When possible, overfill spaces being repaired. Allow the excess to stand for 5 minutes, then strike off and finish without excess troweling. Where the space cannot be overfilled, finish immediately. Cure for at least 3 days using an acceptable method that ensures against loss of moisture by evaporation. When required for all or part of the curing period, hold the mortar in place or support by using an acceptable method that ensures retention of the mortar without its drying out.

12. Concrete Bridge Barriers. Construct barrier as indicated and as shown on the Standard Drawings using either a slip form or conventional fixed forms. Conform to the following finished tolerances for both slip-form and conventional fixed-form methods of bridge barrier construction:

• Bar Reinforcement Cover	±1/4 inch
• Width (Top)	±1/4 inch
• Width (Bottom)	±1/4 inch
• Surface Straightness (Deviation from centerline of individual section of unit)	1/4 inch in 10 feet
• Vertical Profile Alignment (Deviation from a line parallel to the grade line)	1/4 inch in 10 feet
• Alignment with Edge of Bridge Deck	1/4 inch in 10 feet

Test surface straightness and vertical alignment along the front face, top, and rear face of the barrier using a 10-foot straightedge. Hold the straightedge in successive positions for the entire length of the barrier and advance in stages of not more than 5 feet.

Cure barrier as specified in Section 1001.3(p).

12.a Fixed Formed Bridge Barriers. For the fixed form method, provide and install formwork as specified in Section 1001.3(a). Drilling or nailing into the bridge deck for the attachment of formwork is not allowed. Place barrier concrete in three lifts with the first lift being 8 inches in height. Ensure vibration and consolidation at gutterlines. Place remaining two lifts equal in height. Extend vibration equipment from second lift into the first and third lift into the second to ensure consolidation within the entire barrier placement.

12.b Slip-Formed Bridge Barriers. If the slip-form method is used, submit a QC Plan at least 15 calendar days before beginning slip-forming. Obtain acceptance of the QC Plan before placing barrier concrete. As a minimum, include in the QC Plan the type of equipment, materials, slump target and range, coarse aggregate source and procedures required for the test section and to construct the barrier. Furnish concrete conforming to the QC Plan.

If the finished tolerances, specified in Section 1001.3(k)12., cannot be maintained during production, stop slip-forming operations, remove the unacceptable work, and modify the operation. If the modifications do not produce acceptable results, as specified in Section 1001.3(k)12., use the fixed-form method of construction, as specified in Section 1001.3(a). The Department will not grant additional compensation or additional time as a result of required removals, modifications, or changes resulting from the method of forming concrete bridge barriers.

12.b.1 Test Section. Construct one 50-foot test section per project to demonstrate that an acceptable product can be produced. Construct this test section at a location near the project site using the same equipment, material, personnel, and procedures as described in the QC Plan. Construct an additional test section if any changes in equipment, material, procedures, or personnel are made. Place the test section on a concrete slab with reinforcing steel to simulate actual conditions. With the District Executive's written approval, the test section may be constructed

in-place, on the bridge structure. The test section will consist of the first 50 feet of the bridge barrier placed. Include in the submission to the District Executive, documentation of past experience constructing slip-form bridge barriers, with contract references

Test concrete as specified in Section 704. In addition, obtain three test cores from the test section, according to PTM No. 1. Submit cores to LTS to be tested for information. Repair tears as directed. Honeycombing, sags, tears, or other evidence of poor quality concrete that cannot be satisfactorily repaired without the use of water or extra concrete or grout, will be cause for rejection of the test section. Test reinforcement cover, in the presence of the Representative, using a Pachometer, or other non-destructive test method.

The Representative will evaluate the procedure, material, equipment, and appearance of the test section. If the test section is rejected by the Representative, place an additional test section, with the approval of the Representative, or use the fixed-form method of construction. Remove and dispose of rejected test sections. Leave the accepted test section in place until the slip-formed bridge barriers are complete. The slip-formed bridge barriers will be compared to the accepted test section to ensure that similar, acceptable quality is being achieved. If the test section was not constructed in place on the bridge structure, remove and dispose of the test section following completion and final acceptance of slip-formed bridge barriers.

12.b.2 Construction of Slip Formed Bridge Barriers. After set up, make a dry run of the equipment to ensure it will clear obstacles to be embedded or flush with surfaces, such as pull boxes, expansion joint plates, and light standard foundations. Ensure that clearances for concrete cover are maintained on reinforcement bars. If modifications are necessary, correct any deficiencies and perform another dry run, in the presence of the Representative, before starting the slip-form operation. At no additional cost to the Department, place additional epoxy-coated reinforcing steel to provide bracing for the barrier against displacement due to the pressure developed by the slip-form extruding process. If applicable, apply a uniform coat of concrete bonding compound as specified in Section 706 and according to the manufacturer's recommendations, to the interface between the hardened concrete bridge deck surface and the slip-formed bridge barrier, before the slip-forming operation. Coordinate operations for mixing, delivering and placing of concrete with minimal stopping and restarting of the slip-form machine and according to the QC Plan. Do not allow vehicular traffic on the bridge while slip-forming operations are in progress, except for slip-form machine and supply trucks. Meet temperature and humidity requirements as specified in Section 1001.3(k)3.

Ensure that the barrier maintains its shape, without support, after extrusion. If honeycombing, sagging, or tearing of the bridge barrier occurs during the slip forming operation, repair according to the approved QC Plan. Ensure that the completed surface is free of honeycombing, sags and tears, and finish with a light vertical brushing.

Mark the bridge deck in advance of the concreting operation to ensure that saw cuts are made at the indicated locations and do not conflict with the reinforcing steel pattern. Space joints as indicated. Accurately locate saw cut joints to ensure the reinforcement steel will have the specified cover. Saw cut as soon as possible after concrete has set sufficiently to preclude raveling during the sawing, and before any shrinkage cracking occurs in the concrete. Saw cut joints, 1/8 inch wide and 3/4 inch deep, in the top, outside, and inside faces. Complete saw cuts 3 inches above the top of the deck slab or pavement surface.

(l) Not used.

(m) Connections of Existing and New Concrete.

1. Terms. The terms “new concrete construction,” “fresh concrete,” and “hardened concrete” refer to work performed under the current contract. “Hardened concrete” has cured for a minimum of 28 days.

The terms “existing concrete structures” and “existing concrete” refer to work performed under a previous contract.

2. General. To connect fresh concrete with hardened or existing concrete, thoroughly clean the connecting surface of laitance and loose and foreign material before applying the Type II (in a non-load bearing joint) or Type V (in a load bearing joint) epoxy bonding compound as specified in Section 706.

Coat contact surfaces with concrete bonding compound at construction joints between fresh concrete and existing concrete. Coat contact surfaces with concrete bonding compounds to connect fresh concrete with hardened concrete at deck construction joints, deck expansion joints, expansion dam block out areas, and where indicated, as specified in Section 1040.3(e). Coat contact surfaces with concrete bonding compound to connect fresh concrete with hardened or existing deck concrete for Slip-Formed Bridge Barriers as specified in Section 1040.3(e) and Section 1001.3(k)12.b.2. Coat surfaces according to the manufacturer’s recommendations. Use of other bonding compound

coatings extends the period after coating between placement pours, but in no case longer than 24 hours (typical), or according to the manufacturer's recommended viability of the coating, whichever is less.

3. Tied Connections. Where indicated, to connect new concrete construction to existing concrete structures, use drill holes of the required depth and diameter in the existing structure to allow placing dowel bars, expansion bolts, or extensions of reinforcement. Furnish and place in the holes, dowel bars, expansion bolts, and reinforcement of the size and type indicated. Grout studs, dowels, and anchor bolts with nonshrink grout or anchor as indicated.

(n) Joints. Rivet or fold-seam the splices of metal waterstops before soldering. Make splices for rubber, plastic and similar waterstops according to the manufacturer's recommendations.

If the construction plane is to be horizontal and concrete placement is stopped for more than 30 minutes, provide acceptable keyways and sufficient dowel bars.

When directed, place vertical construction joints, then place acceptable dowel bars as required.

(o) Not used.

(p) Curing and Protection of Concrete. Begin curing as soon as the concrete has been placed and is sufficiently hardened. Cure concrete as specified in Section 1001.3(p)3.

1. Definitions of Temperatures.

1.a Air Temperature. Section 101.03

1.b Curing Temperature. Curing temperature is the temperature of the air immediately adjacent to concrete. Where concrete is not covered by forms or other protective coverings, or where protective coverings are considered inadequate, the curing temperature will be the air temperature. During cool and cold weather, the curing temperature is the temperature inside the forms, protective coverings, or housings specified in Section 1001.3(p)4 and Section 1001.3(p)5. The curing temperature for the first 24-hour period after placing concrete will be considered as not more than the temperature of the concrete at the time of its placement in the forms.

2. Curing Days, Curing Temperatures, and Records of Temperature. Do not count as a curing day, a day on which the curing temperature drops below 50F at any time during that day, except for flood curing of footings. For bridge decks, during day 1 through day 7, do not count as a curing day, a day on which the curing temperature drops below 50F. During day 8 through day 14, do not count as a curing day, a day on which the curing temperature drops below 40F. If at any time during the curing period, the curing temperature falls below 35F, the Department will consider the work unsatisfactory and will reject it.

Provide high-low thermometers to maintain an accurate daily record of air and curing temperatures during cool and cold weather. In the presence of an Inspector, take curing temperatures on the surface of the concrete, at representative locations on a structure. Submit these temperature records daily to the Inspector-in-Charge.

3. Normal Curing and Protection.

3.a Liquid Membrane-Forming Curing Compound. Utilize a white liquid membrane-forming curing compound. Apply curing compound according to the manufacturer's recommendations and as follows:

For surfaces cured by the liquid membrane-forming curing compound method, finish before application of the curing compound. Apply curing compound in two coats, by spraying, to provide a continuous, uniform membrane. For each coat, apply at least 1 gallon of curing compound per 300 square feet of concrete. After the first application has set, apply the second coat at a direction perpendicular to the first application. Do not apply curing compound to construction joint surfaces. Protect exposed steel during application of curing compound. Water cure these areas, as specified in Section 1001.3(p)3.b. If curing compound is damaged or peels from concrete surfaces, repair immediately.

Protect the curing compound against damage for a minimum of 7 days. Re-apply an additional coat of curing compound to any damaged areas at no additional cost to the Department. Should the curing compound be subjected to continuous damage, the Representative may limit work until the 7-day period is complete. Reduction of the 7-day period will not be allowed under any circumstance.

3.a.1 Formed Surfaces. For formed surfaces, perform water curing during the finishing period and until forms are removed. Apply the first coat of curing compound immediately after stripping forms, and after acceptance

of the concrete finish. If the surface is dry, soak the concrete with water, and apply the curing compound just as the surface film of water disappears. During spray-curing operations, keep unsprayed surfaces wet with water.

3.a.2 Unformed Surfaces. Apply curing compound to unformed surfaces immediately after finishing operations have been completed and after the surface film of water has disappeared. When applying curing compound after water curing to unformed surfaces, apply curing compound onto the surface within 30 minutes of removing the curing covers. Apply curing compound when no free water remains on the surface, but while the surface is still saturated. If the surface is dry or becomes dry, thoroughly wet the surface using a fogger or mister.

3.b Water Curing.

3.b.1 General. Use curing covers of either a double thickness of burlap, white polyethylene sheeting placed on top of a single layer of burlap, or burlap-backed white polyethylene sheeting. Use one type of cover for the duration of curing, unless a change in type is accepted or a combination of covers are accepted. Place curing covers in a manner that minimizes marring of the finished surface. Secure curing covers to prevent lifting or displacement due to adjacent construction operations or wind. Provide a minimum of 2 feet overlap at white polyethelyne sheeting edges. Replace any torn or damaged curing covers as directed. If curing covers are temporarily removed for any reason during the curing period, use watering devices to keep the entire exposed area continuously wet. Replace saturated curing covers as soon as possible.

Saturate curing covers before use and keep in a saturated condition for the curing period. Soak burlap for a minimum of 48 hours before placement. Re-wet burlap as needed before placement. During times of delay expected to exceed 10 minutes, cover concrete that has been placed, but not finished, with wet burlap.

As soon as the concrete can support curing covers, place curing covers on the exposed concrete. Minimal marking of the concrete from curing covers is allowed. If the double thickness of burlap method is used, place second layer of burlap so each strip overlaps one-half the width of the preceding layer. Maintain curing covers in a fully wet condition using misting hoses, fogging machines, or other accepted devices until the concrete has sufficiently hardened to support watering devices.

As soon as forms or sections of forms are loosened or removed, cover the exposed concrete surfaces with pre-saturated curing covers, then keep saturated for the remainder of the curing period.

Use a fog-spray, perforated pipe, sprinkler, soaker hose, or other accepted watering devices to keep forms and curing covers saturated during the curing period. For curing and protecting covers on endwalls, inlets, manholes, copings, bridge seats, and similar miscellaneous concrete, keep saturated using an acceptable method. Flood curing of concrete footings will be allowed if the water temperature is 40F or above.

Cure for a minimum of 7 days and until minimum compressive strengths are attained, as specified in Section 704.1(d)4.b, as determined from molded cylinder specimens tested according to PTM No. 604.

3.b.2 Bridge Decks, Bridge Deck Patches, Expansion Dam Blockouts, Cast in Place (CIP) Box Culverts at Grade, and Box Culvert Distribution Slabs at Grade. Provide water curing as specified in Section 1001.3(p)3.b.1 and as follows:

Provide curing water that is a minimum of 50F for the entire water curing period. Use only a double thickness of burlap for curing covers. Apply two layers of wet burlap within 15 feet of strike-off from the finishing machine. Do not allow burlap stacked on a work bridge to drip onto the finished surface. Keep work bridge with stacked burlap over covered surfaces or reverse work bridge over covered surfaces when not placing burlap. Do not allow the surface to dry after strike-off, or at any time during the curing period. Maintain burlap in a fully wet condition using misting hoses, fogging machines, or other accepted devices that span the entire burlap covered surface until the concrete has sufficiently hardened to support foot traffic. At that time, place soaker hoses, sprinklers, or other accepted watering devices to maintain continuous saturation of burlap over the entire surface. At a minimum, place watering devices at grade breaks and high sides of superelevations to ensure continuous saturation.

Water cure for a minimum of 14 days. After 14 curing days, if the 14-day QC compressive strength result is greater than or equal to 3,500 pounds per square inch, water cure may discontinue for the lot of concrete represented by the QC cylinders. If the 14-day QC cylinders are less than 3,500 pounds per square inch, continue water curing until the 28 day minimum mix design strength is obtained, or for a maximum of 28 curing days. At the end of the water curing period, remove the wet burlap. While the surface is still saturated, place white polyethylene sheeting. If dry spots are present, ensure entire surface is saturated before placing white polyethylene sheeting. Keep white polyethylene sheeting in place for 7 days. When cool or cold weather curing and protection is required, leaving the insulation in place for 7 days after water curing instead of placing white polyethylene sheeting is allowed. For bridge deck patches and expansion dam blockouts, 7 day polyethylene sheeting is not required.

3.b.3 Approach Slabs. Section 1001.3(p)3.b.1 except use only a double thickness of burlap for curing covers.

3.c Bridge Deck Intermediate Curing. For manually textured decks in the plastic state or as directed by the Representative, apply an intermediate monomolecular film curing agent after the finishing operation. If directed, apply additional applications to prevent surface drying before placement of curing covers.

Apply the monomolecular film in a light-fog application, using a pressure spray tank with an adjustable nozzle. Use a water-to-curing agent ratio and rate of application, both according to the manufacturer's recommendations. Agitate the solution before each application.

Apply the monomolecular film in a continuous film, immediately after the final finishing operation is completed on any area. Do not perform finishing after application of the curing agent.

After application of the monomolecular film, complete curing using water.

3.d Accelerated Structural Concrete (ASC) Curing. When ASC is indicated, cure using white liquid membrane-forming curing compound as specified in Section 1001.3(p)3.a except apply as many uniform continuous coats of curing compound until the surface is equal in appearance to that of a sheet of white copy paper. The 7 day protection is not required. After application of curing compound, place insulation mats or heated curing blankets until a compressive strength of 3,000 pounds per square inch is attained.

3.e High Early Strength Concrete (HES) Curing. When HES is indicated, water cure as specified in Section 1001.3(p)3.b.1 except use only a double thickness of burlap for curing covers and cure for a minimum of 3 days. If the 3-day QC compressive strength result is greater than or equal to 3,000 pounds per square inch, water cure may discontinue for the lot of concrete represented by the QC cylinders. If the 3-day QC cylinders are less than 3,000 pounds per square inch, continue water curing until the 28 day minimum mix design strength is obtained, or for a maximum of 28 curing days. At the end of the water curing period, remove the wet burlap and apply liquid membrane-forming curing compound as specified in Section 1001.3(p)3.a except the 7 day protection is not required.

4. Cool Weather Curing and Protection. If the forecasted air temperature during concrete curing is expected to drop to 50F but not below 35F, or if concrete is placed at an air temperature below 50F but above 35F, follow the requirements specified for normal curing and protection. In addition, cover burlap with polyethylene sheeting and insulation mats as specified in Section 1001.3(p)7. Keep insulation mats in place during curing as required to maintain curing temperatures. Use heating as required during curing to maintain curing temperatures.

5. Cold Weather Curing and Protection. If the forecasted air temperature is expected to drop to 35F or lower, during concrete curing, or if concrete is to be placed at air temperatures below 35F, follow the requirements specified for normal curing and protection. In addition, cover burlap with polyethylene sheeting and insulation mats as specified in Section 1001.3(p)7. Keep insulation mats in place during curing as required to maintain curing temperatures. Use heating as required during curing to maintain curing temperatures.

If forms are removed before the end of the curing period, provide additional heating or insulation, as required, to maintain the curing temperatures for the remainder of the curing period.

After the concrete has cured for the required length of time, gradually lower its temperature to that of the surrounding air. Do not allow the temperature of the concrete to drop more than 20F in any 24-hour period for the first 3 days after the curing period. Continue to record the air temperature and curing temperature during this 3-day period.

6. Heating During Cool and Cold Weather Placement and Curing. Furnish and place sufficient canvas and frames, or another type of housing to enclose and protect fresh concrete, forms, and to protect concrete during curing. Before placing concrete, furnish necessary fuel and sufficient acceptable heating apparatus; preferably steam-heating equipment.

Keep air surrounding fresh concrete during placement at a temperature above 50F but not more than 80F. Maintain temperature of air surrounding concrete during curing as specified in Section 1001.3(p)2. Keep the concrete covers wet during the curing period. Do not allow the temperature difference between the concrete and surfaces in contact with concrete to exceed 22F during concrete placement and curing.

7. Insulating Mats or Foam Insulation. Insulating mats or foam insulation, as specified in Section 711.1(e) and Section 711.1(f), respectively, may be used to maintain curing temperature.

Apply the mat insulation tightly against the forms. Seal the ends of the mat to exclude air and moisture. Overlap the insulation on previously placed concrete by 1 foot.

When using steel forms, place the insulation tightly against the forms. In addition, insulate the framework of the steel forms, either by the use of the insulating mat material or foam insulation, or by draping polyethylene sheets or tarpaulins over the exposed members, to effectively reduce the heat loss.

Immediately repair tears in the mat liner. Where tie rods extend through the insulated form, place close-fitting washers on the rod against the mat and secure, to provide adequate protection.

Cover the tops of piers, abutments, and similar concrete surfaces with the insulation mat, tightly secured to prevent loss of heat.

For the areas around protruding reinforcement that cannot be protected with the insulation mat, cover with a double thickness of burlap. Cover with enough straw or hay to prevent loss of heat from the concrete during the curing period. In addition, cover insulated areas with tarpaulins.

Do not insulate bridge decks unless the underside is enclosed and preheated before the concrete is placed and the heat is maintained at the specified temperature during the entire curing period.

When foam insulation is used, use a minimum thickness of 1 1/2 inches. The Contractor may use cracked molded foam boards only after repairs are made with an adhesive.

Keep the insulation protection in place for the full curing period, but do not allow the concrete temperature to rise above 160F.

Do not expose fresh concrete to subfreezing temperatures. Provide standby heat, if directed. Failure to properly place the insulation material or failure to maintain the necessary concrete temperature will be cause for the Representative to deny continued use of the material on the project, for curing in cool or cold weather, and require the use of heating, as specified in Section 1001.3(p)6.

(q) Removal of Falsework and Forms and Application of External Loads to Concrete. Except for flood curing of concrete footings, do not count a day during which the curing temperature falls below 50F in the total elapsed days required for removal of falsework or forms or for the application of external loads on concrete.

1. Removal of Falsework and Forms. Keep falsework and forms under arches, box culverts, pier caps, slabs, beams, girders, and brackets in place for 5 days after placing the final portion of the section involved, after which they may be removed provided the concrete has attained a minimum compressive strength as specified in Table A. Determine the minimum compressive strength according to PTM No. 604 or determine the minimum compressive strength by the maturity method according to PTM No. 640. Cure test cylinders according to PTM No. 611.

During normal and cool-weather curing, keep forms for walls, columns, outside faces of pier caps, arches, sides of beams, and other vertical faces not sustaining loads, in place for a minimum of 12 hours after completing placement of concrete. Then, remove forms, provided the concrete has hardened enough to preclude damage resulting from form removal. Barrier forms may be removed in less than 12 hours, provided the concrete has hardened enough to preclude damage from form removal. During cold-weather curing, keep forms in place for a minimum of 5 days. Do not remove deck forms before the end of the water curing period (removal of burlap), unless approved by the Representative.

At construction joints, keep bulkheads in place for a minimum of 12 hours after placing concrete. Then, remove bulkheads provided the concrete has hardened enough to preclude damage resulting from removal of the bulkheads. During cold weather curing, keep bulkheads in place for 48 hours, and keep the concrete moist at all times.

Table A
Minimum Compressive Strength

	Minimum psi
Class AAAP	3000
Class AAA	3,300
Class AA	2,750
Class A	2,500

2. Application of External Loads to Concrete. Strength determination for all values as specified in Section 1001.3(q)2 will be determined by compressive strength according to PTM No. 604 or maturity method according to PTM No. 640.

2.a Dead Loads. Do not begin work on wall, column, or pier shaft construction until 12 hours after placing footings. For footings on piles, do not begin work until 48 hours after placing footings.

Where falsework for the cap on pier bents is supported on the footings or from the ground, do not begin work on the cap construction until 24 hours after placing the columns.

Where forms are supported on collars attached to the columns, do not begin work on cap construction until 5 days after placing the columns, and the concrete has attained a minimum compressive strength, as specified in Table A.

Construct column- and pier-shaft lifts according to one of the following methods:

> **Method 1.** Where the forms for previous lifts, not including the footing, are left in place and adequately braced, do not place the next higher lift until 24 hours after placing the lift immediately below.
>
> **Method 2.** Where forms are supported by the concrete in the previous lift, not including the footing, and where other forms and bracing have been removed from the lower lifts, do not place the next higher lift until 5 days after placing the previous lift, and the concrete has attained a minimum compressive strength, as specified in Table A.

Do not place superstructure beams on abutment walls, or solid shaft piers without cantilevers until 3 days after placing the wall or shaft, and the concrete has attained a minimum compressive strength, as specified in Table A.

For all other substructure units, do not place superstructure beams until 5 days after placing the substructure units, and the concrete has attained a minimum compressive strength, as specified in Table A.

2.b Backfilling. Backfill as specified in Section 205 and as shown on the Standard Drawings. Do not backfill or place material adjoining CIP abutment walls, backwalls, retaining walls, box culverts, arches and precast box culvert end sections with closure placements until 7 days after placing last concrete, and then only if concrete has attained the 7-day Minimum Mix Design Compressive Strength as specified in Section 704, Table A.

Maintain symmetrical loading on each side of the span, and progress uniformly in placing embankment and structure backfill adjacent to, and over, arch rings, box culverts, or rigid frame structures, unless otherwise indicated.

2.c Live Loads. Do not allow live loads onto bridge decks or approach slabs until directed and the following minimum criteria are met:

TABLE B
Live Loads - Class AAAP Cement Concrete

Live Load	Min. Duration After Deck Placement	Min. Duration After Barrier Placement	Min. Concrete Compressive Strength (psi)	Additional Requirements
Conveyor Belt Systems	72 Hours	-	-	weight of system is uniformly distributed; operation of system does not damage deck
Truck Mixers, Slip Form Pavers, Truck Agitators, Heavy Equipment, Construction Traffic	7 Days	-	3,250 in Deck	do not exceed 5 mph; no more than one truck on deck at a time in a span or continuous unit for each truck placement occurrence
	-	7 Days	3,000 in Barrier	do not travel within 12 feet of barrier
Barrier or Sidewalk Placement	7 Days	-	3,250 in Deck	-
Power Operated Concrete Buggies	7 Days	-	3,250 in Deck	-
Diamond Grinding and Mechanical Texturing	21 Days	-	3,600 in Deck	-
Opened to Traffic	21 Days	-	3,600 in Deck	min. duration after last deck placement
	-	7 Days	3,000 in Barrier	min. duration after last barrier placement

TABLE C
Live Loads - Bridge Preservation

Live Load	Construction Operation	Min. Duration After Placement			Min. Concrete Compressive Strength (psi)
		AAAP or AA Concrete as noted	ASC	HES Concrete	
Opened to Traffic	Bridge Deck Patching	AAAP, 14 Days	Equal to time to attain min. concrete compressive strength plus time for liquid membrane-forming curing compound to set according to manufacturer's recommendations	*	3,000
	Expansion Dam Blockouts			*	
	Barrier Patching	AA, 7 Days		Equal to 3 days plus time for liquid membrane-forming curing compound to set according to manufacturer's recommendations*	
	Approach Slabs	AAAP, 7 Days			
		AA, 7 Days			

*Do not use HES in bridge decks

(r) Waterproofing. Apply waterproofing as indicated or where directed, as specified in Section 680.3 and as follows:

1. Cracks in Culverts. Where directed, cover minor cracks in culverts by waterproofing them with an accepted sealer. Apply the sealer as recommended by the sealant manufacturer. Seal cracks on backfill sides only.

2. Form Tie Holes. If directed, satisfactorily waterproof form tie holes on the backfill side of the box or arch culverts.

(s) Tack Coat for Bridge Decks. If an asphalt concrete surface is to be placed on the bridge deck, apply an asphalt tack coat on the deck, before placing the asphalt material as specified in Section 460.3.

(t) Bridge Deck, Barrier, and Approach Slab Sealing. For new bridge decks, at a minimum of 28 days after last barrier placement, apply 2 inch by 2 inch strip of epoxy binder resin along base of barrier reveal and deck to seal the gutterlines. Apply 2 inch by 2 inch strip of epoxy resin binder to seal curb gutterlines and barrier sidewalk gutterlines. After gutterlines have been sealed, apply boiled linseed oil as specified in Section 1019.3(a) or penetrating sealer as specified in Section 1019.3(c).2 as indicated to bridge deck and barrier. For new approach slabs, apply boiled linseed oil as specified in Section 1019.3(a) or penetrating sealer as specified in Section 1019.3(c).2 as indicated. If liquid membrane-forming curing compound was used to cure concrete to receive gutterline sealing, boiled linseed or penetrating sealer, remove curing compound from the surface by water blasting before sealing. Water blasting equipment must have a minimum rated capacity of 5,000 pounds per square inch.

(u) Defective Work. At no additional cost to the Department, remove and replace concrete that is bulged, uneven, or showing surface defects resulting from the effects of rain, improper finish, improper cure, scaling or honeycombing, which, in the Structure Control Engineer's opinion, cannot be repaired. If directed, remove and replace concrete that has not attained the minimum compressive strength. Repair or replace concrete that exhibits cracks or surface tears, as directed by the Structure Control Engineer. Use a high molecular weight methacrylate penetrating crack sealer, a low viscosity epoxy resin, or other suitable material to repair the surface cracks and tears.

Submit for review, a detailed Quality Control and Action Plan that includes, at a minimum, the proposed crack sealing material data sheet from the manufacture and conditions for use, including ambient and substrate temperature and moisture conditions. Do not perform any crack sealing before the Quality Control and Action Plan has been reviewed by the Representative.

(v) Bridge Approach Slabs. Construct as shown on the Contract Drawings and as specified in Section 505.3.

1001.4 MEASUREMENT AND PAYMENT—

(a) Cement Concrete. Cubic Yard or Lump Sum

As indicated, for the class specified, for the item indicated.

The Department will not make a deduction in measurement for anchor bolts, expansion plates, drainage openings, weep holes, pipes, or conduits if the volume displaced by an installation of opening does not exceed 1/2 cubic yard.

The Department will not deduct the volume of reinforcement bars from the measured volume of concrete.

Where it is impractical to measure concrete in cavities or sink holes, the Department will measure by the volume shown on the certified slips of the delivered batch weights, as recorded by Department representatives assigned to the work.

The cost of concrete cores, taken to examine tremie-placed concrete, is incidental to the other concrete work.

(b) Reinforcement.

1. Reinforcement Bars. Section 1002.4

Dowel bars required for unplanned joints are incidental to other reinforcement.

2. Steel-Welded Wire Fabric. Pound

Annealed iron wire, chairs, and ties are incidental to the weight of the steel wire fabric.

(c) Structure Foundation Drain. Linear Foot

For the size indicated. Includes outlet protection.

Measurement includes all pipe connections.

(d) Selected Borrow Excavation, Coarse Aggregate, No. 57. Section 205.4

(e) Excavation. Section 204.4
For the class indicated.

(f) Backfill for Excavation Below Indicated Elevation. Cubic Yard
Paid as specified in Section 110.03.

(g) Selected Borrow Excavation, Structure Backfill. Section 205.4

(h) Lighting Pole Anchorage. Each
The price includes anchor bolts, nuts, washers, 1 1/4-inch conduit, junction box, drain pipe, steel angle, and required fittings.

(i) Anti-washout Admixture. Cubic Yard
The price includes only the additional cost associated with the incorporation of AWA into a cubic yard of cement concrete. This associated cost may include material, mix designs, and handling. The actual cement concrete is paid under the lump sum item for the structure or the item for the class of concrete specified.
Section 110.02(d) will not apply to this item.

(j) Mechanical Texturing with Transverse or Longitudinal Sawed Grooves. Square Yard
Measured as the finished grooved area.

(k) Epoxy Binder Resin for Gutterline Sealing. Sealing gutterlines with epoxy binder resin is incidental to the bridge deck and barrier placement.

(l) Boiled Linseed Oil or Penetrating Sealer. Section 1019.4

SECTION 1002—REINFORCEMENT BARS

1002.1 DESCRIPTION—This work is the furnishing and placement of reinforcement bars for cement concrete construction.

1002.2 MATERIAL—

(a) Reinforcement Steel. Reinforcement bars, Section 709.1. As indicated, provide epoxy coating for reinforcement bars as specified in Section 709.1(c). Galvanized reinforcement bars as specified in Section 709.1(e) may be substituted for epoxy-coated reinforcement bars. As indicated, provide stainless steel reinforcement bars as specified in Section 709.1(f).

Uncoated, corrosion-resistant steel reinforcement bars may be substituted for epoxy-coated reinforcement bars as specified in Section 709.1(g). When uncoated, corrosion-resistant steel reinforcement bars are utilized, the Representative will select, for each size of reinforcement bar used, one sample (comprised of three increments, where each increment is collected from separate reinforcement steel bars of the same size and lot). Provide samples 48 inches in length. Immediately package and deliver the samples to the Representative. The Representative will submit the field verification samples (Sample Class FV) to LTS for testing to determine conformance to the specified requirements.

(b) Other Material.

- Annealed Iron Wire—ASTM A 684 as described in Section 1002.3(d)1.
- Cement—Section 701
- Water—Section 720.1
- Welding Material—Section 1105.02(t)

(c) Mechanical Splice System. From a manufacturer listed in Bulletin 15 and conforming to the following physical requirements:

• Ultimate tensile strength of mechanical splice system	90% of specified ultimate tensile strength of reinforcement bars, minimum
• Allowable slip	See Table A
• Yield strength of mechanical splice system	100% of specified yield strength of reinforcement bars, minimum
• Fatigue resistance, allowable slip (California Test No. 670, +25 kips per square inch to -25 kips per square inch for 10,000 cycles)	0.05 inch, maximum

Table A

Reinforcing Bar Number	Total Slip (inch), Maximum
3	0.010

4	0.010
5	0.010
6	0.010
7	0.014
8	0.014
9	0.014
10	0.018
11	0.018
14	0.024
18	0.030

Provide an epoxy-coated mechanical splice system to splice epoxy coated reinforcement bars. Apply a minimum coating thickness of 7 mils to repaired areas but not exceeding the manufacturer's recommendations, and repair according to the following sections of ASTM A 775:

- Scope - Section 1
- Referenced Documents - Section 2
- Terminology - Section 3
- Powder Coating - Section 5.2
- Patching Material - Section 5.4
- Surface Preparation - Section 6
- Coating Application - Section 7
- Coating Thickness Testing - Sections 8.1.3 and 8.1.4
- Coating Adhesion - Section 8.4
- Retests - Section 10
- Repair of Damaged Coating - Sections 11.2, 11.3 and 11.5

Provide a galvanized mechanical splice system to splice galvanized reinforcement bars. Thread reinforcement bar ends before galvanization. Remove all grease, oils, or other contaminants that would adversely affect the bond before galvanization. Galvanize the mechanical splice system according to ASTM A 153 with a minimum thickness of 2 mils or 1.2 ounce per square foot. Tap the splice system oversize according to ASTM A 563, Section 7.4. Chromate according to ASTM A 767, Section 4.3.

Provide a stainless steel mechanical splice system to splice stainless steel reinforcement bars compatible with one of the UNS designations listed in Section 709.1(f) for stainless steel reinforcement bars.

The Representative will select, for each size of reinforcement bar used, four splices, either sample or actual. Three are to be assembled for testing to verify the physical properties and one is to remain unassembled for testing of coating thickness or verification of reinforcement bar strength in case of a failing test result. Assemble samples or actual splices in the presence of the Representative according to the manufacturer's recommendations and Section 1002.3(e). All samples must have a minimum of 30 inches of reinforcement bar extending from each end of the coupler body. Immediately package and deliver the samples to the Representative. The Representative will submit the field verification samples (Sample Class FV) to the LTS for testing and conformance to the specified requirements.

Certify as specified in Section 106.03(b)3.

1002.3 CONSTRUCTION—

(a) General. Provide reinforcement bars free from injurious defects such as cracks and laminations. Provide reinforcement bars free from frost, dirt, oil, grease, paint, mortar, loose rust, mill scale, and other materials that would reduce bond. The Department will not reject reinforcement bars for bonded rust, surface seams, surface irregularities, or mill scale provided the minimum dimensions, cross-sectional area, and tensile properties of a hand wire brushed specimen meet the physical requirements for the size and grade of steel indicated.

Remove loose, scaly, or thick rust. A light powdery coating of rust, formed during project storage, does not require cleaning. The Representative will reject reinforcement bars with rusting that has caused detectable reduction

in cross-sectional area. Obtain the Representative's acceptance of in-place reinforcement bars before concrete is placed. Maintain the reinforcement bars in the correct position.

Verify the compatibility of the bar schedule with the structure plans and details. Make adjustments to the bar schedule, including reinforcement bar details and quantities, and obtain the Representative's acceptance before fabrication. The Department will not grant additional Contract time as a result of adjustments to the bar schedule or to reinforcement bars. With each shipment of reinforcement bars delivered to the project, have the material supplier furnish a bill of lading that provides an itemized listing, as shown on the bar schedule for individual structural units, of all bars in the shipment by quantity, size, length, mark, type, weight, and bending dimensions, as indicated. Include general project identification information as well as any appropriate remarks and plan references (drawing number, description, etc.) on the bill of lading. Submit bills of lading to the Representative to verify and document field quantities and for the Department's project records.

(b) Storage. Section 106.05(d) and as follows:

Store reinforcement bars off the ground on platforms, skids, or other supports, and protect the reinforcement bars from mechanical injury and surface deterioration caused by exposure to conditions producing rust. Keep reinforcement bars free from frost, dirt, oil, grease, paint, mortar, loose rust, mill scale, and other materials that would reduce bond.

Handle and store epoxy-coated reinforcement bars by methods that will not damage the epoxy coating. Furnish all systems for handling epoxy-coated reinforcement bars with adequately padded contact areas if possible. Pad all bundling bands and lift all bundles with a strong back, multiple supports, or platform bridge to prevent bar-to-bar abrasion from sags in the bar bundle. Do not drop or drag bars or bundles. Transport and store epoxy-coated reinforcement bars on wooden or padded supports. For additional storage and handling requirements for epoxy-coated reinforcement bars see Section 1002.3(g)1.

Follow additional storage requirements for stainless steel reinforcement as specified in Section 1002.3(i)3.

Follow additional storage and handling requirement for galvanized reinforcement bars, as specified in Section 1002.3(h)2.

Follow additional storage requirements for uncoated, corrosion-resistant steel reinforcement as specified in Section 1002.3(j)3.

(c) Field Adjustment. Furnish bars with shapes and dimensions, as indicated. Do not field bend except to make minor adjustments when approved by the Representative. If field bending or straightening is required, see Table B. Do not field bend rail or axle steel. Field bend uncoated, corrosion-resistant steel reinforcement bars at ambient temperature and do not bend or straighten bars in a manner that will damage the material. Heating of the uncoated, corrosion-resistant steel reinforcement bars to facilitate bending is not allowed. Cut uncoated, corrosion-resistant steel reinforcement bars by shearing or with a fluid-cooled say. Torch cutting of uncoated, corrosion-resistant steel reinforcement bars is not allowed.

TABLE B
Bend and Straightening Requirements [(1) (2)]

Bar Size	Carbon Equivalent	Bend Temp. F	Straighten Temp. F	Bar Size	Dia. of Former Inches Min.
4 through 7	Unknown	1400-1500	1400-1500	4 5	3 4
	0.55 or less and A 706	70-100 or 1400-1500	70-100 or 1400-1500	6 7	5 6
8	Any	1400-1500	1400-1500	8	8
>8	Bending and straightening not recommended				

(1) Use temperature sticks.

(2) Avoid:

- 450F to 600F

- 1800F and greater

Note:
A. Apply heat to sufficient area to encompass bend area.
B. Apply heat for sufficient time to bring bar center to required temperature.
C. Maintain temperature while bending and/or straightening.
D. Allow free rotation.
E. Bend with smooth continuous application of force.
F. Straighten by moving hickey bar (if used) progressively around bend.

(d) Placing and Fastening.

1. General. Accurately place reinforcement bars as indicated and hold it firmly in position during the placing and settling of concrete using metal chairs or acceptable supports. Do not allow bar spacing to vary from the design spacing by more than 1/2 inch. Do not allow the distance from the surface of the formwork to the bars to vary more than 1/4 inch from the design distance. Do not place reinforcement bars closer than 1.5 times the maximum nominal size of the aggregate used in the concrete mix design. Firmly tie bars with annealed iron wire or secure the bars with acceptable metal clips. Tie bars at all perimeter intersections and at all intersections on the top mat of bridge decks and in bridge barriers. For other intersections, when bar spacing is greater than or equal to 12 inches, tie all intersections; when bar spacing is less than 12 inches, either tie all intersections or tie alternate intersections in each direction to provide a staggered tie layout. Tie bundled bars together at not more than 6-foot centers. When reinforcement bars are tied together and lifted into place as a unit, ensure stability of the unit and maintain proper bar alignment during lifting and placement operations.

For epoxy-coated reinforcement bars and galvanized reinforcement bars, provide plastic-coated tie wire, epoxy-coated tie wire, metal clips, or plastic clips.

When tying stainless steel reinforcement bars together, provide tie wire meeting one of the UNS designations as specified in Section 709.1(f) for stainless steel reinforcement bars. When attaching stainless steel reinforcement bars to any other dissimilar metals, provide 1/8 inch thick (minimum) nylon, polyvinylchloride, or polyethylene spacers or sheathing to ensure no contact between the reinforcement bars a minimum of 1 inch extending beyond the point of intersection in all directions. Use nylon or plastic coated wire ties to bind the spacers and/or reinforcement.

When attaching uncoated, corrosion-resistant steel reinforcement bars to other uncoated, corrosion-resistant steel reinforcement bars use nylon or plastic coated wire ties. When uncoated corrosion-resistant steel reinforcement bars are attached to or may come in contact with any dissimilar metals, provide 1/8-inch thick (minimum) nylon, polyvinylchloride, or polyethylene spacers or sheathing to ensure no contact between the reinforcement bars for a minimum of 1 inch extending beyond the point of intersection in all directions. Use nylon or plastic coated wire ties to bind the spacers and/or reinforcement.

If fabric reinforcement is shipped in rolls, straighten it into flat sheets before placing it. Do not weld cross bars (tack weld) for assembly of reinforcement bars unless authorized in writing by the Representative.

2. Support Systems. Support reinforcement bars in its proper position by use of mortar blocks, wire bar supports, supplementary bars, or other devices. Supply such devices of proper height and at sufficiently frequent intervals to maintain the distance between the reinforcement bars and the formed surface or the top surface of deck slabs within 1/4 inch of that indicated.

Support platforms, supporting personnel and equipment during concrete placement, directly on the forms and not on the reinforcement bars.

For uncoated, corrosion-resistant steel reinforcement bars, provide plastic supports as specified in Section 1002.3(d)2.c or steel bar supports as specified in Section 709.1(g). Use corrosion-resistant supports with plastic coated feet above steel beams or metal stay in place forms.

2.a Mortar Block Supports. Furnish mortar blocks of the same class as the concrete in which they are to be embedded. Use either a tie wire or, if the gravitational force of the reinforcement bars is sufficient to firmly hold the blocks in place, a groove in the top of the block. For epoxy-coated reinforcement bars or galvanized reinforcement bars, use plastic-coated or epoxy-coated tie wires. Do not use mortar blocks on vertical surfaces.

2.b Wire Supports. Furnish wire bar supports, such as ferrous metal chairs and bolsters conforming to industry practice as described in the Manual of Standard Practice of the CRSI. Ensure that chairs or bolsters that bear against the forms for exposed surfaces are either Class 1 - Maximum Protection (Plastic Protected) or Class 2, Type B - Moderate Protection (Stainless Steel Tipped) for which the stainless steel conforms to ASTM A 493, Type 430. For epoxy-coated reinforcement bars or galvanized reinforcement bars, provide plastic-coated, epoxy-coated, or galvanized wire bar supports and bar clips. For stainless steel reinforcement bars, provide plastic supports as specified in Section 1002.3(d)2.c or stainless steel bar supports meeting one of the UNS designations as specified in Section 709.1(f) for stainless steel reinforcement bars. Use stainless steel supports with plastic coated feet above steel beams or metal stay in place forms.

2.c Plastic Supports. Use chairs and bolsters that do not deflect more than 1/4 inch under the minimum point load requirement of 350 pounds-force as described in PTM No. 430. Use supports molded in a configuration that does not restrict concrete flow.

3. Adjustments. Adjust reinforcement used in post-tensioned concrete, or relocate it during the installation of prestressing ducts or tendons, as required to provide planned clearances to the prestressing tendons, anchorages, and stressing equipment, as approved by the Representative.

(e) Splicing and Lapping. Furnish all reinforcement in the full lengths, as indicated, unless otherwise allowed by the Representative.

Do not splice bars, except as indicated or directed. If splicing is allowed, lap the reinforcement bars as shown on the Standard Drawings and as indicated, and wire together securely. Do not substitute alternate bars unless allowed by the Representative. Stagger splices as far as possible.

In lapped splices, place and wire the bars maintaining the minimum distance to the surface of the concrete as indicated. Do not use lapped splices for Nos. 14 and 18 bars, except as provided in Articles 5.11.5.2.1 and 5.11.5.5.1 of the AASHTO LRFD Specification.

As indicated, use welded splices or mechanical splice systems. For welded splices, use butt splices only. Stagger welded splices or mechanical splice system connections if possible. Do not weld uncoated, corrosion-resistant steel reinforcement bars.

Only use welded splices if indicated or if the Chief Bridge Engineer gives written authorization to do so. Ensure that welding conforms to the Structural Welding Code, Reinforcing Steel, AWS D1.4.

Do not use welded splices on epoxy-coated reinforcement bars or galvanized reinforcement bars. Do not weld so close to epoxy-coated reinforcement bars to cause any heating of the coating.

Do not use welded splices on uncoated, corrosion-resistant steel reinforcement bars. Do not weld close to uncoated, corrosion-resistant steel reinforcement bars to prevent any heating of those reinforcement bars.

Assemble all mechanical splice systems according to the manufacturer’s recommendations. Furnish a copy of the manufacturer's recommendations to the Representative. Mark reinforcing bars with scribe marks or indelible ink before splice attachment to ensure equal embedment.

When epoxy coated or galvanized mechanical splice systems are used, clean, assemble and repair any visible damage to the coating with an acceptable repair material according to the manufacturer's recommendations. For epoxy coated mechanical splice systems, seal off the epoxy coated rebar at the point of entry into the mechanical coupler using an acceptable epoxy repair material.

Use a mechanical splice system manufactured from uncoated, corrosion-resistant steel as specified in Section 709.1(g) to splice uncoated, corrosion-resistant steel reinforcement bars as specified in Section 709.1(g).

Do not encase mechanical splices in concrete until visual examination and required testing have been completed and approved.

(f) Epoxy-Coating Exposed Stirrups. If stirrups in precast bridge elements are not epoxy-coated during fabrication, epoxy-coat the exposed portion of the bars. Wire brush the bars before applying the epoxy coating. If epoxy-coated stirrups are expected to be exposed for more than 6 months, cover with opaque polyethylene, or other suitable material, to prevent ultra-violet damage to the epoxy coating.

(g) Epoxy-Coated Reinforcement Bars. In addition to the above, the following requirements apply if using epoxy-coated reinforcement bars:

1. Storage, Handling, and Placement. Where possible, do not store epoxy-coated reinforcement bars at the jobsite for more than 2 months. If field storage on site is expected to exceed 2 months, cover the epoxy-coated reinforcement bars or bundles with opaque polyethylene or other protective material. Provide ventilation to prevent condensation from forming under the covering.

Store, handle, and place epoxy-coated reinforcement bars at the jobsite according to ASTM D 3963. Inspect the bars before placement. If the epoxy coating is damaged and the damages do not exceed 2% of the surface area in any 1-foot section of the epoxy-coated reinforcement bars, repair all visible damage according to ASTM D 3963 before bar placement. Replace epoxy-coated reinforcement bars if damage to the surface area exceeds 2% in any 1-foot section. Do not apply heat to bend or straighten bars.

After placement, inspect the epoxy-coated reinforcement bars again and repair areas damaged during placement.

2. Welding. Do not weld.

3. Appurtenances. Use plastic-coated or epoxy-coated tie wire. Provide epoxy coated appurtenances with a minimum coating thickness of 5 mils according to CRSI Manual of Standard Practice section 3.2.6. Provide galvanized appurtenances according to ASTM A 123 Table 1 with a coating grade consistent with the measured wire diameter or thickness.

(h) Galvanized Reinforcement Bars. In addition to the above, the following requirements apply if using galvanized reinforcement bars:

1. Fabricate. Fabricate reinforcement bars after galvanization.

2. Storage, Handling, and Placement. Where possible, do not store galvanized reinforcement bars at the jobsite for more than 30 days. Store as specified in Section 1002.3(b) to allow air circulation to prevent the formation of wet storage stain. If field storage is expected to exceed 30 days, cover bars with opaque polyethylene or other protective material.

Provide galvanized reinforcement bars having uniform appearance. Do not use reinforcement bars with visible corrosion deposits, uncoated spots, spikes, or acid, flux or black spots.

During galvanization, use methods that prevent bars from becoming stuck together.

Do not field bend galvanized reinforcement bars except to make minor adjustments when approved by the Representative. Do not apply heat to bend or straighten galvanized reinforcement bars.

Do not place or store galvanized reinforcement bars in contact with uncoated reinforcement bars or other uncoated steel or stainless steel.

Before and after placement, inspect the galvanized reinforcement bars and repair areas damaged during placement according to ASTM A 780 using paints containing at least 92% zinc dust in the dry film to a minimum final coating thickness of 3.1 mils (cured). Prepared damaged areas according to SSPC-SP 11 and feather at least 1 inch of the surrounding undamaged galvanized coating before painting.

3. Welding. Do not weld.

4. Appurtenances. Use plastic-coated or epoxy-coated tie wire. Provide epoxy coated appurtenances with a minimum coating thickness of 5 mils according to CRSI Manual of Standard Practice section 3.2.6. Provide galvanized appurtenances according to ASTM A 123 Table 1 with a coating grade consistent with the measured wire diameter or thickness.

(i) Stainless Steel Reinforcement Bars. In addition to the above, the following requirements apply if using stainless steel reinforcement bars:

1. Fabricate. Where bent bars are indicated, provide plastic, polyvinylchloride, polyethylene or rubber sleeves around bending pins and contact points during the bending operation to prevent contamination.

2. Welding. Do not weld.

3. Storage, Handling, and Placement. Do not band strap or allow direct contact of stainless steel reinforcing bars to non-stainless steel reinforcement bars or other dissimilar metals.

Do not store non-stainless steel reinforcement bars or other dissimilar metals above stainless steel reinforcement bars unless adequate protection has been provided to prevent contamination.

Provide stainless steel reinforcement bars having a uniform appearance. Do not use stainless steel reinforcement bars with visible surface oxidation or corrosion deposits.

Do not field bend except to make minor adjustments when approved by the Representative. When field bending is required, do not permit non-stainless steel bending equipment to come in direct contact with the stainless steel reinforcement.

After placement, inspect the stainless steel reinforcement to ensure the no contact and tying requirements as specified in Section 1002.3(d) have been met.

(j) Uncoated, Corrosion-Resistant Steel Reinforcement Bars. In addition to the above, the following requirements apply if using uncoated, corrosion-resistant steel reinforcement bars:

1. Fabricate. Where bent bars are indicated, provide plastic, polyvinylchloride, polyethylene or rubber sleeves around bending pins and contact points during the bending operation to prevent contamination.

2. Welding. Do not weld.

3. Storage, Handling, and Placement. Do not band strap, or allow direct contact of uncoated, corrosion-resistant steel reinforcing bars to reinforcement bars or other metallic items manufactured from any dissimilar metals.

Do not store uncoated, corrosion-resistant steel reinforcement bars uncovered at the jobsite for more than 2 months. If field storage on site is expected to exceed 2 months, cover the bars or bundles with protective material. Provide ventilation to prevent condensation form forming under the covering.

Do not store uncoated, corrosion-resistant steel reinforcement bars below or in contact with reinforcement bars manufactured from any dissimilar metals unless adequate protection has been provided to prevent contamination.

Provide uncoated, corrosion-resistant steel reinforcement bars having a uniform appearance. Do not use uncoated, corrosion-resistant steel reinforcement bars with visible surface oxidation or corrosion deposits.

Do not field bend except to make minor adjustments when approved by the Representative. When field bending is required, do not permit uncoated, corrosion-resistant steel reinforcement to come in direct contact with bending equipment manufactured form any other dissimilar metals.

After placement, inspect the uncoated, corrosion-resistant steel reinforcement to ensure the no contact and tying requirements as specified in Section 1002.3(d) have been met.

1002.4 MEASUREMENT AND PAYMENT—

(a) Reinforcement Bars. Pound or Lump Sum

As indicated for the type specified.

Galvanized coating weight is incidental to the weight of the reinforcement bar.

Annealed iron wire, chairs, ties, spacers, and sheathing are incidental to the weight of the reinforcement bar.

(b) Mechanical Splice System. Each or Lump Sum

As indicated for the type specified.

Painting the uncoated threads and/or repairing the epoxy coating of the splice area after assembly is incidental, if epoxy-coated reinforcement bars and mechanical splice systems are used.

SECTION 1003—DOWEL HOLES

1003.1 DESCRIPTION—This work is the drilling of holes for dowels and the grouting of the dowels in place.

1003.2 MATERIAL—

- Nonshrink Grout—Section 1001.2(e)

1003.3 CONSTRUCTION—Drill holes for dowels at the locations and to the diameter and depth as indicated. Grout the dowels in place, using nonshrink grout to form a complete bond between the dowels and the concrete. Repair structure damage caused by dowel operations.

1003.4 MEASUREMENT AND PAYMENT—Each

SECTION—1005 PILES

1005.1 DESCRIPTION—This work is the furnishing and driving of new, unused test piles and production piles.

The following definitions apply:

(a) Test Pile. A pile driven to verify the capability of the pile hammer, determine driving characteristics, and establish the predetermined pile tip elevation, before driving production piles. Test piles may also be used to perform pile load tests.

(b) Static Pile Load Test. A test to determine pile bearing capacity and integrity by the application of a static load.

(c) Dynamic Pile Load Test. A test to determine pile bearing capacity and integrity by the application of a dynamic load and measuring the force and velocity response with a high strain dynamic load testing system. A dynamic pile load test may include post-driving analysis.

(d) High Strain Dynamic Load Testing System. A portable computer used to determine pile bearing capacity and integrity through instrumentation of the pile with accelerometers and strain gauges during dynamic pile load testing.

(e) Production Pile. A pile installed to provide structural support as part of the permanent foundation.

(f) Point Bearing Pile. A pile that develops bearing capacity primarily by point-bearing on sound, well-defined bedrock.

(g) End Bearing Pile. A pile that develops bearing capacity primarily by embedment of the lower portion in a dense or hard bearing stratum such as soft or decomposed bedrock, or hard or dense soil.

(h) Friction Pile. A pile that develops bearing capacity primarily from soil resistance acting along the pile shaft.

(i) Penetration. The length of pile driven into a soil or rock stratum.

(j) Driving Resistance. The resistance of soil or rock strata to pile driving, measured in blows per length of penetration.

(k) Estimated Pile Tip Elevation. The estimated elevation of the pile tip as indicated.

(l) Predetermined Pile Tip Elevation. The pile tip elevation determined by the Structure Control Engineer or District Geotechnical Engineer from the test pile(s). The predetermined pile tip elevation locates the intended bearing strata for point bearing or end bearing piles, or establishes the length of friction piles. Predetermined pile tip elevations are used to verify or adjust the estimated pile tip elevations indicated.

(m) Maximum Allowable Driving Stress. A driving stress equal to 90% of the yield strength of a steel pile.

(n) Wave Equation. An equation developed from wave propagation theory, used to evaluate the integrity and the bearing capacity of piles by simulating motions and forces in a pile if driven with the approved hammer and pile driving equipment.

(o) Restrike. A series of hammer blows applied to a driven test or production pile after a specified waiting period to evaluate the pile for setup or relaxation after initial driving.

1005.2 MATERIAL—

(a) Cast-in-Place Concrete Piles with Steel Shells. These piles consist of steel shells equipped with steel end closures or other acceptable designs, reinforced as indicated, then filled with Class A cement concrete after driving.

Provide steel shells and end closures of the type and size indicated, and as follows:

- Having a plain, fluted, or other acceptable wall design.
- Cylindrical, uniformly tapered, step-tapered, or a combination of the shapes.
- Having a nominal diameter not less than 12 inches for cylindrical shells and not less than 12 inches for the butt end of uniformly tapered shells.
- Having a tip diameter of not less than 8 inches for uniformly tapered shells.
- Having a diameter at any section of step-tapered piles not less than 8 inches.
- Of watertight construction.

The wall thickness indicated is the minimum required to satisfy structural design requirements. Increase the thickness, as necessary, to withstand driving without damage or exceeding the maximum allowable driving stress. Provide shells having a wall thickness of 9 gauge (5/32 inch) or thicker; consisting of steel pipe, ASTM A 53, Grade B; ASTM A 500, Grade B or C; ASTM A 501, Grade A or B; ASTM API 5L, Grade B, PSL 1 or PSL 2, X42 or X52; ASTM A 252, Grade 2, or 3; or cold-rolled steel tubing, basic open-hearth steel (AISE C1010 or SAE 1010)) with a minimum yield strength of 50,000 pounds per square inch. The use of ASTM A 252 or AISE C1010 or SAE 1010 is not recommended if splicing will be utilized; a Procedure Qualification Record must be submitted along with a Welding Procedure Specification according to AASHTO/AWS D1.1-2008 to the Structural Control Engineer for acceptance

Provide each pile preferably in one piece without splices. Obtain the Structure Control Engineer's acceptance of splice location and splicing details if splicing is necessary, and splice piles as specified in Section 1005.3(g).

Provide end closures of forged steel, cast steel, steel plate, or other material as follows: forged steel, AISI 1020; cast steel, ASTM A 148, Grade 80-50 or 90-60. For flat steel plate end closures, provide plates not less than 3/4 inch thick, conforming to AASHTO M 270 (ASTM A 709), Grade 50. Provide end enclosures not extending more than 1/4 inch beyond the surface of the shell, welded to the shell. Attach end closures of the indicated type and size to the piles as indicated. Use the same end closures for test piles that will be used for production piles. Submit details, including method of attaching, to the Structure Control Engineer for acceptance. Weld end closures as specified in Section 1105.03(m) for the type and position of welding required.

Galvanize piles, or portions of piles, as specified in Section 1105.02(s) if indicated. End closures are not required to be galvanized unless indicated.

Submit a certification from the manufacturer of the steel shells, end closures, and splice material as specified in Section 106.03(b)3. Forward these certifications within 3 working days after shipment, together with a copy of the certified report showing the chemical and physical properties of the base metal to the Representative for the project file.

(b) Steel H-Piles. Provide new or stocked (unused) piles, pile sections, and splice material conforming to AASHTO M 270 (ASTM A 709), Grade 50; or ASTM A 572, Grade 50. Provide cast tip reinforcement conforming to ASTM A 148, Grade 80-50 or 90-60, and fabricated tip reinforcement conforming to AASHTO M 270 (ASTM A 709), Grade 50.

Provide each pile preferably in one piece without splices. Obtain the Structure Control Engineer's acceptance of splice location and splicing details if splicing is necessary, and splice piles as specified in Section 1005.3(g).

Attach pile tip reinforcement of the indicated type and size to the piles as indicated. Use the same pile tip reinforcement for test piles that will be used for production piles. Use prefabricated or cast steel tips as an alternate to the indicated tip reinforcement. Submit details, including method of attaching, to the Structure Control Engineer for acceptance. Weld pile tip reinforcement as specified in Section 1105.03(m) for the type and position of welding

required. Heavy duty pile tips have an area of at least 2.0 times the pile area and steel prongs to penetrate rock.

Galvanize piles, or portions of piles, as specified in Section 1105.02(s) if indicated. Pile tip reinforcement is not required to be galvanized unless indicated.

Submit a certification from the manufacturer of the steel H-piles, pile tip reinforcement and splice material as specified in Section 106.03(b)3. Forward these certifications within 3 working days after shipment, together with a copy of the certified report showing the chemical and physical properties of the base metal to the Representative for the project file.

(c) Other Material.

- Class A Cement Concrete—Section 704, with high-range water-reducing (HRWR) admixture and a slump of 5 inches to 8 inches.
- Reinforcement—Section 709.1.
- Welding—Section 1105.02(t).
- Casing Pipe—Section 1006.2(a).
- Aggregate—Section 703.1 or AASHTO No. 10 as specified in Section 703.2 Table C.

1005.3 CONSTRUCTION—

(a) Equipment. Use pile-driving equipment of an acceptable type, weight, and rated energy. Use an approved pile hammer and pile driving equipment capable of installing the specified pile type in the indicated subsurface conditions to achieve the estimated pile tip elevation and required pile capacity without damage.

1. Hammers. Use diesel, steam, air, or hydraulic actuated pile hammers capable of developing at least 12,000 foot-pounds per blow, unless otherwise allowed. Equip hammers with a suitable drive head or anvil that securely holds the top of the pile in correct position relative to the hammer and that distributes the blows from the ram over the entire top area of the pile. Do not use capblocks or cushions containing asbestos. Inspect the hammer cushion in the presence of the Representative before the start of pile driving, and as requested if damage to the cushion is suspected.

Submit the pile hammer operating specifications and pile information for review and acceptance on Pile Hammer Data Form CS-5 at least 21 calendar days before driving test piles. Do not drive test or production piles before receipt of the Pile Hammer Approval Letter. Acceptance of the pile hammer and driving equipment will not relieve the Contractor of responsibility for properly driving piles, in satisfactory condition, to the driving resistance and tip elevations indicated or directed. The Structure Control Engineer will reject hammers that cause damage or driving stresses greater than the maximum allowable driving stress at any driving resistance.

Equip closed-end diesel hammers with a dial gauge for measuring pressure in the bounce chamber. Provide a hose for the gauge long enough to enable reading at ground level. Calibrate the dial gauge to allow for losses in the gauge hose. Verify the accuracy of the calibrated dial gauge to allow for losses in the gauge hose. Verify the accuracy of the calibrated dial gauge both during driving of the test piles and, as directed, during driving of the production piles. Ensure cylinder lift occurs if the bounce chamber pressure is consistent with the maximum energy given in the hammer specifications. Do not use closed-end diesel hammers that do not attain cylinder lift at the maximum energy bounce chamber relationship given in the hammer specifications.

Measure inlet pressures for double-acting and differential-acting air or steam hammers, using a needle gauge at the head of the hammer if driving test piles and, as directed, if driving bearing piles. As an alternative to periodic measurements with a needle gauge, develop a pressure versus speed calibration for the driving conditions at the site.

Use air compressors that can provide 25% more air than the manufacturer's specified air consumption for air-driven hammers.

Vibratory hammers may be permitted to advance test or production piles but are not acceptable for driving piles to absolute refusal or end of driving criteria. Submit manufacturer data sheets to the Structure Control Engineer for review and acceptance before advancing piles with a vibratory hammer.

2. Leads. Construct pile driver leads to allow free movement of the hammer. Hold the leads in true vertical or inclined positions, as required, by guys or stiff braces to ensure support of the pile during driving. Provide leads of sufficient length so a follower or excessive splices will not be necessary under normal conditions.

3. Predrilling Equipment. Provide predrilling equipment capable of drilling, augering, or boring holes and setting casing for piles to the depths as indicated or directed. Provide necessary equipment to advance through cobbles, boulders, rock, or other natural or manmade obstructions.

(b) Driving Piles.

1. General. Do not drive piles until the excavation is complete in the areas the piles are to occupy, unless otherwise allowed by the Structure Control Engineer. Do not drive piles within 25 feet of uncured concrete.

Use test piles and production piles of the types or sizes indicated. The Department may omit test or production piles. Furnish each steel H-pile or steel shell of the full length indicated and in one continuous unit, unless allowed by the Structure Control Engineer. If a pile is too short for the intended purposes, extend it to the length directed, as specified in Section 1005.3(g).

Lift piles into leads using an acceptable method. Submit a repair procedure for review and acceptance if any section of a pile that has been cut, drilled, or modified to attach a lifting device will be incorporated into the final driven length of pile.

2. Pile Driving Log. A detailed and accurate record will be kept while driving each test and production pile, showing the driving date, model of hammer, capblock material, capblock inspection date, pile numbers, types, sizes, heat numbers, actual lengths before driving, sound lengths after driving, lengths in footings, rebuild lengths, extended lengths, final pay lengths, pile tip elevations and driving resistances for the entire length of the piles driven. The Representative will record the pile driving log on Form CS-1005.

3. Driving Test Piles. Drive test piles in one continuous operation, except for splicing, so they can be incorporated into the permanent work, unless indicated. Drive piles to absolute refusal for point and end bearing piles terminating in bedrock. End of driving criteria will be established for friction piles and end bearing piles terminating in soil, unless indicated or directed. The Structure Control Engineer will verify the capability of the hammer to properly drive the production piles based on driving records of test piles at each substructure unit, at locations indicated or directed.

4. Driving Production Piles. Do not drive production piles until the Structure Control Engineer has established the predetermined pile tip elevation and driving resistance from representative test piles for each substructure unit. Drive production piles for each substructure unit with the same hammer, under the same operating conditions, and with the same type and size of capblock and cushion material used to drive the representative test piles.

Drive piles plumb or to the batter indicated. Drive piles to absolute refusal for piles terminating in bedrock, and end of driving criteria for piles terminating in soil.

Unless indicated, the predetermined pile tip elevation is considered approximate in order to allow for variations in the locations or strength of the stratum from which the pile obtains its primary capacity. The limit of the approximation is established from the test piles.

Redrive piles raised by the driving of adjacent piles to the required driving resistance and tip elevation.

5. Absolute Refusal and End of Driving Criteria.

5.a Absolute Refusal. For steel point bearing and end bearing piles terminating in bedrock, absolute refusal is reached if the driving resistance attains an average of 20 blows per 1 inch, or more in the intended bearing stratum. Minimum blow requirements are as follows:

Case 1. Piles Required to Be Driven to Absolute Refusal into Sound, Well Defined Bedrock (Point Bearing Piles). After the pile tip reaches the predetermined elevation in the intended bearing stratum, and after penetration becomes 1/4 inch or less for five consecutive blows, absolute refusal is reached if the penetration for five additional blows is less than 1/4 inch.

Case 2. Piles Required to Be Driven to Absolute Refusal into Soft or Decomposed Bedrock (End Bearing Piles). After the pile tip reaches the predetermined elevation in the intended bearing stratum, and after the penetration becomes 1/2 inch or less for ten consecutive blows, absolute refusal is reached if the penetration for ten additional blows is 1/2 inch or less. After the pile tip enters the intended bearing stratum, if an unreasonably large number of blows is required to increase the driving resistance from 10 blows per 1 inch to 20 blows per 1 inch, the Structure Control Engineer may waive the requirement for driving to absolute refusal.

The Structure Control Engineer will determine the acceptability of piles that do not achieve absolute refusal and capacity at the predetermined pile tip elevation for piles intended to bear in soft or decomposed bedrock. If piles are determined unacceptable, continue driving piles to Case 2 Absolute Refusal to ensure absolute refusal is obtained. The Structure Control Engineer will contact the BDTD to revise the Pile Hammer Approval Letter for differing site conditions if the continued driving exceeds the criteria provided.

Case 3. Piles Which Attain Absolute Refusal Above Predetermined Pile Tip Elevations. If hard driving is encountered because of dense strata or because of obstructions located above the bearing stratum identified by a predetermined pile tip elevation, absolute refusal is not reached until the Structure Control Engineer determines the total number of blows, as the average driving resistance specified for absolute refusal, indicates further driving will not advance the pile through the dense strata or obstructions. The Structure Control Engineer will verify the driven pile tip elevation is at or below the minimum embedment length indicated.

The Structure Control Engineer will contact the District Bridge Unit to determine the acceptability of piles that attain absolute refusal above the predetermined pile tip elevation. If piles are determined to be unacceptable, drive one or more production piles at locations directed. If the additional piles also fail to reach the predetermined pile tip elevation, and if directed, drive additional test piles to determine whether the predetermined pile tip elevation may have to be adjusted. Perform test borings and pile load tests, if directed. Perform augering, predrilling, spudding, preexcavation, or jetting, if directed. The Structure Control Engineer will contact the BDTD to revise the Pile Hammer Approval Letter for differing site conditions if necessary.

If production piles attain absolute refusal above the predetermined pile tip elevation due to freezing resulting from discontinuous driving, the Structure Control Engineer will reject the piles.

5.b End of Driving Criteria. For end bearing and friction piles terminating in soil, end of driving criteria is reached if the required capacity is attained, and the pile tip reaches the predetermined elevation in the intended bearing stratum. Dynamic pile load testing will be performed on the test piles to establish the end of driving criteria (i.e. hammer stroke, required driving resistance, pile tip elevation, and blow count) The Structure Control Engineer will set the required driving resistance in units of blows per inch or blows per foot based on the test piles, and establish end of driving criteria as follows:

Case 4. Piles Required to Be Driven to Hard or Dense Soil Strata (End Bearing Piles). After the pile tip reaches the predetermined elevation in the intended bearing stratum, end of driving criteria is reached if the driving resistance meets the minimum number of blows per inch established from the test piles.

Case 5. Piles Required to Be Driven to Loose or Soft Soil Strata (Friction Piles). After the pile tip reaches the predetermined elevation in the intended bearing stratum, end of driving criteria is reached if the driving resistance meets the minimum number of blows per inch or blows per foot established from the test piles. If the piles do not reach the required resistance at the predetermined pile tip elevation (or after restrike, if restrike is specified), contact the Structure Control Engineer for guidance. If the required resistance is not attained within an additional 10 feet of driving depth, the Structure Control Engineer is to contact BDTD to review

geotechnical information and recommend further actions.

Case 6. Piles Which Attain End of Driving Criteria Above Predetermined Pile Tip Elevations. If hard driving is encountered because of dense strata or because of obstructions located above the bearing stratum identified by a predetermined pile tip elevation, end of driving criteria is not reached until the Structure Control Engineer determines the total number of blows, as the average driving resistance specified, indicates further driving will not advance the pile through the dense strata or obstructions. The Structure Control Engineer will verify the driven pile tip elevation is at or below the minimum embedment length indicated.
If piles reach the required driving resistance above the predetermined pile tip elevation due to freezing resulting from discontinuous driving, the Structure Control Engineer will reject the piles.

5.c Bearing Value of Piles. If piles are not required to be driven to absolute refusal or end of driving criteria, the Structure Control Engineer will determine driving resistances, tip elevations, and safe bearing values from pile load tests or wave equation analysis of the test pile-driving results. A maximum permissible driving stress of 90% of the steel yield should be used for predicting pile capacity using wave equation and dynamic pile load tests.

1. Static Pile Load Test: The product of a resistance factor of 0.8 times the static pile load test result is greater than or equal to the plan factored axial resistance as indicated.

2. Dynamic Pile Load Test: The product of a resistance factor of 0.65 times the ultimate pile capacity as established by dynamic pile load test is greater than or equal to the plan factored axial resistance as indicated.

3. Wave Equation: The product of a resistance factor of 0.5 times the wave equation predicted ultimate pile capacity result is greater than or equal of the plan factored axial resistance as indicated.

6. Jetting Piles. Jet piles, if directed. Do not jet through embankment areas. Use enough jets and enough volume and pressure of water at the jet nozzles to erode the material adjacent to and below the pile joint. Withdraw jets before the predetermined pile tip elevation is reached.

7. Driving Piles through Embankments. Driving piles through embankments or constructing embankments around driven piles can induce additional loading on the piles due to settlement of the fill. Do not drive piles through quarantined embankments until after the quarantine has been lifted, unless indicated or directed. Do not modify the proposed construction sequence or construction details such as casing, pile sleeves or coatings, pile windows, etc. for piles in embankments without prior approval from the District Geotechnical Engineer. As indicated or directed, spud, auger, or predrill through the embankment material to the original ground.

8. Damaged Piles. Acceptance of a hammer relative to driving stress damage will not relieve the Contractor of responsibility for piles damaged because of misalignment of the leads, failure of capblock or cushion material, failure of splices, malfunctioning of the hammer, or other improper construction methods. The Structure Control Engineer will reject piles damaged for these reasons, if it is determined the damage impairs the strength of the completed piles. Remove piles showing damage due to improper driving if the pile cannot be rebuilt or extended. Backfill the resulting hole if it interferes with other construction. Drive another pile as close as possible to the required location within the indicated distance from the edges of the footing. Fill damaged steel shells left in place with concrete.

(c) Restriking. Restriking of test or production piles may be indicated based on the anticipated subsurface conditions or directed based on the initial driving of the piles.

1. **Restriking Test Piles.** If indicated, restrike the test piles a minimum of 3 days after initial driving at each substructure unit to evaluate pile relaxation or set-up, unless a longer waiting period is indicated. Do not restrike before pile load test reports for the original test pile driving, including supplemental analyses, are submitted to the Structure Control Engineer.

Before restriking test piles, warm up the hammer by striking a minimum of 20 blows of the hammer on a production pile located as far as practical from test pile(s) to be restruck.

Restrike each test pile until the ultimate pile resistance obtained from dynamic testing data is greater than design load requirements.

Maintain driving records and perform dynamic pile load testing during the restriking of the test piles if indicated or directed for the initial drive. Record dynamic data on the first restrike and other blows as approved. Submit data and reports as specified in Section 1005.3(h)2 using the restrike data.

2. **Restriking Production Piles.** Based on the results of the test pile restrike, the Structure Control Engineer will determine the need for restriking production piles. Perform restriking of production piles to termination criteria provided, if directed.

(d) Tolerances. The Structure Control Engineer will reject piles driven outside of the following tolerances:

1. Deviation from Vertical or Batter Indicated. No greater than 2 inches in 10 feet or 1 degree from vertical or batter indicated for all structure types.

2. Rotation of the Horizontal Axis of the Pile. No greater than 15 degrees from the orientation indicated for Integral Abutments, Abutments on Mechanically Stabilized Earth (MSE) Walls, or piles extending above ground for open bent construction. No greater than 30 degrees from the orientation indicated for all other structure types.

3. Location of the Butt End (Top) of the Pile. No greater than 2 inches in any direction from the indicated position for Integral Abutments, Abutments on MSE Walls, or piles extending above ground for open bent construction. No greater than 6 inches in any direction from the position indicated for all other structure types. Extend the footing or pile cap as directed to enclose piles that are driven closer to the edges of footings than indicated. Extend far enough to obtain the indicated encasement. Add additional reinforcement, as directed.

(e) Cutting Off Piles. After piles have been driven and accepted, cut them off at the indicated top elevations, perpendicular to their axis, unless otherwise directed. Provide watertight covers for steel shells which have not been filled with concrete.

(f) Filling Shells with Concrete. Thoroughly clean driven shells of water and debris and inspect driven steel shells using a safe light attached to a cord long enough to reach the entire pile length and obtain the Structure Control Engineer's acceptance before placing concrete in them. Place reinforcement as specified in Section 1001.3(b) and as indicated. Place and cure Class A cement concrete as specified in the applicable parts of Section 1001.3. Drop the concrete into the shells slowly without forming air pockets. Discharge concrete through hoppers with a short pipe centered on the shell for piles without rebar cages. Do not allow concrete to freefall within the length of the rebar cage. Vibrate concrete within the rebar cage.

(g) Splicing, Rebuilding and Extending Piles. Splice, rebuild or extend test and production piles as necessary during the driving operation with approval of the Structure Control Engineer. Use extensions between the tip and butt end not less than 10 feet long. At the butt ends, use extensions at least 5 feet in length for approximately 75% of the piles in a substructure unit. At the tip ends, use extensions at least 5 feet in length. If piles extend above ground for open bent construction, do not rebuild or splice between the cutoff elevation and a point 10 feet below finished grade, unless indicated or directed.

If splicing is anticipated, submit weld procedure specifications for steel H-piles on PennDOT Form TR-52 and for steel shells on PennDOT Form TR-50 to the Structure Control Engineer at least 14 calendar days before the start of driving. Provide copies of current welder certification cards to the Representative before splicing.

Weld splices, pile tip reinforcement, or metal end-closures as shown on the Standard Drawings and as specified in Section 1105.03(m) for the type and position of the welding required.

Provide splices for steel H-piles that fully develop the yield strength of the pile.

Provide splices developing the yield strength of steel shells based on the indicated shell thickness. If the shell thickness exceeds the indicated thickness, base the splice strength on the indicated shell thickness, unless a stronger

splice is needed to resist driving forces.

Do not splice pile reinforcement, unless allowed in writing by the District Executive.

(h) Pile Load Tests.

1. **Static Pile Load Tests.** If static pile load tests are required, the contract documents will specify the detailed requirements.

2. **Dynamic Pile Load Tests.** Conduct dynamic testing on the specified pile(s) at each substructure as indicated or as directed. Conduct dynamic testing during the entire length of piles driven and during the time piles are restruck, if restrike is indicated. The purpose of dynamic testing is to provide the Department with supplemental information for evaluating pile hammer performance, driving stresses, potential pile damage and bearing capacities.

   Provide dynamic pile load testing with equipment and accessories conforming to ASTM D4945. The same hammer and equipment must be used for the dynamic pile load testing on the test piles or production piles or both.

   2.a Qualifications. Submit qualifications for acceptance. Do not begin dynamic testing until qualifications are accepted. Perform the dynamic testing with a Professional Engineer and workforce experienced in dynamic testing meeting the following qualifications and submitting proper documentation:

   - The dynamic testing operator must have a minimum of 3 years of experience that demonstrates successful performance on at least three projects in similar geotechnical conditions and pile type with the use of high-strain dynamic pile testing. Include a brief description of each project and the name and phone number of the owner's representative knowledgeable in each project listed.

   - Furnish the full name and license number of a Professional Engineer registered in the State, having at least 5 years of experience in the performance of dynamic testing of driven piles, who is responsible for the work performed and preparing test reports. Do not use only the company names of consultants or manufacturers to meet the requirements of this section; use the names of the personnel.

   2.b Submittals. Submit proposed methods of documentation and reports for acceptance. Include the format of the electronic template for the submission of pile driving records. As the tests are completed, provide electronic output records from the dynamic pile load testing with data to correlate the records with the respective pile and driving records. Submit records within 24 hours of testing. Record signals on approved electronic media. Perform supplementary office analyses on piles dynamically tested, as directed. Include an interpretive report that summarizes pertinent field data, to determine pile tip elevations, pile capacity, soil resistance distribution, dynamic soil properties of shaft and toe quake and damping resistances and driving stresses throughout the pile for each substructure unit. Evaluate and report the pile capacity versus plan factored axial resistances, maximum measured driving stress, hammer system efficiency, and pile structural damage/integrity. Submit a preliminary report within 48 hours of dynamic pile load testing. Submit a complete report with the information according to ASTM D4945, signed and sealed by a Professional Engineer licensed in the State, to the Representative within 5 days of testing.

   2.c Dynamic Pile Load Testing. Perform dynamic pile load testing only if the Representative is present for witnessing during the entire time piles are driven, redriven or restruck. Notify the Representative of a tentative schedule for testing at least 21 calendar days before starting the tests. Notify the Representative of a firm date at least 48 hours before starting the tests but give the notice between start of work on Monday and noon of the following Friday. Do not schedule dynamic testing on Saturdays, Sundays, or Holidays without prior approval from the Representative. Perform dynamic testing according to ASTM D4945. Drill the necessary holes in the pile to fasten a pair of transducers

and a pair of accelerometers. Drive the pile while testing until ordered to stop by the Representative. Remove the transducers and accelerometers after the dynamic testing is completed. Submit a repair procedure to the Representative to seal holes drilled in the pile if that section is to be incorporated into the structure.

(i) Predrilling. Predrill holes at pile locations and to depths and intended bearing strata if indicated. Deviations of drill hole from plan location and verticality are allowed, provided the driven pile is within the tolerances as specified in Section 1005.3(d). Piles installed in predrilled holes must be driven to absolute refusal or end of driving criteria to ensure the pile is not bearing on sloughed material.

For non-integral abutments, drill a hole with a minimum diameter 3 inches larger than the largest cross-sectional dimension of the pile. For integral abutments, drill a hole with a minimum diameter that is the larger of 2 feet or 10 inches larger than the largest cross section dimension of the pile.

Provide permanent casing if indicated for integral abutments or piles in embankments.

Provide temporary casing if indicated. Temporary casing is required to maintain an open hole for the following conditions:

- If there is evidence of exchange of soils or materials between adjacent predrilled holes.
- If drilling methods compromise the lateral support provided by the soil surrounding the pile due to excessive loss or migration of material.
- If excessive sloughing of material occurs into the predrilled hole so infilling of the predrilled hole is visible and evident at the surface.

The use of casing is recommended for predrilled holes influenced by groundwater. Unless otherwise specified, casing is not required for a predrilled hole to be maintained as an open hole for pile insertion.

1. **Piles Driven without the Use of Casing.** The length of the predrilled hole is to remain open and unobstructed to allow insertion of the pile and aggregate, and to maintain adequate lateral support for the installed pile. An incidental amount of material, which can be penetrated by the pile during driving, may slough into the bottom of the hole. Minimize the potential for sloughing and collapse of the hole by installing the pile and aggregate (or aggregate only, if the predrilled length is less than 20 feet and approved) in predrilled holes promptly after predrilling. Drive piles in as specified in Section 1005.3(b).
2. **Piles Driven with the Use of Casing.** Install casing as indicated or required to maintain an open hole and install the pile and aggregate (or aggregate only, if the predrilled length is less than 20 feet and approved) in cased holes. Temporary casing may be removed after backfilling if site conditions and project specifications permit. Drive piles as specified in Section 1005.3(b). Piles that reach absolute refusal or end of driving criteria above the bottom of the predrilled hole will be rejected. Remove temporary casing after driving operations, unless directed otherwise.

(j) Predrilling for Unforeseen Obstructions. For piles that cannot be advanced to the predetermined tip elevation due to unforeseen obstructions, extract the pile(s) using a vibratory hammer, crane or other acceptable method. Inspect extracted piles for damage and obtain approval from the Structure Control Engineer to reuse extracted piles or portions thereof. Discard damaged piles or portions of piles not able to be reused. Predrill holes at the extracted pile location(s) as specified in Section 1005.3(i) and drive new or extracted piles, if approved.

1005.4 MEASUREMENT AND PAYMENT—The Department will not pay for unauthorized piles, defective piles, unsatisfactorily driven piles, piles that reach absolute refusal or end of driving criteria above a predrilled elevation, portions of piles cut off, piles not driven, or for costs for such piles or portions of piles.

The following work will be considered Extra Work as specified in Section 110.03 (if items are indicated for this work, the work will be paid for as indicated and will not be considered Extra Work):

- Spudding, preexcavation, jetting, and test borings related to such work, if such work is directed to advance the piles to predetermined pile tip elevations due to unforeseen conditions.
- If piles installed for integral abutments or abutments on mechanically stabilized walls are damaged by twisting as a result of conditions identified as differing site conditions as specified in Section 110.02(b), the extraction of such damaged piles, predrilling for the driving of piles replacing such damaged piles,

and the driving of piles replacing such damaged piles.

- Splicing required due to one or more individual piles penetrating more than 10 feet below the estimated pile tip elevation indicated if the total quantity of piling does not significantly change the character of the work to be performed under the contract, as specified in Section 110.02(d). Payment for splicing if a pile penetrates more than 10 feet below the estimated pile tip elevation is limited to one splice per individual pile.

The cost of spudding, augering, or drilling to original ground through embankments placed is incidental for test and production piles, unless payment for such work is indicated.

The Department will not pay for the extraction and replacement of piles damaged due to misalignment of the leads, failure of capblock or cushion material, failure of splices, malfunctioning of the hammer, or other improper construction methods, if it is determined the damage impairs the strength of the completed pile.

(a) Test Piles. Lump Sum

The Department will pay for test piles at the Contract lump sum price per unit or group of units, including necessary cutting off, splicing and rebuilding to the indicated test pile length. The price includes necessary excavation for pile splicing, rebuilding, and extending; pile driving equipment furnished on the project; costs of transporting the equipment to the project; erecting, maintaining, and moving the equipment within the project; and dismantling and removing the equipment from the project, and pile tip reinforcement.

If any portion of a test pile is indicated to be galvanized, the entire length of the pile will be paid under the galvanized test pile item unless indicated.

Additional test piles and extensions in excess of the indicated number and length will be measured and paid for by the linear foot price of corresponding production piles. The excess length will be measured from the estimated pile tip elevation to the elevation of the final driven tip end for test piles driven below the estimated pile tip elevation, or from the cutoff elevation to the final driven tip end for additional test piles not indicated.

For test piles specified in the proposal but not required to be placed, adjustment of payment will be made as specified in Section 110.02. Cutoff portions of test piles will remain the property of the Contractor.

Costs associated with the use of proximity switches for the monitoring of piles, as specified, will be incidental to the price bid for test piles.

(b) Production Piles. Linear Foot

Measured from the indicated or directed cutoff elevation to the final driven tip end of the pile, including length of pile driven if restrike is indicated or directed. This length does not include any portion of the tip reinforcement or end closure that extends below the driven end of the pile.

The unit price includes costs of furnishing and driving, cutting off, splicing, rebuilding or extending and excavating necessary for splicing and rebuilding or extending.

If any portion of a production pile is indicated to be galvanized, the entire length of the pile will be paid under the galvanized production pile item unless indicated.

If acceptable piles must be replaced with another type of construction and are removed or cut off, payment will be made for the length below the cut off elevation, or the bottom of the other construction.

Piles that reach absolute refusal or end of driving criteria above a predetermined pile tip elevation due to freezing resulting from discontinuous driving are unsatisfactorily driven piles, and the Department will not pay for these piles. If augering, predrilling, spudding, preexcavation, or jetting is directed because of these unsatisfactory piles, the additional work is to be done at no additional cost to the Department.

The Department will not deduct the volume of concrete displaced by piles from the foundation concrete quantities.

Costs associated with the use of proximity switches for the monitoring of piles, as specified, will be incidental to the price bid for production piles.

(c) End Closures for Steel Shells. Metal end closures will be included in the Contract unit price per linear foot for the pile of which it is a part. The Department will not pay separate or additional compensation.

End closures for test piles will be included in the Contract lump sum prices for those items.

(d) Production Pile Tip Reinforcement. Each

(e) Dynamic Pile Load Test. Each

Applies if dynamic testing is performed while driving the entire length of pile, including restrike if indicated. No additional time or payment will be made for the following:

- Testing that is unable to be completed or is terminated by the Contractor before driving the entire length of the pile, as determined.
- Work determined to be unsatisfactory due to improper driving methods, inadequate equipment and materials, or unacceptable splice or tip welding.
- Cost for interruptions, delays, time lost due to malfunction, breakdown of equipment, or inclement weather.
- Additional testing done without the prior approval of the Representative.
- Costs associated with replacing a hammer rejected due to unacceptable performance, inadequate capacity based on the dynamic pile load testing results, or if the Contractor should choose to replace an already accepted hammer. These costs include, but are not limited to, transporting the replacement hammer to the job site, unloading and setup, additional analyses and submissions, additional dynamic pile load tests required for the replacement hammer acceptance, lost production time, etc. Before driving piles with the new hammer, the Contractor must submit the operating specifications and Pile Hammer Data sheet (Form CS-5) for acceptance of the proposed hammer as specified in Section 1005.3(a)1.

(f) Restriking Test Piles. Each.

Includes costs to mobilize and restrike test piles. Additional driven length of pile will be paid as specified in Section 1005.4(a). Paid only if restrike of test piles is indicated or directed. Does not include costs for restriking due to poor hammer performance or rejection, or restriking piles raised by driving of adjacent piles.

(g) Restriking Production Piles. Each.

Includes costs to remobilize and restrike piles, except for additional driven length of pile which is paid as specified in Section 1005.4(b). Paid only if restrike of production piles is indicated or directed. Does not include costs for restriking due to poor hammer performance or rejection, or restriking piles raised by driving of adjacent piles.

(h) Predrilling.

1. Mandatory Predrilling for Driven Piles. Linear Foot.

Measured from the bottom of the footing elevation or ground surface elevation at the time of drilling, whichever is lower, to the bottom of the predrilled hole. Includes mobilization, access to the foundations, drilling, maintaining an open hole, permanent or temporary casing and backfilling with aggregate.

2. Predrilling for Unforeseen Obstructions, Earth Drilling. Dollar.

The proposal will include an item and a predetermined amount of money for Predrilling for Unforeseen Obstructions, Earth Drilling. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for by determining the actual amount of equipment, tools, labor, and work involved to acceptably perform the work as follows:

1.a Negotiated Price. At a price agreed upon by the Department before performing the work.

1.b Force Account Basis. Section 110.03(d).

Includes access to the foundations, drilling, maintaining an open hole, temporary casing and backfilling with aggregate.

3. Predrilling for Unforeseen Obstructions, Obstruction Drilling. Dollar.

The proposal will include an item and a predetermined amount of money for Predrilling for Unforeseen Obstructions, Obstruction Drilling. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for by determining the actual amount of equipment, tools, labor, and work involved to acceptably perform the work as follows:

1.a Negotiated Price. At a price agreed upon by the Department before performing the work.

1.b Force Account Basis. Section 110.03(d).

Includes access to the foundations, drilling, maintaining an open hole, temporary casing and backfilling with aggregate.

4. Pile Extraction and Redriving. Dollar.

The proposal will include an item and a predetermined amount of money for Pile Extraction and Redriving. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for by determining the actual amount of equipment, tools, labor, and work involved to acceptably perform the work as follows:

1.a Negotiated Price. At a price agreed upon by the Department before performing the work.

1.b Force Account Basis. Section 110.03(d).

Pile extraction and redriving for driven piles that reach absolute refusal or end of driving criteria above the predrilled elevation will be considered unsatisfactory and payment will not be made. Payment will not be made for piles or portions of piles which are not able to be reused after extraction.

5. Mobilization for Predrilling of Unforeseen Obstructions. Dollar.

The proposal will include an item and a predetermined amount of money for Mobilization for Predrilling of Unforeseen Obstructions. This work includes transportation, assembly, setup and removal of the equipment needed to perform predrilling operations, permitting, access to the foundation, initial items required to start the work, restoration of disturbed areas and site cleanup associated with predrilling. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for by determining the actual amount of equipment, tools, labor, and work involved to acceptably perform the work as follows:

1.a Negotiated Price. At a price agreed upon by the Department before performing the work.

1.b Force Account Basis. Section 110.03(d).

SECTION 1006—DRILLED CAISSONS

1006.1 DESCRIPTION—This work is construction of reinforced cement concrete drilled caisson foundations consisting of shaft sections with or without casings left in place, and with or without rock sockets or belled footings, formed within drilled excavations.

The following definitions apply:

(a) Drilled Caisson. Cast-in-place foundation element consisting of shaft section with or without enlarged bearing area at its base, a minimum of 30 inches in diameter, and deriving load capacity through load transfer to the bearing strata in side resistance, tip resistance, or a combination of both.

(b) Bell Footing. Enlargement at base of shaft constructed with an underreaming tool in materials that will stand open.

(c) Bearing Strata. Layer(s) of soil or rock providing principal support of applied loads.

(d) Rock Stratum. A stratum of geomaterial having an unconfined compressive strength equal to or greater than 250 pounds per square inch that cannot be drilled with conventional earth augers or underreaming tools, thus requiring the use of special rock augers, core barrels, air tools, blasting, or hand excavation.

(e) Shaft Section in Soil. Length of caisson shaft from top of shaft to top of rock stratum.

(f) Shaft Section in Rock. Length of caisson shaft from top of rock stratum to top of rock socket.

(g) Rock Socket. Length of caisson in rock stratum below the shaft, providing a fixed connection between the caisson and the rock stratum.

(h) Permanent Casing. Steel pipe, typically of cylindrical shape, installed by drilling, driving, or vibrating that when filled with concrete, becomes a permanent part of the drilled caisson.

(i) Temporary Casing. Protective steel pipe, typically of cylindrical shape, installed by drilling, driving, or vibrating, that provides lateral earth support during shaft excavation, cleaning, and inspection; controls groundwater infiltration; and is removed as part of the concrete placement operation.

(j) Obstruction. A natural or manufactured object above designated rock socket tip elevation that cannot be drilled with conventional earth augers or underreaming tools, and that requires the use of special rock augers, core barrels, air tools, blasting, or hand excavation.

(k) Class A Self Consolidating Concrete (SCC) for Drilled Caissons and Sockets. Class A SCC typically consists of a mixture of Portland cement, supplementary cementitious material, fine aggregate, coarse aggregate, water, viscosity-modifying admixtures, air-entraining admixture with high range water reducing admixture, and other ASTM C494, Type S admixtures.

(l) Thermal Image Profiling (TIP). Used to measure the temperature profile within a deep foundation element constructed using cast-in-place concrete. The thermal profile induced by the curing concrete is used to evaluate the homogeneity and integrity of the concrete mass for the entire height and diameter of the caisson within the deep foundation element. TIP will also show misalignment of the reinforcement cage within the caisson.

(m) Crosshole Sonic Logging (CSL). Used to measure the propagation time and relative energy of an ultrasonic pulse between parallel access ducts installed in the drilled shaft. The velocity reduction is correlated to a concrete quality and is used as an indicator of the homogeneity and integrity of the concrete mass between the access ducts.

(n) Submersible Inspection Device (SID). An inspection device consisting of a digital video camera and video control housing unit used for inspection of the bottom of the drilled caisson excavation capable of being submersed in water.

(o) Downhole Camera. An inspection device consisting of a digital video camera and video control housing unit used for inspection of the sides of the drilled shaft excavation, or rock socket capable of being submersed in water.

1006.2 MATERIAL—

(a) Casing. Section 1105.02(a)2. Provide smooth, clean, rust-free metal casing of sufficient strength to withstand handling and installation stresses and the pressure of concrete, water, and the surrounding earth; and to prevent water seepage. Casing diameters refer to inside diameters subject to applicable API tolerances for steel pipe. Weld any required casing splices according to ANSI/AWS D1.1 with no interior splice plates, producing true and straight casing.

(b) Reinforcement Bars. Section 1002.2. Provide reinforcing steel for main vertical bars and ties and for spirals as specified in Section 709.1(a)1. Use mechanical splice systems as specified in Section 1002.2(c).

(c) Welding Material. Section 1105.02(t)

(d) Class A Cement Concrete. Section 704, with high-range water-reducing (HRWR) admixture and a slump of 5 inches to 8 inches.

(e) Class A SCC. Section 704, conforming to ACI 211 and ACI 237R, and as specified in Table A. Submit mix designs to the DME/DMM for review and approval**.** Use of an approved workability retention admixture is required to ensure slump flow is maintained throughout the duration of the concrete placement. Use of an anti-washout admixture, according to PTM 641, is required for concrete placed in a caisson containing 3 inches or more of standing water. Take immediate corrective action whenever the slump flow range limit or action points are exceeded. Perform plastic SCC slump, air, and temperature tests on the first three consecutive trucks at the beginning of placement operations or after significant stoppage such as plant or equipment breakdown to determine if material control has been established. Material control is established when all test results of SCC slump, air, and temperature for three consecutive trucks are determined to be within the established action points.

TABLE A

SCC Requirements		
Cement	Section 701, Type(s) I, II, IP, or IS	-
Water	Section 720.1	-
Admixtures	Section 711.3	-
Supplementary Cementitious Material	Section 724	-
Cement Factor, Diameters ≤ 6'-0"	564 lb/cy - 752 1b/cy	Note 1
Cement Factor, Diameters > 6'-0"	400 lb/cy min. (including supplementary cementitious material)	Note 1
	250 lb/cy min. of Portland Cement	-
Maximum Water Cement Ratio	0.45 lb/lb	-
Minimum Mix Design Compressive Strength	7 day 2,750 psi	-
	28 day 3,000 psi	-
28 Day Structural Design Compressive Strength	3,000 psi	-
Minimum Allowable Compressive Strength	2,500 psi	-
Fine Aggregate	Section 703.1	-
Coarse Aggregate	Section 703.2	Note 2
Coarse Aggregate Volume	9.10 cf/cy - 13.43 cf/cy	-
Column Segregation (Mix Design Phase)	ASTM C1610, 12% max. (9% where gravels are used having a crushed fragment percentage less than 55%	-

Slump Flow Target	ASTM C1611, 20 inches - 30 inches	Note 3
Visual Stability Index (VSI)	≤ 1	Note 4
J Ring	ASTM C1621	Note 5
Plastic Air Content Target	6.5% within a tolerance of ± 1.5% during the work	Note 6
Hardened Entrained Air	2% min.	Note 6

Note 1 - Include one or more of the following as a replacement for a portion of the cement as specified in Section 704.1(g). The minimum percentages listed are required to be met when one or more of the aggregates have a linear expansion listed in Bulletin 14 greater than 0.10%:

- Slag Cement, Grade 100 or 120, 25% min.
- Flyash (Type F or Type C**) 15% min. (for flyash minimum cement content equal to 580 pounds per cubic yard. **Type C may be used provided alkali–silica reaction (ASR) is mitigated through the use of additional Supplementary Cementitious Materials.
- Silica Fume 5% - 10%
- The total substitution of Portland cement must not exceed 50%, including the amount in the blended cement.

Note 2 - Section 703.2 except: The requirement for crushed fragments is not required provided the column segregation testing performed during mixture qualifications does not exceed 9%. The requirement for meeting established Section 703 gradations do not apply if an optimized aggregate gradation is submitted and approved during the mix design qualification phase and controlled/verified during production according to an approved QC plan.

Note 3 - Maintain slump flow within ± 3 inches of target. Reject SCC if upper slump flow limit is exceeded. If the slump flow test is less than the lower limit, reject SCC unless approved for vibration and is vibrated.

Note 4 - Reject SCC with a VSI > 1

Note 5 - If the difference between the slump flow test and J Ring test is greater than 2 inches, reject SCC unless approved for vibration and is vibrated.

Note 6 - Air entrainment is not required where the top of caisson is 36 inches or more below grade.

(f) Nonshrink Grout. Section 1080.2(c). Use nonmetallic nonshrink grout.

(g) TIP Materials. Provide materials necessary to perform TIP testing according to ASTM D7949 Method B and as indicated. Provide a sufficient quantity of thermal wires as indicated. If not indicated, provide quantity of thermal wires to achieve a distribution of one embedded thermal sensor for every foot of caisson diameter, with a minimum of four embedded thermal sensors, extending the full length of each drilled caisson. Provide wire length sufficient to be attached to readout boxes upon completion of concrete placement. Provide connection supplies and necessary splices. Provide sufficient data loggers to maintain readings on each thermal wire for 96 hours from the completion concrete placement.

Provide and maintain functional TIP equipment. At a minimum, maintenance includes protection during use and repair/replacement of any damaged equipment. Maintain redundant equipment based on manufacturer's recommendations. Provide equipment according to the approved TIP supplier and the following:

- Thermal Wires (as indicated)
- Wire splices
- Data Logger (one per active wire)
- Connection and charging wires
- Software (most recent version available at time of shaft installation)

(h) CSL Materials. Provide crosshole sonic access tubes at each caisson for all projects. Provide CSL testing equipment only when indicated, as needed, or as directed to verify the integrity and homogeneity of drilled caissons.

1. CSL Access Tubes. Section 1105.02(j)1. Provide 2 inch inside diameter (ID), Schedule 40 steel pipe access tubes. Provide one tube for every foot of caisson diameter, with a minimum of three tubes per caisson. Prepare access tubes according to ASTM D6760. Fit each tube with a watertight shoe on the bottom and a removable cap on the top. Use threaded couplings according to ASTM A865. Provide a threaded joint at the top for use during testing. Hydrostatic test requirements are waived. CSL access tubes are required in all caissons. CSL access tubes may also be used for performing TIP according to ASTM D7949, Method A, as required or directed.

2. CSL Equipment. Provide equipment to conduct CSL testing according to ASTM D6760. At a minimum, include the following CSL equipment:

- Microprocessor-based CSL system for display of individual CSL records, analog-digital conversion and recording of CSL data, analysis of receiver responses and printing of CSL logs
- Ultrasonic source and receiver probes for use in 2 inch ID pipe
- Ultrasonic voltage pulsar to excite the source with a synchronized triggering system to start the recording system
- Depth measurement device to determine and record depths
- Appropriate filter/amplification and cable systems for CSL testing.

(i) SID. Provide a SID that consists of a rugged steel device incorporating a high-resolution digital color video camera and probing tool in a submersible housing and employs pressurized nitrogen gas and water to enable viewing of the bottom of the hole in murky conditions. Provide electrical power, lighting, cable connections, color monitor, audio and video recording system and any other necessary electronic devices required to document the inspection operation. Provide a probe inside the SID with a visible gauge, graduated in 0.25 inch increments or smaller, to measure the amount of sediment on the bottom of the rock socket shaft.

(j) Downhole Camera. Provide a downhole camera when indicated or as directed. Provide a downhole camera conforming to the following requirements:

- Color camera with supplemental dive lighting
- Capability of recording at low light and/or in turbid water.
- Capability of tilting vertically and horizontally using motorized panning and tilting.
- Fits into a 2 3/4 inch diameter hole.
- Waterproof to a depth of 120% of the indicated drilled shaft length.
- A high-resolution color video and audio recording system, with microphone, mounting bracket, and sunshade.
- 7 inch LCD color monitor or better.
- Operating cable capable of holding 200 pounds.
- Compass Attachment.
- Winch Manual Emergency Hand Crank.
- Carrying case to hold the monitor, compass attachment, LCD screen, and camera.
- Capability to operate on rechargeable battery power for eight hours - Batteries and charger to operate the camera for eight hours.
- Depth readout.
- Cable protection from top of hole or casing friction.
- Centralizer assembly.
- Corrosion resistance.

1006.3 CONSTRUCTION—

(a) Qualifications and Submittals. Provide submittals a minimum of 30 days before construction of drilled caissons. Do not construct drilled caissons before review and acceptance of submittals.

1. Contractor Qualifications. Construct caissons with a supervisor and workforce experienced in the construction of drilled caissons, and meeting the following qualifications:

- Submit a list containing at least five projects that, together, demonstrate a minimum of 3 years of experience in the construction of drilled caissons, including the proposed method of concrete placement. Required experience is drilling, reinforcement installation, concrete placement and all aspects of caisson construction. Include a brief description of each project, and the name and telephone number of owner's representative knowledgeable in each project listed.

- Provide the name of the Professional Engineer registered in the State, directing the work, with at least 3 years of experience in the design and construction of drilled caissons.

- Provide names of drill operators and on-site supervisors under the direction of the Professional Engineer. Each drill operator and on-site supervisor must have at least 1 year of experience in the construction of drilled caissons.

- Furnish names and experience of those performing bottom inspections using the SID, with at least five projects that demonstrate proficiency in the performance of bottom inspections.

- Provide the names of personnel, consultant companies, and manufacturers to meet the requirements of this Section. Do not provide only company names of consultants or manufacturers.

2. Site Inspection. Inspect the project site and the available subsurface information including any available soil or rock samples. Prospective bidders are to contact the District Geotechnical Engineer to schedule a viewing of the subsurface information.

3. Independent Testing Agency. Furnish the name of an independent testing agency(ies) providing TIP testing, and CSL testing (as necessary). Include a list containing at least five projects that, together demonstrate a minimum of 3 years of experience with TIP and CSL testing for drilled caissons. Include names and experience of specific representatives and their roles. Include a brief description of each project, and the name and telephone number of owner's representative knowledgeable in each project listed. Include the name and experience of the independent testing agency Professional Engineer registered in the State who will oversee the testing and sign and seal reports.

4. Drilled Caisson Installation Plan. Submit a Drilled Caisson Installation Plan with the following information:

- List of proposed equipment to be used on the project, including cranes, templates, drill rigs, drills, augers, concrete and rock socket core barrels/downhole hammers, bailing buckets, final cleaning equipment (including airlift/suction equipment), core sampling equipment, welding equipment, tremie, concrete pumps, casing, lifting ring and cradle, etc.

- Details of the overall construction operation sequence and the sequence of drilled caisson construction, including a specific planned schedule for caisson installation.

- Details and methods for locating and maintaining non-drilled and drilled caisson and casing position and alignment during excavation, inspection, and concreting operations, including curing and the use of temporary tool casing. Floating templates attached to a barge will not be allowed. Provide stable templates fixed directly to the ground (or streambed).

- Details and methods for caisson excavation.

- Details and procedures for the installation and removal of casing including details for cutting off permanent casing Include details of methods proposed to backfill any remaining annular space between the caisson and adjacent ground surface.

- Details of methods to mechanically clean the drilled caisson excavation, including airlift or suction methods.

- Details, methods, equipment for bottom inspections using the SID and downhole camera. Include SID and downhole camera for sign structure, sound barrier, and highway lighting caisson foundations only when indicated.

- Details of reinforcing cage fabrication and handling, lifting and installation along with methods and devices that will be used to center the reinforcing cage and maintain concrete cover.

- Details of methods for concrete mixing, transport and placement including operational

procedures. Placement procedures should demonstrate that a continuous supply of concrete is provided to the finished elevation. Include procedure used to ensure that unsuitable concrete is removed by overfilling or other methods. Describe concrete placement and curing procedures to be used during hot/cold weather to protect and provide acceptable concrete. Provide a procedure and detail for an emergency cold joint.

- Details of methods to monitor and maintain concrete temperatures below 75F during concrete placement. Also, for drilled caissons larger than 5 feet in diameter, include methods to monitor and maintain the concrete at a minimum temperature of 50F and a maximum temperature of 150F during curing. Develop the placement method, taking into account water condition, set time and hydraulic pressures.

- Sample of proposed drilled caisson report, including log of materials encountered; sample of proposed test boring log, and sample integrity testing TIP and CSL logs. Provide caisson integrity testing for sign structure, sound barrier, and highway lighting caisson foundations operated by qualified individuals only when indicated.

- Welding procedures and qualifications of welders and tackers according to ANSI/AWS D1.1 for casing steel.

- Mix designs for concrete and non-shrink grout.

- For SCC, submit slump flow, VSI and J-ring tests with a trial mix as follows:

  1. Make the trial mix for the slump test from a trial mix proportioned from the approved concrete mix design. Ensure that it is at least 3.5 cubic yards in volume and prepared in a mixing truck.

  2. Prepare the mix for the slump loss test at a temperature consistent with the highest ambient temperature and concrete temperatures anticipated during concrete placement. Obtain the Representative's approval of the test temperature.

  3. After initial mixing, determine slump, concrete temperature, ambient temperature, and air content. Concrete properties must be within specification limits.

  4. Mix the concrete intermittently for 30 seconds every 5 minutes at 6 to 18 truck-drum rpm.

Accepted procedures are subject to trial in the field. If the procedures fail to perform, this failure will not result in additional cost to the Department or relieve the Contractor of the responsibility to satisfactorily complete the work. Do not begin construction on work affected by the Drilled Caisson Installation Plan until approved. Delays due to resubmission of the Drilled Caisson Installation Plan will be at no additional cost to the Department and with no extension of contract time. After approval of the installation plan, make no changes in the procedures without review and approval.

5. QC Procedures.

- Method for determining initial drilled caisson position and verticality, including the formed section, as well as method for monitoring and procedures for correction during excavation.

- Procedure for coring drilled caisson concrete.

- Methods and procedures for downhole inspection, including the use of downhole inspection camera, maintaining access for SID testing, TIP testing and for the use of CSL tests to verify the integrity of the caisson concrete.

- Include a plan and protocols to maintain continuous access for the Representative to observe TIP testing for the entire duration of the testing at each drilled caisson.

- Plan for compliance with applicable environmental regulations.

6. Drilled Caisson Pre-Construction Meeting. Attend a pre-construction meeting to discuss drilled caisson construction after submittals are accepted and a minimum of 7 calendar days before beginning drilled caisson construction. Discuss construction procedures, personnel, and equipment to be used. The following are required to attend: Project Superintendent, Drilled Caisson Superintendent, Testing Firm Representative, and other individuals designated by the Department. If key personnel change or if significant revisions to Drilled Caisson Installation Plan are proposed, an additional drilled caisson pre-construction meeting may be required at the discretion of the Representative.

(b) Excavation. The Representative will confirm the top elevation of the rock socket before the start of drilling for rock sockets. The effective "top elevation" is based on observation of the boundary zone where broken or weathered rock becomes competent rock and is also influenced by the presence of any coal seams, which are not considered competent rock. The top of the rock socket cannot be located within casing or within a coal seam. Competent rock is rock that cannot be drilled with conventional earth augers and/or under reaming tools and requires the use of special rock augers, core barrels, air tools, and/or other methods of hand excavation. Excavate to the dimensions and elevations indicated, or as directed. The estimated lengths indicated are considered to be approximate. Actual lengths and embedment will be verified by inspection. Additional shaft lengths may be required depending on actual subsurface conditions. Variations of indicated shaft lengths may only be constructed with the written approval of the Representative.

Unless otherwise indicated, bore excavations for vertical caissons plumb to within a tolerance equal to 2% of the shaft length; and for battered caissons, as indicated, to within a tolerance equal to 5% of the shaft length but not more than 1 foot. If holes are more than 6 inches out of plumb, redesign the footing that is to be supported by the caissons. If caissons are out of tolerance, make needed corrections to the structure at no additional cost to the Department. Do not place the top of a caisson out of the indicated position by more than 1/24 of the shaft diameter or 3 inches, whichever is less. If belled footings are required, excavate to form a bearing area of the size and shape indicated. Do not disturb formations below or outside the limits of the caisson under construction or any previously constructed caissons adjacent to the excavation. Blasting is not allowed.

Provide excavation and drilling equipment with a capacity to excavate to a depth of 120% of the proposed drilled shaft length, but not less than 15 feet beyond the rock socket tip depths indicated. Submit the minimum output of the drill rig torque and crowd to the Representative.

Do not excavate within three diameters of caissons with new concrete until 24 hours after concrete placement.

If satisfactory foundation materials are encountered at other than the indicated elevations, adjust drilling depths as directed.

Use permanent metal casing when indicated to prevent caving of the soil material, to exclude groundwater or surface water, and to form the non-drilled and drilled caisson, including the shaft section. Seal the casing a minimum of 2 feet into impervious materials and bedrock to create a tight seal. Use casing to control dimensions and alignment of excavations within tolerances and to execute other construction operations. If artesian water flow is encountered, extend the top of the casing to above the level required to achieve static water head conditions for proper placement of concrete.

If a caving condition or excess groundwater is encountered, discontinue the drilling operation and employ a construction method that prevents caving and groundwater infiltration, such as the installation of casings.

Remove, as directed, caked material from the sidewalls and loose cuttings from the bottom of the excavation so that such material will not cause unanticipated settlement, reduce caisson capacity, or affect concrete strength.

Do not expose the rock socket to water for more than 48 hours without approval. Ream rock socket exceeding 48 hours of water exposure, or that, as determined by the Representative, has deteriorated due to exposure to air or water, with an approved grooving tool to a depth of not less than 1/2 inch, or as directed. Reaming of the rock socket, if necessary, is incidental to drilling the rock socket.

Unauthorized over-drilling, including the additional reinforcement and concrete resulting from over-drilling, will be at no additional cost to the Department.

Promptly remove tools lost in the shaft during drilling and repair hole degradation due to removal operations at no additional cost to the Department with no extension of contract time.

Provide casing through soil and broken or unstable rock during hand cleaning and inspection of the excavation. If joining two or more sections of casing to obtain the required length, weld sections together as specified in Section 1105.03(m) to develop the full tensile strength of each section. Provide no interior splice plates.

Maintain a log of excavation to complete the As-Built Record.

(c) Test Holes. For caissons founded on or socketed into rock, drill standard NW (NX) size core borings at each caisson location, to a minimum depth of 10 feet below the bottom of the excavation (caisson or rock socket), unless otherwise directed. Provide a PennDOT certified drilling inspector for this work. Advance a minimum of one test hole per substructure through overburden soil using continuous Standard Penetration Testing techniques. Begin test hole from the existing ground surface, before site excavation. Advance additional test holes for other caissons at the same substructure locations using unsampled methods through overburden soils, unless otherwise directed. Begin coring at the top of bedrock (auger refusal) or the depth indicated or directed. Drill, log, store, and ship the samples according to the Department's Standard Specification for Subsurface Boring, Sampling, and Testing, Publication 222. The Representative will use the samples to verify whether there is material of sufficient strength and thickness at the bearing elevations indicated to support the required load and for proper founding of caissons. Test holes will also be used to establish the presence of obstructions within the soil shaft of the caisson. Adjust depth or length of caisson shafts and/or rock sockets, as directed.

(d) Probe Holes. Drill 2 inch diameter unsampled holes at the specified locations, to the specified depth below the bottom of the excavation (caisson or rock socket), or as directed. The Representative will use the rate of drilling of the holes to determine whether there is satisfactory material or rock of sufficient thickness and type to support the required load, and to locate the presence of open joints, voids, soft rock, or other deleterious material that may be inadequate for support of the required load.

(e) Inspection. Do not place concrete until the foundation excavation has been inspected and accepted. After completion of excavation and cleaning of the rock socket, perform required inspections and provide details of drilled caisson construction to the Representative for review. Inspect each drilled caisson excavation in the presence of the Representative. Check the dimensions and alignment of each drilled caisson for its full length, including the cased/ formed section and rock socket excavation using methods indicated in this section or others approved by the Representative. Determine dimensions and alignment under the observation and/ or direction of the Representative. Measure the final drilled caisson depth (after final cleaning) using a weighted tape or other approved method.

Record Caisson Bottom and Side Inspections. Provide a copy of recordings and field boring logs to the Representative within 7 calendar days of drilled shaft completion on flash drives or digital video disc (DVD) format compatible with Department approved software. Store and catalog flash drives or DVDs on-site in dust-free containers and label the project title, drilled shaft number, date, and other appropriate information.

The Representative reserves the right to order an inspection dewatering and manual cleaning/inspection or by diving or other acceptable methods if the above-describe procedure does not obtain the appropriate information.

Upon completion of each rock socket excavation and inspection, the Representative may accept the socket, or order deeper excavation. The adequacy of each rock socket will depend on the condition of its sides, bottom surface, and underlying layers. Concrete must be placed in the accepted drilled caisson within 18 hours of completion of excavation (including cleaning) and within 3 hours of final inspection.

1. Drilled Caisson Bottom Inspection. Perform the drilled caisson bottom inspection (cleanliness inspection) using a SID according to the accepted Drilled Caisson Installation Plan and as directed. Use the SID water flushing jets to clean sediment from the rock as directed. Include SID for sign structure, noisewall and highway lighting caisson foundations only when indicated.

Provide an approved, qualified individual to operate the SID and allow the Representative to visually evaluate the caisson bottom condition. Provide slack in line and ensure SID is fully seated on the bottom of the caisson before taking measurements of sediment. Using the SID, observe the bottom of the caisson at a minimum of five locations, including the center of the base and the 3, 6, 9, and 12 o'clock positions around the perimeter to verify cleanliness requirements are met. Locate perimeter positions approximately 1 foot from the wall of the socket. Based on the results of readings at these five locations, make additional observations at other locations as directed.

Perform cleaning operations for the base of the rock socket so that, at the time of concrete placement, a minimum of 50% of the base of each socket will have less than 1/2 inch of sediment and the maximum depth of sediment or other debris at any place on the base of the socket cannot exceed 1-1/2 inch.

2. Drilled Shaft Side Integrity Inspection. Inspect the quality of rock along each drilled caisson using a downhole camera and/or other means considered appropriate by the Representative. Include downhole camera for sign structure, sound barrier, and highway lighting caisson foundations only when indicated.

Using the downhole camera, observe the shaft and rock socket sides of the drilled caisson at a minimum of four locations, including the 3, 6, 9, and 12 o'clock positions around the perimeter to visually inspect the quality of the rock. Dewater or flush the drilled caisson with clean water to increase visibility as directed. Make additional observations as directed.

Follow safety practices as specified in Section 107.08 and include, as a minimum, the following items specifically required for inspection of drilled caisson excavations:

- Cover open excavations immediately upon completion or, if work is discontinued for any period of time, with a cover capable of preventing persons from falling into or entering the excavation without proper authorization. Secure the cover by approved methods.

- Provide casing through soil cavities and broken or unstable rock for inspection of the excavation.

(f) Reinforcement. Section 1002.3 and as follows:

Provide a reinforcing cage that consists of longitudinal bars, spiral, hoop, or tie bars, cage stiffener bars, spacing devices, and any other appurtenances required to maintain alignment, shape, and clearances. Maintain an absolute minimum clearance of 5 times the maximum aggregate diameter between reinforcing steel, including spirals and hoops. Use concrete spacers or other approved non-corrosive spacing devices at sufficient intervals (within 5 feet of the top and bottom and at intervals not exceeding 10 feet along the length of the drilled caisson) to ensure concentric spacing for the entire cage length. Provide one centering device for each 36 inch of caisson perimeter but a minimum of four at each level. Install the indicated or required number of equally spaced steel tubes in the reinforcement cage for use in CSL testing. Install the indicated or required number of thermal wires to each drilled caisson reinforcement cage for use in TIP testing. Attach CSL access tubes and thermal wires according to the testing agency's recommendations. Provide testing agency(ies) representative(s) onsite during CSL access tube and thermal wire installation, reinforced steel installation, and concrete placement for the initial caisson construction.

Use splicing methods for the reinforcement as indicated or approved. Tie intersections of drilled caisson reinforcing steel with cross or figure 8 ties. Tie and support reinforcing steel in the drilled caisson so that the reinforcing steel remains within allowable tolerances for position.

Before placing the reinforcing cage, demonstrate to the satisfaction of the Representative that the fabrication and handling methods to be used will result in a reinforcing cage placed in the proper position, with the proper clearances, and without bending or racking of the reinforcing cage.

Before installation of reinforcing steel cage, check and clean the cage of any materials that would prevent bonding. Immediately upon approval of the condition of the cage, acceptance of the rock socket, and just before placement of concrete, install the fully assembled cage into the hole. Use of a lifting ring and a rigid cradle is required to achieve full support of the cage. Place each cage as one unit by lowering into the hole in a manner that will prevent distortion. Remove cages distorted by placement and replace with a new approved cage. Remove internal stiffeners as the cage is placed in the caisson so there is no interference with the placement of concrete.

Epoxy-coat reinforcing bars and steel centering devices.

Support the cage from the top by use of a frame or other positive means.

Place the bottom of reinforcing steel cage a minimum of 3 inches and a maximum of 6 inches from the bottom of the drilled caisson excavation. The Representative may approve additional clearance. Do not set the cage on the rock socket bottom without support.

If the caisson has been excavated below the anticipated tip elevation, extend the reinforcing cage at the tip (low) end using splicing methods as indicated or approved and extend thermal wires and CSL access tubes.

Unless otherwise indicated or specified, place No. 6 deformed bars vertically around the circumference at a 6 inch spacing, and No. 4 bars as tie bars on 12 inch centers. Furnish bars with hooks meeting seismic requirements.

(g) Dewatering. Unless otherwise specified, dewater excavations before placing concrete. A drilled caisson excavation is considered dry if less than 3 inches of groundwater is present in the bottom of the excavation at the start of concrete placement and the groundwater infiltration rate is less than 1/4 inch rise per minute. Remove water that has accumulated in the excavation after final inspection and before concrete placement using approved methods.

(h) Concrete Placement. Class A cement concrete mixes are only allowed for sign structure, sound barrier, and highway lighting caisson foundations. Use SCC for all other drilled caisson foundations.

Before production placement of SCC, produce and transport a mock batch of not less than 3 cubic yards of SCC to the project for testing to verify plastic concrete test requirements will be met. The mock batch for previously approved SCC mixes may be eliminated by the Representative. If the time between batches of concrete could exceed 30 minutes, submit a procedure to the DME/DMM before placement describing how the placed concrete will be evaluated to ensure the minimum slump value is maintained and the concrete does not reach initial set. Ensure uninterrupted delivery of concrete to avoid cold joints.

Do not start production concrete placement without written acceptance.

Place concrete within 18 hours of the completion of excavation, within 3 hours of final inspection approval and after the reinforcing steel cage has been installed in the shaft section and rock socket and is approved. Keep the excavation free from accumulated seepage water and loose material until concrete is placed. If the Representative determines that water seepage will be detrimental to the quality of the caisson or hinder proper placement of concrete by the free fall method, fill the excavation to the surrounding groundwater level with clean, fresh water and place concrete to the cutoff elevation by the tremie method, as specified in Section 1006.3(h)2, in one continuous operation.

Mix, place, vibrate, and cure concrete as specified in Section 1001.3. Place concrete for each caisson in one continuous operation. Thoroughly work and vibrate the upper 5 feet of concrete. Vibration of the concrete is required, unless the clear distance between bars is more than three times the bar diameter or three times the maximum aggregate size

Do not allow concrete to come in contact with aluminum during placement.

Do not exceed 75F concrete placement temperature unless otherwise noted. For drilled caissons larger than 5 feet in diameter, maintain the concrete at a minimum temperature of 50F and a maximum temperature of 150F during curing.

1. Placement by Free Fall Method. Place Class A cement concrete by free fall only in dry, clean, unobstructed excavations that are at least 30 inches in diameter. Provide a hopper and a section of rigid pipe not less than 5 feet long and 10 inches in diameter to direct concrete fall and avoid impact with reinforcement on the sides of the excavation. Unless otherwise directed, limit depth of free fall to 25 feet. Do not place SCC by free fall method.

2. Placement by Tremie Method. Place concrete using a rigid, watertight, ferrous metal tremie pipe, as specified in Section 1001.3(k)3.c. Place concrete using a tremie tube of sufficient length, height, and diameter to discharge concrete at the drilled shaft base elevation. Provide a tremie pipe with a minimum inside diameter of 10 inches to a maximum inside diameter of 18 inches and marked clearly on the outside at 1 foot intervals. Use a tremie pipe which is clean and watertight with smooth inside and outside surfaces to permit both flow of concrete and unimpeded withdrawal during concreting. Provide a tremie pipe that does not crimp or restrict the flow of concrete. Test the tremie tube joints for water tightness in the presence of the Representative before using it for concrete placement using a method acceptable to the Representative.

Do not begin concrete placement until the tremie tube is placed at the bottom of the caisson. Valves, bottom plates, or plugs may be used only if concrete discharge starts within approximately 2 inches above the excavation bottom. Provide plugs that either can be removed from the excavation or of an approved material that will not cause defects in the drilled shaft if not removed. Once the tremie flow begins, set the tremie tube on the bottom of the caisson and allow the tremie tube to completely fill with concrete. Once full then raise the tube and begin placing the concrete.

Place concrete for each caisson in one continuous operation. Pumping of concrete into the drilled caisson will not be allowed, but concrete may be pumped to the tremie. Thoroughly work the concrete. Provide documentation to satisfactorily demonstrate experience in the use of the tremie method.

Construct the discharge end of the tremie pipe to permit the free radial flow of concrete during placement operations. Maintain the tremie pipe discharge end at or near the bottom of excavation as long as practicable during concrete placement. Maintain the tremie discharge end immersed as deep as practicable in the concrete, consistent with the approved construction methods, and at least 5 feet but not more than 20 feet in concrete after starting the flow of concrete. Maintain a continuous flow of concrete. Maintain the concrete in the tremie at a positive pressure differential to prevent water intrusion into the concrete.

The entire drilled caisson will be considered defective if at any time during concrete placement, the tremie pipe orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level or it is found that the tremie pipe is not watertight. In such case, remove the reinforcing cage and concrete, complete necessary rock socket sidewall removal as directed, and reconstruct the drilled caisson at no additional cost to the Department.

Overflow the concrete until only fresh, uncontaminated concrete is visible at or above the indicated top of caisson elevation, as determined by the Representative. Completely remove overflow concrete.

Use tremie method to place SCC under all conditions.

3. Placement by Pumping Method. Pump only if concrete placement cannot be done by other means. Place concrete by pumping, as specified in Section 1001.3(k)4, through a flexible; ferrous metal, rubber, or plastic pipe with a minimum diameter of 6 inches. Do not allow the concrete to segregate during pumping. If directed, pump 1 cubic foot of concrete into a container so that the Inspector may verify that the concrete is not segregating during the pumping operation.

Begin pumping with the pipe discharge positioned not more than 6 inches off of the bottom of the excavation. Maintain a concrete head of not less than 5 feet above the discharge. Keep the pump hopper continuously filled with concrete to prevent entrapment of air in the discharge.

4. Placement within Casing. Use the free fall or tremie method to place Class A cement concrete in dewatered excavations supported by casing. Pump Class A cement concrete within casing only if placement cannot be done by other means. Use the tremie method to place Class A cement concrete under water in casing supported excavations. Use tremie method to place SCC under all conditions.

If the top of shaft elevation is below ground level at the time of concrete placement, provide an oversized casing from ground elevation to a point below the top of shaft to prevent extraneous material from falling into fresh concrete during and after placement. Keep the oversized casing in place until concrete has cured at least 24 hours.

For permanently cased drilled caissons that carry lateral loads, grout the area between casing and excavation to provide adequate bearing.

5. SCC Test Requirements. Perform acceptance tests on plastic SCC mix as follows:

5.a Before placement of SCC, obtain acceptance of a Field Operation QC Plan as specified in Section 704.1(d)1.a.

5.b Provide a Concrete Field Testing Technician as specified in Section 704.1(d)2 during placement of concrete to perform the required acceptance testing.

5.c Conduct concrete tests as specified in Table A.

6. Field added admixtures. For SCC mixes, high range water reducers and/or viscosity modifying admixtures may be added in the field following the manufacturer's recommendations. Submit a QC plan for acceptance. Clearly identify the process for incorporating the admixtures in the field in the QC Plan and include a personnel matrix listing names and titles of individuals involved in the field addition process. A representative of the admixture supplier is required to be onsite during the mock batch and initial production placement.

7. Lot Size for Concrete Acceptance. For SCC mixes, the lot size is 100 cubic yards or less. Mold a minimum of four concrete test cylinders for each lot placed. Mold additional test cylinders for Department acceptance testing if directed. Test cylinders according to PTM No. 604. Match-mark test cylinders with the lot represented. Record test results and give records to the Representative.

8. Finishing. Finish exposed concrete free from open and rough areas, and free from depressions and projections. Do not add water or curing agents to the concrete surface to assist in finishing. Ensure the top elevation of the caisson is within plus 1 inch or minus 3 inches of the indicated top elevation.

(i) Casing Removal. If temporary casing is used, withdraw each section, except the final section, in partial stages, as concrete is deposited, at a rate that keeps the bottom of the casing below the top of the fresh concrete. During removal, ensure that there is no reduction in shaft cross-section and that displacement of steel reinforcement is less than 2 inches upward and less than 2 inches downward per 20 feet of shaft length. Maintain the specified 3 inch reinforcement bar clearance at bearing level and on the sides during casing removal. If observations indicate otherwise, reduce the rate of casing removal and establish a head of concrete within the casing sufficient to offset the forces tending to cause concrete arching or displacement of the reinforcing cage. As concrete is deposited, withdraw the final section of casing to a point 2 feet below existing ground elevation and allow it to remain for approximately 2 hours, depending on the temperature. Then, completely withdraw the section or cut it off flush with existing ground. If cavities or unstable materials are encountered and the danger exists of losing concrete or of the concrete becoming mixed with extraneous material, cut off the casing at the top of shaft elevation and leave in place.

When temporary casing is used to form caisson above the ground surface or in open water, remove the casing at the prescribed elevation after the drilled caisson has been completed and the concrete has attained sufficient strength so as not to be damaged as specified in Section 1001. If split casings, forms or other special casing systems are proposed for use in open water, design the casing or forms to be watertight and to prevent damage to the finished concrete during their removal.

(j) Caisson Integrity Testing. Use the TIP method as the primary test method to verify the integrity and homogeneity of each drilled caisson. In the event of an equipment malfunction, loss of data, or other conditions that results in a failure to produce acceptable TIP data, perform CSL Testing at no additional cost to the Department.

Retain a qualified independent testing agency(ies) to perform TIP testing according to ASTM D7949, and CSL testing according to ASTM D6760. Prepare and label thermal wires and CSL tubes according to the respective ASTM standards as if both tests were required.

Provide caisson integrity testing for sign structure, sound barrier, and highway lighting caisson foundations operated by qualified individuals only when indicated.

Log TIP data for a minimum of 96 hours immediately following concrete placement at each drilled caisson. Provide safe and secure access for the Representative and TIP testing agency representative during TIP data logging at each drilled caisson.

Submit TIP reports and evaluations to the Representative within 5 calendar days of completion of TIP testing at each caisson. The TIP results will determine conformance with diameter and quality requirements or if additional testing is necessary.

If the Representative does not accept the drilled caisson based on the TIP test results, or if the TIP method fails to produce acceptable data, perform CSL testing to evaluate the quality of the drilled caissons. Do not perform CSL testing until a minimum of 96 hours after concrete placement, but before 10 calendar days after placement. Do not perform CSL testing until the concrete has gained sufficient strength for a satisfactory test.

Perform CSL testing in the presence of the Representative. Submit CSL reports and evaluations to the Representative within 5 calendar days of completion of CSL testing at each caisson tested. The CSL results will then be used to determine the integrity and acceptability of each drilled caisson tested. CSL is backup testing and is incidental to TIP testing.

(k) Integrity Testing Results. Prepare a drilled caisson integrity testing report for each caisson. At a minimum, include the following in the report:

- Date of test.
- Description of the testing apparatus unit and probes.
- Identification of testing agency and person responsible for the validity of the test report.
- Identification and location of shaft.
- As-built geometry of shaft including nominal and/or actual diameter and length.
- Arrangement and identification of access tubes and wires, relative separation of tubes and wires, and identifying designation documentation.
- Documentation of water removal and replacement in access tubes, if applicable.
- Thermal profiles including the access location for each profile with temperature and depth axes and scales allowing clear data interpretation (TIP).
- Report any failure of the probes to penetrate the full depth of the access tubes (CSL, if applicable).
- Initial pulse arrival time or compression wave velocity versus depth (CSL, if applicable).
- Pulse energy/amplitude versus depth (CSL, if applicable).
- A log that presents results for each tube/wire pair tested with any anomaly/defect zones indicated on the log and discussed in the report as appropriate.
- Analysis, evaluation, and summary of any defect zones indicated on the logs with recommendations regarding acceptability and soundness.

(l) Evaluation of Integrity Test Results. Based on the results of the drilled caisson integrity testing reports and other information on the drilled caisson construction, the Representative will decide if each drilled caisson is accepted.

The Representative may allow the construction of additional drilled caissons to continue before acceptance of the completed drilled caisson, if observations of the drilled caisson construction, integrity testing, and other information are satisfactory.

Acceptance criteria of the drilled caisson based on the test results will be determined by the Representative according to guidance set forth in FHWA Publication No. FHWA-NHI-18-024 dated September, 2018.

1. **TIP Results.** Measurements showing a non-uniform temperature distribution will be considered anomalous. Anomalies identified by the TIP results will require further investigation. Perform CSL testing or core drilling as further investigation methods.

2. **CSL Results.** CSL results will be evaluated based upon the following criteria.

   - A Good test cannot exhibit reductions in relative velocities of greater than 10%, and cannot exhibit any reductions in relative signal strength energies of greater than 6 dB. These caissons are accepted provided that no other indicators of potential defects have been identified by other means or test methods.

   - A Questionable test exhibits a reduction in relative velocities of greater than 10% but less than 20%, or a reduction in relative signal strengths of greater than 6 dB but less than 9 dB. In no case can the reduction in relative velocity exceed 20%, nor can the reduction in relative signal strength exceed 9 dB. Submit for acceptance, sufficient justification with supporting evaluation, analysis, or testing. The Representative reserves the right to reject the caisson based on CSL or other non-destructive testing and subsequent justification, and to require additional analysis and/or testing, or verification by core drilling.

   - A Poor test exhibits a reduction in relative velocities greater than 20%, or a reduction in relative signal strengths of greater than 9 dB. These caissons will be rejected and require verification by core drilling**.**

If the review of the caisson integrity test results determine that a drilled caisson is acceptable, dewater the tubes at the accepted caisson location and fill with nonshrink grout having a strength equal to or greater than the 28 day compressive strength of the concrete used in the caisson.

(m) Evaluation by Core Drilling. If the Representative does not accept a drilled caisson based on the integrity test results and/or other non-destructive testing, verify the drilled caisson conditions using concrete coring.

Core drilled caissons using HQ double-tube core barrels, with a split inner barrel, to core drilled caissons that have been rejected. Provide a PennDOT certified drilling inspector for this work. Drill one or more core holes at the location(s) determined by the Representative. Adjust coring procedures and the length of coring to maximize recovery and quality of cored material. Provide continuous core sampling. Keep an accurate log of the core and box and properly mark the core according to Publication 222, showing the drilled caisson depth at each interval of core recovery. Submit the core and Field Inspector's Boring Log within 24 hours of the completion of the coring.

If the quality of the caisson, as represented by the core samples, is determined to be acceptable by the Representative, grout the hole using tremie procedures with nonshrink grout having equal to or greater strength than the concrete used in the caisson, before proceeding with further construction. If testing and inspection of cores indicates that concrete meets specifications, coring and grouting will be paid for as specified in Section 1006.4(i).

If a defect is confirmed, investigative coring will be at no additional cost to the Department. Submit a corrective action plan for repair for approval. Engineering evaluations and any modifications to the drilled caisson and load transfer mechanisms caused by the repair will require calculations and working drawings stamped by a Professional Engineer registered in the State for foundation elements affected. Do not begin repairs until notified that the proposed corrective action plan is approved by the Representative. Provide test data on the repaired drilled caisson that confirm the integrity of the repair. Perform corrective action engineering, evaluation, design, repairs, and provide test data on the repaired caisson at no additional cost to the Department with no extension of contract time.

If this information is not sufficient for a proper judgment, the Representative will reserve the right to order an inspection by other methods either through a separate specialty subcontractor or through the Contractor at no additional cost to the Department with no extension of contract time.

(n) Records. Prepare and submit detailed inspection reports for each drilled caisson, and include the following information:

1. **Drilling Records.** Submit within 24 hours of completion of drilling.

   - Accurate location and dimensions of the excavation.
   - Accurate top and bottom elevations.
   - Measurement data for plumbness.
   - Methods of excavation used.
   - Description of materials encountered during excavation.
   - Description of groundwater conditions encountered.
   - Description of obstructions encountered and whether or not obstruction removal was achieved.
   - Description of temporary or permanent casing placed including purpose, length, and wall thickness, and anchorage or sealing methods used, if any.
   - .
   - Elevation at which the top of rock was encountered and description of rock.
   - Elevation at which bearing material was encountered. Description of bearing material. Probe holes made, along with method of probing, rate of drilling in rock, samples taken, tests made, and conclusions reached regarding adequacy of bearing material.
   - Shaft, bell footing, and rock socket measurements.
   - Downhole camera inspection data.

2. **Concrete Placement Records.** Submit within 24 hours of concrete placement.

   - Description of clean-out methods, adequacy of initial clean-out, and final clean-out just before concrete placement.
   - Record of depth of water in excavation and rate of water infiltration before concrete placement.
   - SID inspection data.
   - Record of reinforcing steel inspection for position and adequacy.
   - Method of concrete placement and casing removal, if any. Record of concrete head and elevation during removal of casing. Record of concrete elevation when vibration started. Also, include when temporary casing was removed from hardened concrete.
   - Difficulties encountered including soil inclusion, voids, shaft squeeze-in, and casing collapse.
   - Concreting curves showing actual versus theoretical volume of concrete required to fill caisson excavation. Concrete curing details. Concrete strength test results. Include volume of concrete placed to the bottom of permanent casing, top of permanent casing, and top of the drilled caisson.
   - Condition of concrete delivered to site including record of slump, density, air content, and other tests. Record of cylinders made for compression testing.

3. **Integrity Testing Reports and Evaluation.** Submit within 5 calendar days of completion of testing.

   - TIP results.
   - CSL results, if applicable.
   - Core drilling logs and photographs of core samples
   - Any deviations from the specifications.

1006.4 MEASUREMENT AND PAYMENT—

(a) Drilled Caissons, Shaft Section.

1. Shaft Section in Soil. Linear Foot
Measured from the shaft top to the top of rock.

2. Shaft Section in Rock. Linear Foot
Measured from the top of rock to the shaft bottom.

(b) Drilled Caissons, Bell Footing. Each

(c) Drilled Caissons, Rock Socket. Linear Foot

Measured from the shaft bottom to the socket bottom. For uneven rock surfaces, measure length of rock excavation from the rock surface at shallowest depth to the socket bottom.

(d) Permanent Casing for Drilled Caissons. Linear Foot

The Department will measure and pay for temporary casing left in place, as specified in Section 1006.3(i), as permanent casing.

(e) Test Holes. Linear Foot

Augering through overburden, from existing ground surface to the elevation at which NW (NX) core boring is to begin (bottom of caisson or rock socket excavation as specified in Section 1006.3(c)), is incidental to this work.

(f) Probe Holes. Linear Foot

(g) Obstructions. Linear Foot

The unit price includes mobilization of drilling equipment.

(h) TIP. Each

The unit price for each drilled caisson includes work associated with the TIP test and reporting. Grouting of access tubes is incidental to this item.

(i) HQ Coring. Linear Foot. The unit price includes drilling, inspection and reports. HQ coring will only be paid if quality of the caisson, as represented by the core samples, is determined to be acceptable. Grouting of cored concrete is incidental to this item.

SECTION 1007—MICROPILES

1007.1 DESCRIPTION—This work is the furnishing of materials, tools, equipment, and labor for the installation of micropiles. This includes test micropiles, production micropiles, and load testing. A micropile is a small-diameter, bored, cast-in-place composite pile, in which the applied load is resisted by steel reinforcement, cement grout and frictional grout-ground bond.

The following definitions apply:

(a) Alignment Load (AL). A minimum initial load, no greater than 5% of the design load, applied to the micropile during testing to keep the testing equipment correctly positioned.

(b) Centralizer. A device to support and position the reinforcing steel in the drill hole and casing so that a minimum grout cover is provided.

(c) Mechanical Splice System. Component that transmits load capacity from one partial length of reinforcement to another.

(d) Creep Movement. The movement that occurs during the portion of the micropile load test that applies a sustained loading over a relatively long period of time.

(e) Design Load (DL). Anticipated maximum service load in the micropile.

(f) Load Test. Incremental test-loading of a pile that includes the measurement and recording of the total movement at each load increment.

(g) Maximum Test Load. The maximum load to which the micropile is subjected during testing.

(h) Post-Grouting. The injection of additional grout into the load transfer length of a micropile after the primary grout has set. Also known as re-grouting or secondary grouting.

(i) Primary Grouting. Portland-cement-based grout injected into the micropile hole before or after the installation of the reinforcement to direct the load transfer to the surrounding ground along the pile.

(j) Proof Load Test. Testing of a production pile performed to prove load resistance.

(k) Spacer. A device to separate elements of a multiple-element reinforcement.

(l) Test Pile. A pile constructed to confirm installation methods and validate contractor technique, evaluate micropile capacity with depth, and establish contractor micropile order lengths.

(m) Verification Load Test. Testing of a test pile performed to verify design and load resistance.

1007.2 MATERIAL—

(a) Grout. Provide a neat-cement grout or sand-cement grout with a minimum 3-day compressive strength of 2,000 psi and a minimum 28-day compressive strength of 5,000 psi according to AASHTO T106. Determine material proportions with adequate flowability without causing segregation at the end of the grout tube.

(b) Water. Section 720.1.

(c) Fine Aggregate. Type A, Section 703.1.

(d) Cement. Use Type I, II, or III cement, manufactured according to ASTM C150 and as specified in Section 701.

(e) Admixtures. Section 711.3. When approved by the Representative, admixtures may be used according to the manufacturer's recommendations to control bleed, reduce shrinkage, improve flowability, reduce water content, or retard setting time. Accelerators and admixtures containing chlorides are not permitted.

(f) Reinforcement Bar. Section 709. Provide solid, continuous deformed reinforcing steel bars according to AASHTO M31, Grade 75. Bars with full-length thread meeting the same material requirements are allowed. Provide bars clean of deleterious substances. When mechanical splice systems are required, they must develop the ultimate tensile strength of the bars.

(g) Casing. Steel pipe casing according to API 5CT or 5L Grade N80, or meet the Tensile Requirements of ASTM A-252 Grade 3 with an elongation of 15 percent and have a minimum yield strength of 50 ksi to 80 ksi as used in the design submittal. Pipe casing diameter and minimum wall thickness as indicated. Pipe casings from 5 inches to 12 inches in diameter will be considered micropiles. Material with visual defects such as dents, cracks or tears will be rejected.

Use of material classified as mill secondary is acceptable when tests are performed verifying tensile strength and steel chemical composition.

Provide flush-joint type pipe casing splices, threads and joints. Threaded casing joints and welded joints must develop at least the required compressive, tensile, and bending strength used in the design of the micropile.

For permanent pipe casing seams and splices that will be shop or field welded the following fabrication and material conditions apply:

- Maximum carbon equivalency (CE) of 0.45, according to AWS D1.1 as specified in Section 1005, and according to mill certification.
- Maximum sulfur content 0.05%, according to mill certification.
- Use only complete penetration welds.
- Do not use welded lap splicing.

(h) Welding Material. Section 1105.2(t). Visual Inspection only.

(i) Centralizers and Spacers. Fabricate centralizers and spacers from PVC, steel, or other acceptable material that is non-detrimental to the reinforcing steel or grout. Do not use wood or aluminum.

1007.3 CONSTRUCTION—

(a) Qualifications. Construct the micropiles with a supervisor and workforce experienced in the construction of micropiles, and meeting the following qualifications:

- Micropile contractor has completed at least five projects that demonstrate experience in the construction of micropiles.
- Employ a Professional Engineer registered in the State, with at least 3 years of experience in the design and construction of micropiles and pile load test systems, who is to design the system, verify the proper construction of the testing system and the piles, and certify the test results.
- Employ drill operators and on-site supervisors each having at least 3 projects within the last 5 years of experience in micropile construction in similar site and soil conditions.

(b) Pre-Construction Submittals. Provide the required submittals as specified in Section 105.02 at least 21 calendar days prior to planned micropile construction. Begin micropile work only after all construction submittals have been received, reviewed, and accepted in writing by the Representative.

1. Qualifications Report. Submit the required company qualifications according to Section (a). List the company names of consultants or manufacturers, and provide the names of the applicable personnel as follows:

- List at least five completed projects that, together, demonstrate the required experience in the construction of micropiles. Experience must include all phases of micropile construction, from start to finish. Include a

brief description of each project, and the name and telephone number of owner's representative knowledgeable in each project listed.

- The Professional Engineer who is to design the system, verify the proper construction of the testing system and the piles, and certify the test results.
- List of drill operators and on-site supervisors that will be under the direction of the Professional Engineer.

2. Mill Test Reports. Certified reports for the reinforcing steel and for steel pipe casing. Include the ultimate strength, yield strength, elongation, and material properties composition. For mill secondary pipe casing, coupon test results may be submitted instead of mill certification. Provide testing results for two coupons per 500 linear feet of casing for each lot of mill secondary casing delivered to project site.

3. Welding Procedure. If welding of casing is proposed, submit the Welding Procedure Qualification Record along with Welding Procedure Specifications according to AWS D1.1, Structural Welding Code, to the Structure Control Engineer for acceptance.

4. Calibration Reports. Verify calibration for each test jack and pressure gauge to be used. Perform calibration tests by an independent testing laboratory within 6 months prior to the date submitted.

5. Grouting Plan. Include complete descriptions and details in the grouting plan for the following:

- Grout mix design. Include type of materials used, certified test data, trial batch reports, and specific gravity of the wet mix.
- Methods and equipment for accurately monitoring and recording the grout depth and volume as the grout is being placed.
- Procedure and equipment for monitoring of grout quality. At a minimum, immediately prior to grout placement, measure the unit weight of mixed grout from each truckload using a mud balance, according to API RP-13B-1.
- Estimate curing time for grout to achieve specified strength. Previous test results for the proposed grout mix completed within one year of the start of grouting may be submitted for initial verification and acceptance and start of production work. Any previous test results must have used the same materials and proportions as the proposed mix design.
- Method to control and dispose of surface water, groundwater, and excess grout generated by the work.

6. Load Testing Plan. Provide a plan sealed by the Professional Engineer that details the proposed micropile load testing method. Include drawings, details, and structural design calculations necessary to clearly describe the proposed test method, reaction load system capacity and equipment setup, types and accuracy of apparatus to be used for applying and measuring the test loads and pile top movements according to this specification. The Professional Engineer must verify that the load test system is constructed correctly and the testing is done according to the approved plan.

7. Work Plan for Installation of Micropiles. Define the equipment, materials and procedures to be used to install the micropiles.

(c) Excavation. Coordinate work so the micropile structures are properly constructed. Perform the micropile construction and related excavation as indicated, and according to the approved submittals.

(d) Drilling. Use drilling equipment and methods suitable for the conditions encountered. Do not damage adjacent or overlying facilities, structures, or newly installed piles. Provide an open borehole free of loose material and of minimum diameter and length as indicated, prior to placing reinforcement and grout. Do not use bentonite-based muds or other drilling slurries that adversely affect the grout to rock bond.

(e) Casing and Reinforcement. Extend top of steel pipe casing a minimum of one foot above the adjacent ground to avoid water and other drill material from entering and contaminating the drillhole. Lengths of casing and reinforcing bars to be spliced shall be secured in proper alignment and in a manner to avoid eccentricity or angle between the axis of the two lengths to be spliced. Splices and threaded joints shall meet the requirements of the reinforcement. Threaded pipe casing joints shall be located at least two casing diameters (OD) from a splice in any reinforcing bar. When multiple bars

are used, bar splices shall be staggered at least 12 inches.

Bar reinforcement groups, if used, shall be sufficiently strong to withstand the installation and grouting process without damage or displacement. Use only threaded couplers for bar reinforcement splices. Bars must be threaded sufficiently into the couplers to develop the full tensile strength of the bar. Do not weld bar reinforcement.

Bar reinforcement may be placed before or after the drillhole grout is placed. Lower the bar reinforcement steel with centralizers into the stabilized drillholes to the desired depth. Do not drive or force partially-inserted reinforcing bars into the drillhole. Provide centralizers at 10-foot maximum spacing on bar reinforcement. Locate the upper-most and lower-most centralizers 3 feet maximum from the top and bottom of the central reinforcement. Use no less than 3 centralizers per micropile. If steel is placed first, centralizers must allow insertion of grout tremie pipe to the bottom of the drillhole. Securely attach and position centralizers and spacers to the reinforcement; sized and positioned to allow grout to flow freely and entirely within the length of the drillhole and casing, and between adjacent reinforcing bars without causing misalignment of the reinforcement.

(f) Grouting. Use verifiable means and methods of measuring the grout quality, quantity and pumping pressure during the grouting operations. Determine and schedule adequate installation methods such that there will be no grout communication between boreholes or damages to micropiles in which grout has not achieved final set. Keep and provide records for inspection by the Representative that show the quantities, test data, and grout pressures as indicated.

After drilling is complete and immediately prior to grouting, assure the drillhole is free of drill cuttings and loose debris. Clean the final drillhole by flushing with air or water if necessary. When in a karst geology, protect groundwater and subsurface habitat during drilling and grouting. When significant voids are encountered within the bonded zone, stop installation activity and notify the Representative. When voids greater than 12 inches are encountered, or grout takes begin to exceed 200% of the neat theoretical borehole volume, take measures to control grout take.

Provide neat-cement or sand-cement grout meeting the specified minimum unconfined compressive strengths that is colloidally-mixed, completely and thoroughly disbursed, free of clumped cement or sand. Use a mixer capable of continuous agitation of the grout. Use a progressing cavity pump capable of developing sufficient pressures and flow rates.

Monitor grout consistency and delivery pressures with a pressure gauge equipped pump. The pressure gauge must be capable of measuring pressure twice the actual grout pressures used. Size the grouting equipment to enable the grout to be pumped in one continuous operation. Estimate the required grout take volume needed based on borehole dimensions and geologic conditions.

In the presence of the Representative, test grout cube samples for compressive strength according to AASHTO T106 at a frequency of no less than one set of three 2-inch grout cubes from each grout plant each day of operation or every 10 micropiles, whichever occurs more frequently. The compressive strength for acceptance is considered the average of the cubes tested. Provide compressive strength and density test results to the Representative within 24 hours of testing.

Place primary grout in one continuous operation within 24 hours after the load-transfer (rock bond zone) length is drilled. Inject the grout by tremie tube method only, to deliver grout from the lowest point of the drill hole. Fill the entire rock socket and annulus above rock with grout without voids from bottom to top until uncontaminated grout flows from the top of the micropile. Use pumping pressure only as required to aid grout delivery through the tremie tube, countering the flow resistance within the tube. Grout take should mimic gravity-head placement. Control grout delivery pressures to prevent fracturing of the adjacent rock and soil formations and ground heave.

Grout the entire micropile to the designed cut-off level. If the tremie is withdrawn as the grouting progresses, extract it incrementally such that the tube remains extended a minimum of 3 feet below the wet grout level in the micropile. Alternately, the tremie tube may remain permanently within the pile, but must remain filled with grout. Do not use compressed air to directly pressurize the grout. Post-grouting is not allowed unless approved by the Chief Bridge Engineer.

Check the micropile top elevations and cut off installed piles to plan elevations.

(g) Site Drainage Control. Control surface water, drill flush water, and excess grout such that entry into the micropile drill holes is prohibited. Dispose of these fluids as indicated and according to local, state, and federal regulations and standards.

(h) Tolerances. Install micropiles within the following tolerances:

- Center of top of pile within 2 inches of the indicated planned pile center location.
- The pile alignment within 2% of the specified alignment (vertical or specified batter) for the entire length of the

pile.

- Pile top vertical elevation within plus 1 inch to minus 1 inch of the design top of pile elevation including required pile embedment in footing.
- Center of the entire length of reinforcement bar or bar group within 0.5 inches from the center of the micropile.

(i) Micropile Damage. Replace, in a manner acceptable to the Representative, piles deemed unacceptable due to improper or inadequate construction or due to damage caused by the Contractor. Prior to making a modification which requires changes to the design or construction of the structure, the Representative must review the modification and accept in writing.

(j) Load Testing. Notify the Structure Control Engineer at least 7 calendar days prior to beginning the installation and testing of any micropile scheduled for load testing. The grout within a micropile must attain the minimum required 3-day compressive strength of 2,000 psi prior to performing the load testing.

Design and construct the test reaction frame to be sufficiently rigid and of adequate dimensions such that excessive deformation of the testing equipment does not occur. Reaction testing that utilizes weighted-frames must not cause instabilities in supporting ground or adjacent embankment slopes. An analysis may be required to verify ground and slope stability during loading imposed by the weighted test platforms.

During test set-up, align the testing jack, bearing plates, and stressing anchorage such that unloading and repositioning will not be required during the test. An AL may be applied to the micropile prior to setting the movement recording devices. Zero the dial gauges at the first setting of AL.

Perform the required Verification Load Testing by loading piles in compression at the loads and increments in Table A.

TABLE A
Verification Test Loading Schedule

Cycle	Step	Applied Load	Hold Time (minutes)
Apply AL	1	AL	2.5
Load Cycle 1	2	0.15 DL	2.5
	3	0.30 DL	2.5
	4	0.45 DL	2.5
	5	AL	1
Load Cycle 2	6	0.15 DL	1
	7	0.30 DL	1
	8	0.45 DL	2.5
	9	0.60 DL	2.5
	10	0.75 DL	2.5
	11	0.90 DL	2.5
	12	1.00 DL	2.5
	13	AL	1
Load Cycle 3	14	0.15 DL	1
	15	1.00 DL	1
	16	1.15 DL	2.5
	17	1.30 DL	10 to 60*
	18	1.45 DL	2.5
	19	AL	1
Load Cycle 4	20	0.15 DL	1
	21	1.45 DL	1
	22	1.60 DL	1

	23	1.75 DL	2.5
	24	1.90 DL	2.5
	25	2.00 DL	10
	26	1.50 DL	5
	27	1.00 DL	5
	29	0.50 DL	5
	30	AL	5

*The verification test pile shall be monitored for creep at the 1.30 DL. Pile movement during the creep test shall be measured and recorded at 1, 2, 3, 4, 5, 6, 10, 20, 30, 50, and 60 minutes.

Tension load testing for verification according to the loading shown in Table A is allowed in place of compression load testing if indicated on the contract drawings. The tension load test method, if used, requires the reinforcing bar to be sized to handle the test loads, and the bar length must extend adequately above the micropile to allow proper coupling with the load cell. If upsizing the reinforcement bar is needed to complete the tension testing, the larger bar size is not required to be used in the production piles.

Within 24 hours of completing a load test, submit a summary report to the Structure Control Engineer that includes time-load settlement data. Indicate in the report if micropile has passed or failed the load test.

1. Case 1: Verification Load Testing

Perform Verification Load Test on a test micropile as indicated, or as directed by the Structure Control Engineer. Verification Load test the first production pile installed at each designated substructure unit prior to the installation of the remaining piles in that unit. Two additional production piles may be installed to serve as reaction piles for the test.

The acceptance criteria for the Verification Load Test are:

1.a The pile must sustain the DL with no more than 0.75 inches of total vertical movement at the top of the pile as measured relative to the top of the pile prior to the start of testing. If an alignment load is used, then the allowable movement will be reduced by multiplying by a factor of (DL-AL)/DL.

1.b Test piles must have a creep rate at the end of the 1.3 DL increment which is not greater than:

- 1/32 inch/log cycle time (1 to 10 minutes), or
- 1/16 inch/log cycle time (6 to 60 minutes) and has a linear or decreasing creep rate.

1.c Failure does not occur by 2.0 DL. Failure is defined as a slope of the load versus deflection curve (at end of increment) exceeding 0.025 inch/kip.

Submit the Verification Load Test time-load settlement data and graphical representations of the data which show the acceptance criteria and the actual test data of the pile being load tested to the Structure Control Engineer and District Geotechnical Engineer. For test piles, the test results must be reviewed and accepted by the Structure Control Engineer prior to beginning the construction of any production piles represented by the test pile. The drilling and grouting methods, pipe casing, grout, and minimum depth of embedment of the production micropiles must be identical to those of the accepted verification test micropile.

If a verification-tested micropile fails to meet the acceptance criteria, modify the construction procedure. Modifications may include, but are not limited to, modifying the installation method, installation equipment, or installed material as required to achieve acceptable verification tests. Submit proposed modifications of the accepted Work Plan to the Structure Control Engineer and the Designer for review and acceptance.

Costs resulting from any micropile construction procedures that deviate from the accepted Work Plan, and the associated costs of additional verification testing, will be at the Contractor's expense. Any modifications of the micropile design that are due to changes or limitations in equipment or material will be at the Contractor's expense. These modifications include, but are not limited to, changes to maximum load, bond length, or micropile type, size or spacing. The Structure Control Engineer's and the Designer's prior review and acceptance is required for any modification that necessitates changes to the structure.

If a verification load tested pile fails to meet the acceptance criteria, immediately verification-test another micropile within the footprint of that substructure unit using the accepted modified criteria. At the completion of

verification testing, remove the failed micropile down to a minimum of 2 feet below the bottom of the pile cap elevation.

2. Case 2: Verification Load Testing and Proof Load Testing.

Case 2 Verification and Proof Load Testing is intended for micropiles in highly variable geology, or for verifying consistency of sizeable micropile capacity. If load testing is conducted according to Case 2, micropile details such as bond lengths may be adjusted according to the grout-to-ground bond values from the results of the verification testing and supporting approved design calculations.

2.a Verification Load Testing

Perform test in accordance with 1007.3(j)1 Case 1.

Submit design calculations, prepared by a Professional Engineer licensed in the State for any proposed modifications to the micropile details, including modifications to the bond length or diameter which may result from the results of the micropile Verification Load Test for approval. If a verification tested micropile fails to meet the acceptance criteria, propose modifications to the design, the construction procedure, or both. Include a copy of the Verification Load Test results with the submittal containing proposed modifications. The submittal containing modifications to the micropile details is incidental to the micropile item. A subsequent pile redesign requires an additional Verification Load Test to be completed and passed to determine the grout-to-ground bond strength of the redesigned pile.

The as-designed pile cannot be modified based on the results of the Verification Load testing without the approval of the District Bridge Engineer.

2.b Proof Load Testing

After Verification Load Tests are performed and proposed modifications to the micropile details are approved by the District Bridge Engineer, perform Proof Load tests at the micropile locations indicated on the plans, or as directed by the Structure Control Engineer. Proof Load test the first post-verification load tested production pile installed at each designated substructure unit prior to the installation of the remaining piles in that unit. Two additional production piles may be installed to serve as reaction piles for the test. Submit the Proof Load Test time-load settlement data and graphical representations of the data which show the acceptance criteria and the actual test data of the pile being load tested to the Structure Control Engineer and District Geotechnical Engineer. The Proof Load Test results must be reviewed and accepted by the Structure Control Engineer prior to beginning the installation of the remaining piles for a given pile group or substructure represented by the proof-tested pile. The drilling and grouting methods, pipe casing, grout, and minimum depth of embedment of the production micropiles must be identical to those of the accepted proof-tested micropile.

Perform the required Proof Load Testing by loading piles in compression at the loads and increments in Table B.

TABLE B
Proof Test Loading Schedule

Cycle	Step	Applied Load	Hold Time (minutes)
Apply AL	1	AL	2.5
Load Cycle	2	0.15 DL	2.5
	3	0.30 DL	2.5
	4	0.45 DL	2.5
	5	0.60 DL	2.5
	6	0.75 DL	2.5
	7	0.90 DL	2.5
	8	1.00 DL	2.5
	9	1.15 DL	2.5
	10	1.30 DL	10 to 60*
	11	1.45 DL	2.5
	12	1.60 DL	2.5

Unload Cycle	13	1.30 DL	4
	14	1.00 DL	4
	15	0.75 DL	4
	16	0.50 DL	4
	17	0.25 DL	4
	18	AL	4

*Depending on performance, either a 10-minute or 60-minute creep test shall be performed at the 1.30DL Test Load. Where the pile top movement between 1 and 10 minutes exceeds 0.04 inches, the 1.30DL Test Load shall be maintained an additional 50 minutes. Movements shall be recorded at 1, 2, 3, 5, 6, l 0, 20, 30, 50 and 60 minutes.

The acceptance criteria for the Proof Load test are:

2.b.1 The pile must sustain the DL with no more than 0.75 inches of total vertical movement at the top of the pile as measured relative to the top of the pile prior to the start of testing. If an alignment load is used, then the allowable movement will be reduced by multiplying by a factor of (DL-AL)/DL.

2.b.2 Test piles must have a creep rate at the end of the 1.3 DL increment which is not greater than:

- 1/32 inch/log cycle time (1 to 10 minutes), or
- 1/16 inch/log cycle time (6 to 60 minutes) and has a linear or decreasing creep rate.

2.b.3 Failure does not occur by 1.6 DL. Failure is defined as a slope of the load versus deflection curve (at end of increment) exceeding 0.025 inch/kip.

For failed micropiles and further installation of other micropiles, modify the construction procedure. Modifications may include, but are not limited to, revising the installation method, the installation equipment, the installed material, installing replacement micropiles, or incorporating micropiles at not more than 50% of the maximum load attained. Costs for modifications due to non-performance of the accepted Work Plan will be at the Contractor's expense, including modifications to installation procedures, additional production micropiles, additional verification tests and verification and/or proof load testing. Submit variations from the approved work plan to the Structure Control Engineer and the Designer for review and acceptance.

Any modifications of the micropile design that are due to changes or limitations in equipment or material will be at the Contractor's expense. These modifications include, but are not limited to, changes to maximum load, bond length, or micropile type, size or spacing. The Structure Control Engineer's and the Designer's prior review and acceptance is required for any modification that necessitates changes to the structure design.

If a proof-tested micropile fails to meet the acceptance criteria, immediately proof test another micropile within the footprint of that substructure unit using the modified criteria. Re-submit the Proof Load Test time-load settlement data and graphical representations of the data which show the acceptance criteria and the actual test data of the pile being load tested to the Structure Control Engineer. At the completion of proof testing, remove any failed micropiles down to a minimum of 2 feet below the bottom of the pile cap elevation, at no additional cost to the Department.

(k) Installation Report. Within 28 calendar days after completion of the micropile construction, submit a pile installation report to the Structure Control Engineer for acceptance. The report must be sealed by a Professional Engineer licensed in the State. Include written confirmation that the test load system was properly constructed, the tests were completed correctly, and the test piles have met the required acceptance criteria. Provide a separate log for each micropile that includes the following:

- Pile identification.
- Pile materials and dimensions.
- Pile drilling start and finish times along with drilling observations.
- Description of soil, rock and water encountered.
- Actual pile location.
- Actual top of rock elevation.
- Final tip elevation.
- Cut-off elevation for top and bottom of casing.

- Grout pressure measurements.
- Grout quantities pumped, including start and finish times.
- Grout cube compression test results.
- Description of unusual installation behavior or conditions.
- Deviation from plans or planned parameters.
- Load testing time-load settlement data and graphs, including items required by ASTM D1143.
- Comparison of load testing results and acceptance criteria.

1007.4 MEASUREMENT AND PAYMENT-

(a) Micropiles. Linear Foot.

Measured from the micropile tip elevation (bottom of the bonded zone) to the final cutoff elevation (top of the casing) for accepted test micropiles and production micropiles. Includes compensation for labor, materials, equipment and incidentals necessary to perform the intended work to complete micropile installation. Includes temporary casing if required and drilling through, soil, rock, concrete and obstructions. No payment will be made for reaction piles installed solely to provide reaction loads for the verification testing of a test pile.

The Representative will reject micropile(s) because of mis-location, mis-alignment, damage, or failure to meet other installation criteria. No payment will be made for rejected piles. Replace rejected piles as directed.

(b) Verification Load Test. Each.

Payment will be payment in full for testing apparatus design and analysis, furnishing and placing materials, furnishing, erecting, maintaining, and replacing equipment, and for labor and incidentals necessary to complete the verification testing and installation report as specified. No payment will be made for a Verification Load Test when the contractor has not performed the Verification Load Test in accordance with this specification, or when a load test fails due to improper pile construction.

(c) Proof Load Test. Each.

Payment will be payment in full for testing apparatus design and analysis (if it differs from Verification Load Test apparatus design and analysis), furnishing and placing materials, furnishing, erecting, maintaining, and replacing equipment, and for labor and incidentals necessary to complete the proof testing and installation report as specified. No payment will be made for Proof Load Test when the contractor has not performed the Proof Load Test in accordance with this specification, or when a load test fails due to improper pile construction.

(d) Mobilization. Lump Sum.

Includes all movements of materials and equipment for all phases of micropile construction.

(e) Grout. Cubic Foot.

Grout in excess of two (2) times the neat theoretical volume of the drill hole. Any grout required to fill the pile that is less than two times the neat volume is considered incidental to the micropile.

SECTION 1008—PREFORMED NEOPRENE COMPRESSION JOINT SEAL FOR BRIDGES

1008.1 DESCRIPTION—This work is the furnishing and installation of preformed neoprene compression seals for bridge joints.

1008.2 MATERIAL—

(a) Seal and Lubricant Adhesive. Section 705.4(d) and from a manufacturer listed in Bulletin 15. Notify the District Executive as to the brand of seal to be furnished. Provide a data sheet from the manufacturer showing the nominal dimensions and allowable joint openings for the seal to be furnished. Do not change the brand, except with written permission from the District Executive.

(b) Premolded Expansion Joint Filler. Section 705.1

(c) Foam Joint Fillers. Section 705.4(e) or (f), except that the dimensions specified in Section 705.4(f) do not apply.

1008.3 CONSTRUCTION—

(a) General. Construct the basic joint as indicated.

(b) Basic Joint. The basic joint is the as-designed joint required for the anticipated movement. Form the basic joint, top to bottom, to the width as indicated. Place two strips of foam joint filler in the joint, with one strip placed tightly on top of the other. Provide a depth of the upper strip equal to the depth of the seal groove plus 3/4 inch. After the joint is sawed, remove this upper strip of foam with the broken concrete.

(c) Seal Groove. The seal groove is the sawed joint opening into which the seal is to be installed. The seal groove width is the width of the formed basic joint plus the seal seating ledge on each side of the joint, provided by the sawcut. Provide a seal groove width and depth according to the manufacturer's recommendations. Make joints true to alignment, ±1/4 inch, having vertical faces and uniform width throughout the length of the joint.

1. Deck Slab. Saw the seal groove, in the deck slab using a double-bladed, self-propelled concrete saw to the width and depth according to the manufacturer's recommendations. Begin the saw-cut at the centerline of the bridge and proceed beyond the gutter line in one operation. Use a saw speed that minimizes spalling. Provide smooth, even seal seating ledges. Grind 1/8 inch to 1/4 inch x 45 degree chamfer at the top corners along the entire length of the sawcut.

2. Curb on Sidewalk Section. Saw the seal groove in the curb, sidewalk, and barrier section, as shown on the Standard Drawings. Grind 1/8 inch to 1/4 inch x 45 degree chamfer at the top corners along the entire length of the sawcut.

(d) Seal Installation. Submit for approval the manufacturer's data sheet for the seal that includes seal preparation and installation recommendations. Before installing the seal, remove foreign material, including broken concrete, and thoroughly clean the joint according to the manufacturer's recommendations. Keep the joint in a dry or damp-dry condition. Swab the lubricant adhesive on the faces of the groove, and while the adhesive is wet, install the seal according to the manufacturer's recommendations.

Install the seal with the top surface continuous. Upturn seal continuous into barriers, curbs, and sidewalks as shown on the Standard Drawings. Do not install cocked or twisted seals. At walls, place the top of the seal in contact with the deck joint at a uniform depth of 1/4 inch minimum to 1/2 inch maximum below the deck surface. Ensure seals are waterproof at the gutter line.

Do not splice the seal unless indicated. If splices are indicated, use only if splices are vulcanized and spliced by the manufacturer in the shop/factory and are watertight. If necessary to stretch the seal during installation, do not exceed 5% elongation.

If the seal is damaged during installation, remove and install a new seal. Seal or cap the ends of the seal.

After installation, flood seal with water and inspect for leaks and/or damage. Repair any leaks or damage as directed and according to the manufacturer's recommendations.

1008.4 MEASUREMENT AND PAYMENT—Linear Foot

Measured out-to-out along centerline of seal, including horizontal, vertical, inclined, or curved portions.

SECTION 1012—PEDESTRIAN RAILING

1012.1 DESCRIPTION—This work is the construction of a pedestrian railing.

1012.2 MATERIAL—Before fabrication, submit shop drawings of the railing for review and acceptance.

(a) Railing.

- Aluminum-Alloy Casting—ASTM B 26/B 26M, Alloy SG70A-T6 or ASTM B 108, Alloy SG70A-T6.
- Aluminum-Alloy Bolts—ASTM B 211/B 211M, Alloy 2024-T4.
- Aluminum-Alloy Nuts—ASTM B 211/B 211M, Alloy 6061-T6.
- Nylon Washers—Section 1103.11(j)2
- Bolt Heads—Regular hexagon, ANSI B18.2.3.5M (ANSI B18.2).
- Nuts. Finished hexagon, ANSI B18.2.4.6M (ANSI B18.2)—Threads, Class 6, 6g, or 6H (Threads, Class 2, 2A, or 2B).
- Aluminum Alloy Balusters – ASTM B 221/B 221M, Alloy 6061-T4.
- Post assembly and panel to post aluminum washers – ASTM B 209, Alloy 2024-T3.
- Cast Aluminum Post Base – ASTM B 26/B 26M, Alloy SG70A-T6 or ASTM B 108/ B 108M, Alloy SG70A-T6.
- Other Aluminum Alloys—Section 1013.2(a)

Certify as specified in Section 106.03(b)3.

(b) Anchor Bolts, Nuts, and Washers. Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

(c) Caulking Compound. Section 705.8

1012.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) General. Before erection, thoroughly coat the surface of aluminum alloys in contact with other metals, stone masonry, or concrete with caulking compound. After erection and alignment, seal openings between metal surfaces and concrete with caulking compound.

After the concreting and other operations have been completed, thoroughly clean the railing. Remove accumulations of oil, grease, dirt, or foreign materials, using a solvent cleaner.

(b) Assembly. Assemble, as shown on the accepted shop drawings and the Standard Drawings.

Make cuts true, smooth, and free from burrs or ragged edges. Fillet-drill all re-entrant cuts, before cutting. Do not flame cut.

To facilitate bending, the Contractor may heat material to a temperature of 400F for a period not exceeding 15 minutes.

Drill rivet and bolt holes, or subpunch 3/16 inch smaller than the nominal diameter of the fastener; then ream to size.

1012.4 MEASUREMENT AND PAYMENT—Linear Foot

Measured from center to center of end posts. The Department will not deduct gaps at lighting pole foundations.

SECTION 1013—ALUMINUM BRIDGE RAILING

1013.1 DESCRIPTION—This work is the construction of an aluminum bridge railing.

1013.2 MATERIAL—Before fabrication, submit shop drawings for review and acceptance.

(a) Railing.

- Cast Aluminum Railing Posts—ASTM B 108, Alloy A444-T4 or ASTM B 26/B 26M, Alloy SG70A-T6.
- Aluminum-Alloy Extruded Bars, Rods, Shapes, and Tubes—ASTM B 221/B 221M, Alloy 6061-T6 or 6351-T5.
- Aluminum-Alloy Drawn Seamless Tubes—ASTM B 210/B 210M-Alloy 6061-T6.
- Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube—ASTM B 241, Alloy 6061-T6, 6061-T4 or Aluminum-Alloy Extruded Structural Pipe and Tube ASTM B 429, Alloy 6061-T6.
- Aluminum-Alloy Sheet and Plate—ASTM B 209/B 209M-Alloy 6061-T6, 1100-0 or Alclad 2024-T4.
- Aluminum-Alloy Bars, Rods, and Wire—ASTM B 211/B 211M, Alloy 6061-T6, 6262-T9, or 2024-T4. (Alloy 2024-T4 with an anodic coating of 0.0002 inch minimum thickness and dechromate or boiling water seal.)
- Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded—ASTM B 308/B 308M-Alloy 6061-T6
- Toggle Bolts—Section 1014.2(a)
- Miscellaneous—Aluminum wedges, shims, end caps, washers, and nuts of acceptable material.

Certify as specified in Section 106.03(b)3.

(b) Anchor Bolts, Nuts, and Washers. Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

(c) Caulking Compound. Section 705.8

1013.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) General. Section 1012.3(a)

(b) Assembly. Section 1012.3(b) except:
At bend areas, do not vary the diameter of rail tubes by more than 5% of the outside diameter, when rail tubes are bent to the radii indicated.

1013.4 MEASUREMENT AND PAYMENT—Linear Foot
Measured from center-to-center of end posts. The Department will not deduct gaps at lighting pole foundations.

SECTION 1014—STEEL BRIDGE RAILING

1014.1 DESCRIPTION—This work is the construction of a steel bridge railing.

1014.2 MATERIAL—Galvanize materials as specified in Section 1105.02(s). Before fabrication, submit shop drawings for review and acceptance.

(a) Railing.

- Steel Rails—Rails may be either pipe conforming to ASTM A53, Type E or S, Grade B; or tubing conforming to ASTM A500 or A501.
- Railing Posts—ASTM A47/A47M, Grade 24018 (Grade 35018), or ASTM A536, Grade 60-40-18.
- Toggle Bolts—An acceptable, galvanized type, capable of supporting a 9,000-pound load in tension, when tested through a 1-inch round hole. Toggle bolts may be cadmium-plated to conform to the requirements of ASTM B766, Class 5, in place of galvanizing.
- Miscellaneous—Malleable iron wedges, shims, end caps, washers, and nuts of acceptable material.

Certify as specified in Section 106.03(b)3.

(b) Anchor Bolts, Nuts, and Washers. Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

(c) Caulking Compound. Section 705.8

1014.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) General. Before erection, use caulking compound to thoroughly coat surfaces of posts in contact with concrete. After erection and alignment, use caulking compound to seal openings between metal surfaces and concrete.

(b) Assembly. Remove blemishes and scratches from exposed surfaces. For areas that have been damaged, exposing base metal, paint with two coats, according to ASTM A780. Assemble the rail members to grade and the posts normal to grade.

Make cuts true, smooth, and free from burrs or ragged edges. Fillet-drill all re-entrant cuts, before cutting. As indicated, provide slotted holes for expansion.

The diameter of holes in the posts, for anchor bolts, may exceed the nominal bolt diameter up to 50%, with a maximum measurement of 1/2 inch greater than the nominal bolt diameter.

Place joints, as indicated.

At bend areas, do not vary the diameter of rail tubes by more than 5% of the outside diameter when rail tubes are bent to the radii indicated.

1014.4 MEASUREMENT AND PAYMENT—Linear Foot
Measured from center-to-center of end posts. The Department will not deduct gaps at lighting pole foundations.

SECTION 1015—PROTECTIVE BARRIER

1015.1 DESCRIPTION—This work is the construction of a protective barrier on bridges over electrified railroads.

1015.2 MATERIAL—Before fabrication, submit shop drawings for review and acceptance.

(a) Barrier.

- Aluminum-Alloy Extruded Section—ASTM B 221/B 221M, Alloy 6061-T6 or 6351-T5.
- Aluminum-Alloy Sheet and Plate—Alloy 6061-T6
- Aluminum-Alloy Bolts— ASTM B 211, Alloy 2024-T6 or 6061-T6
- Aluminum-Alloy Nuts—ASTM B 211/B 211M, Alloy 6061-T6.
- Nylon Washers—Section 1103.11(j)2
- Bolt Heads—Regular hexagon. ANSI B18.2.3.5M (B18.2)
- Nuts—Finished hexagon, ANSI B18.2.4.6M (B18.2) Thread, Class 6, 6g, or 6H (2, 2A, or 2B)
- Other Aluminum Alloys—Section 1013.02(a)

Certify as specified in Section 106.03(b)3.

(b) Anchor Bolts, Nuts, and Washers. Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

(c) Caulking Compound. Section 705.8

(d) Miscellaneous Connection Elements.

1. Used for barrier attachment at PA HT Bridge Barrier, PA Type 10M Bridge Barrier, and PA Bridge Barrier

- High strength bolts. ASTM A 325 as specified in Section 1105.02(d), galvanized as specified in Section 1105.02(s).
- Elastomeric pads and washers. Section 1113.03(h), Type I
- Fabric bushing material, Section 1113.03(h), Type II
- Anchor bolts. Section 1105.02(c)3, galvanized as specified in Section 1105.02(s).

2. Used for barrier attachment at PA HT Bridge Barrier and PA Type 10M Bridge Barrier.

- Galvanized plate channel assembly, C8 x 13.75, 3/4 inch fill plate and 1/2 inch x 3 inch x 1 foot 3 inches connection plate. ASTM A 709Grade 36, as specified in Section 1105.02(a), galvanized as specified in Section 1105.02(s).

3. Used for barrier attachment at PA Bridge Barrier.

- 1/2 inch fill plate as specified in Section 1105.02(a), galvanized as specified in Section 1105.02(s).

1015.3 CONSTRUCTION—As shown on the Standard Drawings and as specified in Section 1013.3.

1015.4 MEASUREMENT AND PAYMENT—Linear Foot
Measured from end-to-end of barrier.

SECTION 1016—PROTECTIVE FENCE

1016.1 DESCRIPTION—This work is the construction of barrier protective fences and sidewalk protective fences.

1016.2 MATERIAL—Before fabrication, submit shop drawings for review and acceptance.

(a) Protective Fence (Steel).

1. Fabric. Section 1110.01(a), size of mesh, 1 inch.

2. Fabric Tie Wire. No. 9 gage aluminum wire; or No. 9 gage steel wire, galvanized, conforming to ASTM F 626, or aluminized, conforming to ASTM A 491.

Certify as specified in Section 106.03(b)3.

3. Posts, Rails, and Fittings. End, corner, and line posts; top and bottom rails; and brace rails to be Heavy Industrial Steel Fence Pipe ASTM F 1043 Grade IC 50,000 pounds per square inch minimum yield strength) with plain ends. Substitution of High Strength ASTM F 1083 Grade 83000 (83,000 pounds per square inch yield strength) Schedule 40 pipe is allowed at no additional cost to the Department. Fittings and hardware as specified in Section 1110.02(a).

Certify as specified in Section 106.03(b)3.

(b) Anchor Bolts, Nuts, and Washers. Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

(c) Caulking Compound. Section 705.8

1016.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) General. Fasten fabric to the line posts, top and bottom rails, and brace rails, using tie wires spaced not more than 24 inches apart; fasten to end and corner posts using 3/16-inch by 3/8-inch stretcher bar bands. Use stretcher bars with square edges attached by threading through the fabric, attached with clamps, or attached by other positive mechanical means.

Use brace bands and stretcher bar bands 1/8 inch by 1 inch, with 3/8-inch diameter by 1 1/2 inches long, non-removable bolts.

Do not use bent or damaged posts or rails. Place moisture-proof post tops. Position line-post tops to pass the top rail through the post tops.

Place top rails in 20-foot lengths, with couplings or expansion devices joining the lengths to form a continuous brace for each stretch of fence. Fasten top rails to end and corner posts by means of rail ends and brace bands.

Use brace rails at end and corner posts, midway between the top and bottom rail, extending from the end or corner post to the adjacent line posts.

Fasten bottom rails and brace rails to end, to corner, and to line posts, using rail ends, brace ends, and brace bands.

Place truss rods, 3/8 inch in diameter, with turnbuckles, between the brace ends of the brace rail and the bottom rail.

(b) Steel Welding. According to AWS.

1016.4 MEASUREMENT AND PAYMENT—Linear Foot

Measured from center-to-center of end posts. The Department will not deduct gaps at lighting pole foundations.

SECTION 1017—PRESSURE MORTAR POINTING AND SURFACING

1017.1 DESCRIPTION—This work is the pointing and the surfacing of areas of structures.

1017.2 MATERIAL—

(a) Cement. Section 701

(b) Fine Aggregate. Type A, Section 703.1

(c) Water. Section 720.1

(d) Reinforcement Bars. Section 709.1

(e) Fabric Reinforcement. AASHTO M 55 (ASTM A 185). Use fabric reinforcement, consisting of galvanized, welded straight-line fabric, conforming to one of the following:

- No. 12 gage wire, spread 2 inches in each direction;
- No. 10 gage wire, spaced 3 inches in each direction; or
- as indicated.

Certify as specified in Section 106.03(b)3.

(f) Burlap. Section 711.1(d)

(g) Liquid Membrane-Forming Curing Compound, Clear. Section 711.2(a)

(h) Expansion Bolts. From a manufacturer listed in Bulletin 15.
Certify as specified in Section 106.03(b)3.

1017.3 CONSTRUCTION—

(a) Preparation of Structure. Thoroughly clean the surfaces and voids of rust, scale, grease, loose and disintegrated particles, and material that might impair the bond between the surfaces to be covered and the mortar mixture. Remove unsound concrete and mortar as directed, and thoroughly clean surfaces.

(b) Placing Reinforcement. Lap adjacent sheets of fabric at least 4 inches for 2-inch mesh and at least 6 inches for 3-inch mesh. Fasten fabric together with wire ties at intervals of not more than 18 inches.

1. Steel Surfaces. Place fabric on the top, sides, and bottom of steel members. Bend the fabric to conform to the outlines of the members and hold approximately 3/4 inch away from the surface of the members, or as directed. Place 1/4-inch diameter bars vertically on each side of the webs, then tie in place, using holes in the webs or clip plates. Space on 3-foot centers, or as indicated. Tie the fabric outside of and to the bars, on approximately 12-inch centers. Place the fabric or bars clear of the surface of the members.

2. Masonry Surfaces. In areas of buildup for the replacement of disintegrated material, unless otherwise indicated or directed, place a layer of fabric for each 3-inch layer of mortar or fraction thereof. More than one layer of fabric may be attached to an anchor bolt, provided the bolt is long enough.

Hold the fabric in place by means of lead-collared expansion bolts, either 1/4 inch by 3 inches, or 3/8 inch by 4 inches. Use longer bolts, where necessary. Space 1/4-inch diameter bolts approximately 20 inches center-to-center in each direction, starting 3 inches from the outside edges of the areas to be pressure-mortared. Space 3/8-inch diameter bolts approximately 30 inches center-to-center in each direction, starting 6 inches from the outside edges of the areas to be pressure mortared. Fasten the fabric to the expansion bolts away from the prepared surface, with 1 inch clear below the finished surface of the repair.

Where existing reinforcement is exposed due to removal of deteriorated concrete, fabric may be tied to this reinforcement at 18-inch intervals, to form a cage to position and support the fabric within 1 inch of the finished surface of repair.

Avoid excessive fabric layers, which may create planes of weakness or internal stresses.

(c) Mixing Mortar. Mix the mortar of one part cement and 3 1/2 parts fine aggregate. Thoroughly dry-mix the mortar in a batch mixer. Screen the dry-mix and remove material retained on a No. 4 sieve, before placing the mixture in the hopper of the mortar pressure gun. Do not mix more than 1 hour's supply of mortar at a time. Keep the mixture in the gun bin thoroughly stirred.

(d) Pressures. At the gun, supply air pressure of at least 35 pounds per square inch when shooting the mixture. Increase the air pressure, as necessary, when the lift is greater than 25 feet, or when using more than 100 feet of hose. Maintain uniform air pressure. At the nozzle, maintain a uniform water pressure of at least 15 pounds per square inch greater than the air pressure at the gun. Supply pressure in the lower gun chamber to produce a nozzle velocity of 375 feet per second to 450 feet per second, with a 1 1/4-inch tip opening. Vary these pressures and velocities only when directed. Determine the nozzle pressure and velocity from the nozzle velocity meter attached to the gun.

(e) Moisture Content of Mortar. Use approximately 8% to 10% moisture, by weight, when shooting, of approximately 3 1/2 gallons of water per bag of cement. Do not use a greater quantity of water than necessary to produce a proper mixture. When using reinforcement fabric, supply a moisture content of approximately 8%, for mortar below the fabric, and approximately 9% to 10% above the fabric.

(f) Application. Perform pressure mortar work under the continuous supervision of an experienced pressure-gun foreperson, using only experienced personnel as gun and nozzle operators. When pointing masonry, saturate the surfaces with clean water before applying mortar. When surfacing structural steel, keep the outer edges of the mortar at the flanges and stiffeners square and true to line by using shooting strips, placed to maintain the specified dimensions without trapping the rebound.

Use guide strips at corners and other places, where necessary, to ensure true lines, corners, and the placement of specified thickness, dimensions, and designs. Bring mortared surfaces to a reasonably true plane, then finish the entire mortared area with a pressure-gun finish. Apply the main body of the mortar in at least two coats. Apply bottom surfaces in at least two coats to obtain proper adhesion and to avoid sagging. Bring the last main coat to within 1/8 inch of the proposed surface, then correct irregularities and remove high spots with trowels. Give the entire surface a thin coat of mortar, but do not trowel or float. If directed, give the final surfaces a finish using a long-bristled brush, saturated with clean water, then dragged over the surfaces. Do not work the surfaces with the brush.

For masonry pointing, or pointing and surfacing, fill voids with mortar, making the surface flush with the adjacent face of the structure. After completing the pointing, clean the face of the masonry.

Shoot mortar at right angles to the surface, holding the gun nozzle approximately 3 feet from the surface, when using a 3/4-inch or a 1-inch nozzle, or 4 feet from the surface, when using a 1 1/4-inch nozzle. Use a shorter distance only where working space requires closer shooting. Remove deposits of loose fine aggregate. If any deposit of loose, fine aggregate is covered by succeeding layers of mortar, remove the surfacing and replace with suitable mortar. At the end of a day's work or at other required stopping periods, slope off the mortar to a thin edge. Do not use square joints. Before shooting the adjacent section, joining new work to old work, or placing additional coats, clean this sloped portion, old work, or previous coat.

Saturate the previous coat by a combination of air and water blasting. Do not place mortar unless the air temperature or the surface on which it is placed is 50F or higher.

(g) Curing. Immediately after initial hardening, saturate mortar and keep wet for a period of at least 96 hours. Protect pressure mortar pointing and surfacing on masonry surfaces, and where practical on structural steel, with burlap. Keep burlap wet during this curing period.

If allowed as an alternative to burlap curing, apply Liquid Membrane Forming Curing Compound, Clear, as specified in Section 1001.3(p)3.a.

Cure in cool and cold weather, as specified in Section 1001.3(p).

(h) Backfilling. For spaces excavated around areas being pointed and surfaced, backfill with acceptable embankment material in layers no more than 4 inches in depth. Thoroughly compact mechanically, as specified in Section 202.3(f).

1017.4 MEASUREMENT AND PAYMENT—

(a) Pressure Mortar Surfacing. Square Yard

(b) Pressure Mortar Pointing. Linear Foot

SECTION 1018—REMOVAL OF EXISTING BRIDGES OR CULVERTS

1018.1 DESCRIPTION—This work is the removal and disposal of existing bridges, culverts, or superstructures.

1018.2 MATERIAL—

- Topsoil—Section 802.2
- Seeding and Soils Supplements—Section 804.2
- Mulching—Section 805.2

1018.3 CONSTRUCTION—

(a) General. Submit a plan to the District Executive showing or describing the demolition and removal methods to be used for the removal of an existing bridge or culvert, as indicated. Demolition is considered to be the point in time when a portion of the structure is being cut, sawed, drilled, or impacted through excavation or other means that could affect the stability of the structure. Provide, at a minimum, the following information within the plan:

- Methods of protection and safety for the general public, inspection personnel, and construction personnel.
- Location and method of protection of utilities.
- Phasing and sequence of operations indicating construction equipment to be used for the intent of the operation being performed.
- Location and weights of equipment during demolition.
- Weights of equipment/materials to be staged/stockpiled on the structure. Consider the condition of the existing structure when proposing to place loads on the portion of the structure to be demolished.
- When and how critical sections of the structure are to be removed (i.e. fracture critical components, arches, rigid frames) and provide analysis as required by the Representative to determine the structural stability of partial or complete parts of the structure being demolished.
- Method of providing temporary support for elements which will become unstable.

Demolition plan submissions for bridge removal are to be signed and sealed by a Professional Engineer, registered in the State if one or more of the following criteria apply to the structure being removed:

- Over a roadway;
- Span length exceeds 80 feet;
- Existing structures without plans with span length over 50 feet;
- Arches or rigid frame structures with span length over 50 feet;
- Fracture critical structures;
- Structures on, under, or adjacent to a railroad; or
- Specifically called for in the contract.

Do not proceed with demolition work until the plan has been reviewed and accepted. Acceptance of the demolition plan by the Representative will not relieve the Contractor of liability for safe demolition and/or removal of the structure. A pre-demolition meeting is to be held at the project site prior to the start of demolition with the Representative, Structure Control Engineer, Contractor's superintendent, and the person responsible for development of the demolition plan (if requested by a party with involvement in the demolition).

If the structure to be removed is over or under a railroad, submit the accepted demolition plan to the railroad company's Area Engineer. Do not proceed with the demolition work until written acceptance is received from the railroad company. Provide a copy of this written acceptance to the Department. Notify the railroad company 10 days before starting demolition work. Failure to obtain the railroad company's acceptance will require an alternate plan

submittal to the Department and the railroad company for review and acceptance.

After removing the existing structure, backfill the area where the existing bridge or culvert was removed, as specified in Section 202.3(f). Grade into the existing topography. If directed, place topsoil. Seed and provide soil supplements, as specified in Section 804.3. Use a type and rate of seeding and soil supplements typical for project. Mulch with the type and rate of mulch typical for project, as specified in Section 805.3.

Where the removal area coincides with new construction, backfill voids below the elevation of the bottom of the proposed footings, using acceptable material, then compact, as specified in Section 202.3(f).

If indicated, leave in place portions of the existing substructure that do not interfere with new construction, landscaping, or other operations. Provide documentation (photographs, survey notes) for portions of the structure to remain in place if blasting is used as a method of removal.

(b) Structures Retained by the Department. If indicated, remove members or parts of the structure to be retained by the Department. Match-mark the members or parts, and place them within the right of way at an indicated or directed location, within 1,000 feet of the existing structure. If indicated, load the members or parts, haul them to, and unload them at, the indicated location. If indicated, load the members or parts on railroad cars, ready for shipment.

(c) Structures Retained by the Contractor. If not otherwise indicated, the Department will not retain structures, or parts of structures. Remove and dispose of the structure, or parts of the structure, in a satisfactory manner.

1018.4 MEASUREMENT AND PAYMENT—

(a) Removal of Existing Bridge. Lump Sum

When removal area coincides with excavation area of new construction, the pay limit for removal extends 1 foot horizontally beyond the outer limits of the structure being removed.

The Department will pay for backfilling of voids below the indicated elevation of the bottom of proposed footings for new construction as specified in Section 1001.4(f).

(b) Removal of Existing Culvert. Lump Sum

When removal area coincides with excavation area of new construction, the pay limit for removal extends 1 foot horizontally beyond the outer limits of the structure being removed.

The Department will pay for backfilling of voids below the indicated elevation of the bottom of proposed footings for new construction as specified in Section 1001.4(f).

(c) Removal of Existing Bridge Superstructure. Lump Sum

SECTION 1019—PROTECTIVE COATING FOR REINFORCED CONCRETE SURFACES

1019.1 DESCRIPTION—This work is applying a protective coating on concrete surfaces.

1019.2 MATERIAL—

(a) Boiled Linseed Oil. Section 503.2
Certify as specified in Section 106.03(b)3.

(b) Epoxy Resin (For Abutments, Pier Caps, and Endwalls). A two-component, epoxy resin system, as follows:

1. General. An epoxy-type base polymer, thermosetting resin as follows:

- Composed of 100% reactive constituents (condensation products of the reaction of epichlorohydrin with bisphenol A).
- Essentially pure, diglycidyl-ether of bisphenol A, containing no more than trace amounts of hydrolyzable chlorine.
- Epoxide equivalent between 465 and 530.
- Reacting system consisting of a blend of condensation polymers of dimerized and trimerized unsaturated, fatty-acids and an aliphatic polyamine.
- Pigmentation added so the cured coating conforms to the Federal Color Standard 595, and as indicated.
- Nonskid material added, if directed.

2. Physical Requirements of the Mixed Epoxy System.

- Viscosity—300 centipoises to 700 centipoises at 72F
- Pot Life—a minimum of 7 hours at 75F
- Minimum solids content—48%
- A cured system that does not exhibit amine blushing or sweating.

When the pigmented finished coats are tested for abrasion, according to ASTM D 968, a minimum of 25 L of sand is required to abrade a 1-mil thickness of coating.

A 2 1/2-mil dry film thickness of the coating, tested by ASTM D 522, is required to pass a 1/8-inch diameter mandrel test, without splitting the film or causing loss of bond.

3. Sampling. A representative sample of each component will be taken for the required tests, either from a well blended bulk lot, before packaging or by withdrawing thief samples from no less than 5% of the containers comprising the lot or shipment. Unless the samples show evidence of variability, they may be blended into a single composite sample to represent that component. Package materials may be sampled by random selection of containers or each component from each lot. The entire lot of both components may be rejected if samples fail to meet any specified requirements.

4. Packaging and Marking. Furnish the two components in separate containers that are nonreactive with the contained materials. If directed, provide a container size so the recommended final mixture proportions can be obtained by combining one container of a component with one or more containers of the other component. Have containers marked as base polymer and reacting system, showing the mixing directions and usable temperature range. Have each container marked with the name of the manufacturer, the lot or batch number, the date of packaging, pigmentation, if any, and the quantity in pounds and gallons.

Indicate the potential hazards on the package, according to the Federal Hazardous Products Labeling Act.

5. Certification. If directed, certify, as specified in Section 106.03(b)3. Provide either a copy of the manufacturer's dated test report or a statement, accompanied by a copy of the dated test results, showing the system has been sampled and tested.

(c) Penetrating Sealers (For Reinforced Concrete Substructure Surfaces). Furnish a penetrating sealer from a manufacturer listed in Bulletin 15 as follows:

- Silicates in Water.
- Epoxies Dispersed in Water. Only use on surfaces that the sealer does not totally encapsulate the structural unit being treated.
- Organo-Silicon Compounds in Solvent.
- Resins in Mineral Spirits.

Certify as specified in Section 106.03(b)3.

(d) Penetrating Sealers (For Bridge Superstructure). A one-component, penetrating sealer material, composed of a minimum of 40% silane or siloxane material, with no petroleum distillates meeting the following properties:

- **Water Absorption.** The final average percent water absorbed, for concrete coated with the protective sealer, not greater than 20.0% of the final average percent water absorbed by the uncoated reference concrete.
- **Moisture Vapor Transmission.** The final average percent moisture loss, for concrete coated with the protective sealer, not less than 75.0% of its final average percent water absorption.
- **Chloride Ion Penetration.** The final average absorbed chloride ion content, for concrete coated with the protective sealer, not greater than 15.0% of the final average absorbed chloride ion content of the uncoated reference concrete.
- **Durability.** The protective sealer does not show any signs of weathering, discoloration, or deterioration after 6 months of exposure to atmospheric conditions.

Certify as specified in Section 106.03(b)3.

1019.3 CONSTRUCTION—

(a) Boiled Linseed Oil.

1. Areas and Preparation.

1.a General. Thoroughly dry and clean the surfaces of dirt, debris, oil, grease, and foreign matter that would prevent protective coating penetration, adhesion, or drying. Do not use membrane-forming curing compound where linseed oil treatment is to be applied.

Apply the protective coating as soon as possible after completion of a structure or portion of a structure.

2. Application. Section 503.3(b)

3. Safety Precautions. Section 503.3(c)

(b) Epoxy Resin.

1. Substructures (Subject to Staining). If indicated, apply epoxy resin protective coating as follows:

1.a Surface Preparation. Clean sound, dry, new concrete surfaces, of laitance or other potential bond-inhibiting matter. Do not apply epoxy until 28 days after placing concrete, unless allowed to apply sooner. Do not use membrane-forming curing compounds where epoxy treatment is to be applied.

Clean old concrete surfaces of oil, grease, and potential bond-inhibiting matter by acid etching, using a 10% to 15% muriatic-acid solution. Spread the acid solution and allow it to react for 3 minutes to 5 minutes or until bubbling has subsided. Flush the surface with clear water and allow to dry. Where, in the Representative's opinion, acid etching is insufficient to clean the concrete, use an acceptable method of mechanical abrading. Clean steel surfaces until bright metal is exposed. Then immediately apply the protective coating to prevent the reoccurrence of oxidation.

1.b Mixing. Measure and mix, as recommended by the manufacturer of the epoxy, in a clean mixing container. Thoroughly mix the epoxy using a 400 rpm to 600 rpm (low speed, ± 2-inch) electric drill, and paddle-type mixer. After mixing, let the material stand for an induction period of one hour before application.

1.c Application. Apply the mix by brush, roller, or spray. If applied by roller, use a first-quality, long-nap roller for rough surfaces and a short-nap roller for smooth surfaces. If applied by spray, use an externally atomized spray gun. For spray application, use a thinner of the type and quantity recommended by the manufacturer of the epoxy.

Apply two thin, uniform coats of the mixed material, each approximately 2 mils to 3 mils dry film thickness (4 mils to 5 mils wet thickness). Apply the second coat 24 hours after the application of the first coat. Use a rate of cover recommended by the manufacturer of the epoxy. Apply at temperatures between 60F and 90F.

(c) Penetrating Sealers.

1. Substructures.

1.a Surface Preparation. Thoroughly dry and clean the surfaces of dirt, debris, oil, grease, and foreign matter that would prevent protective coating penetration, adhesion, or drying.

1.b Application. Apply penetrating sealer, which does not discolor the concrete, to areas indicated according to the manufacturer’s instructions.

2. Bridge Superstructure. Provide a penetrating sealer meeting the material requirements of Section 1019.2(d) and apply according to the manufacturer’s recommended application procedures to exposed concrete surfaces of bridge decks; curbs, sidewalks, and divisors; and to inside and top surfaces of barrier. Apply the penetrating sealer after the completion of the specified concrete wet cure period, followed by an initial drying period of a minimum of 14 days after the wet curing period and the concrete surface is dry.

1019.4 MEASUREMENT AND PAYMENT—Square Yard

For the type indicated.

The Department will pay for additional maintenance and protection of traffic, if necessary for the application of additional protective coating to bridge decks experiencing excessive cracking, as specified in Section 110.03(d).

SECTION 1020—TOOTH EXPANSION DAM WITH DRAIN TROUGH

1020.1 DESCRIPTION—This work is construction of a tooth expansion dam with fabric reinforced drain troughs for bridge joints.

1020.2 MATERIAL—

(a) Fabricated Structural Steel. Section 1105.02(a)2, hot-dipped galvanized as specified in Section 1105.02(s).

(b) High Strength Bolts. Section 1105.02(d)

(c) Stainless Steel Bolts and Studs. ASTM F 593. Certify as specified in Section 106.03(b)3.

(d) Stainless Steel Washers and Lock-Nuts. ASTM F 594. Certify as specified in Section 106.03(b)3.

(e) Galvanizing. Section 1105.02(s)

(f) Polyester or Nylon Fabric. Certify as specified in Section 106.03(b)3. Conform to the following requirements:

- Number of plies 2
- Minimum fabric weight, oz./sq. yd. 7.5
- Minimum tensile strength lb./in., ASTM D 378 425

(g) Rubberized Trough Material. Certify as specified in Section 106.03(b)3. Furnish Butadiene Acrylonitrile Elastomer conforming to the following requirements:

- Hardness shore 'A', ASTM D 2240, minimum – maximum 60-70 durometer
- Minimum tensile strength, psi, ASTM D 412 1400
- Minimum elongation at break, %, ASTM D 412 300
- Oven aging, 70 hours at 212F, ASTM D 573

  Maximum elongation loss, % -25

  Maximum tensile strength loss, % -35

  Maximum hardness points change +10
- Brittleness to heat aging, ASTM D 2137 0F
- Tear resistance, lb./in., Die C, ASTM D 624 120
- Resistance to ozone aging, ASTM D 1149 (Method B, bent loop) No cracks, 70 hours @ 104F and 50 ppm ozone,
- Oil swell, ASTM D 471, 70 hours @ 212F using

IRM 903 oil, mass change % maximum	45

(h) Fabric Composite Properties. Preformed fabric material consisting of the multi-ply polyester or nylon fabric and rubberized trough material, vulcanized to form a laminate, with the following properties:

• Minimum thickness, in.	1/8
• Minimum composite tensile strength of the fabric reinforced bridge trough, lb./in., ASTM D 378	800
• Maximum elongation @ ultimate tensile strength, % ASTM D 412	30
• Maximum resistance to water absorption, (less than 10% weight gain for 7 days of water immersion @ 150F, ASTM D 471 – Procedure for Change in Mass with Liquid on One Surface Only	10

1020.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

Prepare shop drawings as specified in Section 105.02(d). Obtain acceptance of the shop drawings before beginning fabrication.

Use a prequalified fabrication shop as specified in Section 1105.01(a).

Weld as specified in Section 1105.03(m).

Fabricate and erect the expansion dam according to the shop drawings and as appropriate for the bridge deck grade and crown. Preset the dam opening before shipment and assemble with temporary shipping angles.

Install the dam as indicated. After erection, remove the temporary shipping angles and grind plates smooth.

Place concrete under the expansion dams, vibrate until the concrete is forced through air holes, and strike off excess concrete. After the concrete has cured, clean air holes and fill with an approved sealer.

Do not splice the drain trough, unless indicated. If splices are indicated, use only if splices are vulcanized and spliced by the manufacturer in the shop/factory and are watertight. Do not use longitudinal splices.

Repair galvanizing damaged during construction operations as directed and according to the manufacturer's recommendations, at no additional cost to the Department.

Install the trough with stainless steel fasteners.

After installation, flood trough with water and inspect for leaks and/or damage. Repair any leaks or damage as directed and according to the manufacturer's recommendations.

1020.4 MEASUREMENT AND PAYMENT—Pound

SECTION 1021—ARMORED PREFORMED NEOPRENE COMPRESSION DAM

1021.1 DESCRIPTION—This work is the furnishing and installation of armored preformed neoprene compression dams for bridge joints, including the necessary fabricated structural steel.

1021.2 MATERIAL—

(a) General. Use a prequalified fabrication shop, as specified in Section 1105.01(a).

(b) Preformed Neoprene Compression Seal and Lubricant Adhesive. Section 705.4(d), from a manufacturer listed in Bulletin 15.

(c) Structural Steel. Section 1105.02(a)2, hot-dip galvanized as specified in Section 1105.02(s). The galvanization in the retainer extrusion must be of uniform thickness and free of excessive build-up, which would hinder the installation of the dam.

(d) Studs. Section 1105.02(e)

1021.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

Before fabrication, submit shop drawings, as specified in Section 105.02(d), showing complete details, dimensions, size, type, and compression-deflection characteristics of the seal, as well as other information and data necessary for the complete fabrication and erection of the dam. Obtain acceptance of shop drawings before beginning fabrication.

The seal may be installed in the shop, at the width determined for the erection temperature. For a shop-installed seal, make final width adjustment on the completed seal, if necessary, in the field for the temperature at the time when the dam is securely fastened to beams. No field adjustment will be needed for a ± 10F variation in temperature from the temperature for which the joint width was adjusted in the shop.

After width adjustment, the seal may be installed in the field.

Submit for approval the manufacturer’s data sheet for the seal that includes seal preparation and installation recommendations. Before installing the seal, clean metal surfaces in direct contact with the seal, to remove foreign material and to provide for proper bond between the seal and the metal surfaces. Clean according to the manufacturer’s recommendations.

Swab the lubricant-adhesive on the faces of the angles forming the groove, according to the manufacturer's recommendations. While the adhesive is wet, install the seal, according to the manufacturer’s recommendations.

Do not splice the seal, unless indicated. If splices are indicated, use only if splices are vulcanized and spliced by the manufacturer in the shop/factory and are watertight.

If stretching of the seal during installation is unavoidable, do not exceed 5% elongation.

Place the top of the seal at the walls, in contact with the deck joint structural steel, at a uniform depth of 1/4 inch minimum to 1/2 inch maximum below the deck surface.

The Department will not accept cocked or twisted seal installations.

Remove and replace seals that are damaged during installation. Repair galvanizing damaged during construction operations as directed and according to the manufacturer’s recommendations, at no additional cost to the Department.

After installation, flood seal with water and inspect for leaks and/or damage. Repair any leaks or damage as directed and according to the manufacturer’s recommendations.

1021.4 MEASUREMENT AND PAYMENT—Linear Foot

For the movement specified.

Measured out-to-out along the centerline of the exposed surfaces of the seal and the steel plates, including sidewalks if applicable, following the vertical and sloped faces of curbs and barriers, resulting in a true length, not a horizontally projected length.

SECTION 1022—STEEL BRIDGE HAND RAILING

1022.1 DESCRIPTION—This work is construction of a steel bridge hand railing.

1022.2 MATERIAL—

(a) Railing.

- Pipe for the Rails—ASTM A53, Type F, Schedule 40, certified as specified in Section 106.03(b)3.
- Plates—AASHTO M 270 (ASTM A709), Grade 36. Certify as specified in Section 106.03(b)3.
- Welding Material—Section 1105.02(t)

(b) Toggle Bolts. Use an acceptable galvanized type capable of supporting a 1,000-pound load in tension, when tested through a 3/4-inch round hole. Toggle bolts may be cadmium-plated to meet the requirements of ASTM B766, Class 5, in place of being galvanized.

Certify as specified in Section 106.03(b)3.

(c) Malleable Iron Wedges, Shims, End Caps, Washers, and Nuts. Certify as specified in Section 106.03(b)3.

(d) Anchor Bolts, and Nuts and Washers for Anchor Bolts. Section 1105.02(c)2

(e) Caulking Compound. Section 705.8

(f) Galvanizing. Section 1105.02(s)

1022.3 CONSTRUCTION—Construct as shown on the Standard Drawings and as follows:

(a) General. Submit shop drawings for review and acceptance before starting fabrication.

Before erection, coat the surface of posts in contact with concrete or masonry, using caulking compound. After erection and alignment, use caulking compound to seal openings between metal surfaces and concrete.

After the concreting and other operations have been completed, clean the railing. Use an acceptable solvent cleaner to remove accumulations of oil, grease, dirt, and foreign materials.

(b) Assembly. Remove blemishes and scratches from exposed surfaces. Assemble the rail members with the rails parallel to grade and with the posts normal to grade. Place joints as indicated.

Make cuts true, smooth, and free from burrs or ragged edges.

Fillet drill all re-entrant cuts before cutting.

(c) Welding. Section 1105.03(m)

1022.4 MEASUREMENT AND PAYMENT—Linear Foot

Measured from center to center of end posts. The Department will not deduct gaps at lighting pole foundations.

SECTION 1023—ALUMINUM BRIDGE HAND RAILING

1023.1 DESCRIPTION—This work is construction of an aluminum bridge hand railing.

1023.2 MATERIAL—

(a) Railing.

- Pipe for the Rails—ASTM B241-Alloy 6061-T6, 6063-T6 or ASTM B429-Alloy 6061-T6, 6063T6.
- Plates—Section 1103.04(a)

Certify as specified in Section 106.03(b)3.

(b) Toggle Bolts. Use an acceptable galvanized type capable of supporting a 1,000-pound load in tension, when tested through a 1/2-inch round hole. Toggle bolts may be cadmium-plated to conform to the requirements of ASTM B766, Class 5, in place of being galvanized.
Certify as specified in Section 106.03(b)3.

(c) Aluminum Wedges, Shims, End Caps, Washers, and Nuts. Certify as specified in Section 106.03(b)3.

(d) Anchor Bolts, and Nuts and Washers for Anchor Bolts. Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

(e) Caulking Compound. Section 705.8

1023.3 CONSTRUCTION—Construct as shown on the Standard Drawings and as follows:

(a) General. Before fabrication, submit shop drawings for review and acceptance.
Before erection, coat surfaces of aluminum alloys in contact with other metals, stone masonry, or concrete, using caulking compound. After erection and alignment, seal openings between metal surfaces and concrete, using caulking compound.
After the other bridge construction operations have been completed, clean the aluminum bridge hand railing. Remove accumulations of oil, grease, dirt, or foreign materials, using an acceptable solvent cleaner.

(b) Assembly. Assemble the rail members. Place joints as indicated.
Make cuts true, smooth, and free from burrs or ragged edges. Fillet drill all re-entrant cuts before cutting. Do not flame cut. Weld according to AWS.

1023.4 MEASUREMENT AND PAYMENT—Linear Foot
Measured from center to center of end posts. The Department will not deduct gaps at lighting pole foundations.

SECTION 1025—MODIFICATION OF EXISTING BARRIERS

1025.1 DESCRIPTION—This work is the modification of existing bridge barriers for the type indicated.

1025.2 MATERIAL—

- Class AA Cement Concrete—Section 704
- Reinforcement Bars—Section 1002.2
- Concrete Bonding Compound—Section 706
- Threaded Rods and Couplings and Steel Plates—Section 1105.02(a)2.
- Galvanizing—Section 1105.02(s)
- Welding Material—Section 1105.02(t)
- Nuts and Washers—ASTM A 536 for nuts, certified as specified in Section 106.03(b)3, and Section 1105.02(c)2.b for washers.
- Dowel Holes—Section 1003
- Caulking Compound—Section 705.8
- Joint Backing Material—Section 705.9
- Overlay Material—Section 1042.2. Use material of the same type as the deck overlay material.

1025.3 CONSTRUCTION—In the field, verify sizes, dimensions, and types of materials, as necessary to satisfactorily complete work.

Before beginning barrier modification, submit plans for review and acceptance to the Chief Bridge Engineer. On the plans, show the method of modification proposed, including modification of open joints, expansion dam, and the deck at the existing scuppers.

Satisfactorily repair any damage done to the existing structure beyond the indicated removal limits.

Straighten existing reinforcement that is to remain in place, within the limits of removal. If necessary, cut and bend the existing reinforcement. Wire brush, clean, and paint the existing reinforcement with a coating of neat-cement (semi-liquid mixture of cement and water).

Satisfactorily dispose of debris resulting from the removal operation.

The Department will retain the bridge barrier railings, posts, and miscellaneous hardware. Remove and store within the right of way for removal from the project site by Department forces. When removing railings and posts from the structure, bundle and stack in piles. Store nuts, bolts, washers, and shims in boxes or barrels with the railing elements. Store the bundles and boxes or barrels in a manner to be picked up and moved with a fork lift.

If necessary, provide additional deck overlay. Modify the deck portions of the existing expansion dam, then warp the deck to existing scuppers, when indicated.

1025.4 MEASUREMENT AND PAYMENT—Linear Foot

For the type indicated, measured from end to end along the inside face of the completed barrier, with no deductions for expansion dams or joint areas.

SECTION 1026—NEOPRENE STRIP SEAL DAM

1026.1 DESCRIPTION—This work is the furnishing and installation of neoprene strip seal expansion dam for bridge joints, including the necessary fabricated structural steel extrusions and sliding plates.

1026.2 MATERIAL—

(a) General. Use a prequalified fabrication shop as specified in Section 1105.01(a).

(b) Structural Steel. Section 1105.02(a)2, hot-dipped galvanized as specified in Section 1105.02(s). The galvanization in the retainer extrusion must be of uniform thickness and free of excessive build-up, which would hinder the installation of the seal. Have the expansion dam fabricator demonstrate that the seal can be installed properly before shipment.

(c) Anchor Bolts and Washers. Section 1105.02(c)

(d) Studs. Section 1105.02(e)

(e) Neoprene Strip Seal and Lubricant Adhesive. Section 705.4(d), from a manufacturer listed in Bulletin 15.

1026.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

Before fabrication, submit shop drawings, as specified in Section 105.02(d), showing complete details, dimensions, size, and type of seal as well as other information and data necessary for the complete fabrication and erection of the dam.

Before installing the seal, clean metal surfaces in direct contact with the seal according to the manufacturer's recommendations. Install seal with hand or air driven tools recommended by the manufacturer.

Do not splice the seal, unless indicated. If splices are indicated, use only if splices are vulcanized and spliced by the manufacturer in the shop/factory and are watertight.

If stretching of the seal during installation is unavoidable, do not exceed 5% elongation.

The Department will not accept cocked or twisted seal installation.

Remove and replace seals that are damaged during installation. Repair galvanizing damaged during construction operations as directed and according to the manufacturer's recommendations, at no additional cost to the Department.

After installation, flood seal with water and inspect for leaks and/or damage. Repair any leaks or damage as directed and according to the manufacturer's recommendations.

1026.4 MEASUREMENT AND PAYMENT—Linear Foot

For the movement specified.

Measured out-to-out along the centerline of the final, in place, exposed surfaces of the seal, fabricated structural steel extrusion, and the steel sliding plates, including sidewalks if applicable, following the vertical and sloped faces of curbs and barriers, resulting in a true length, not a horizontally projected length. Non-exposed surfaces will not be included in the final, in-place measurement.

SECTION 1031—TIMBER STRUCTURES

1031.1 DESCRIPTION—This work is the construction of all timber structures except hardwood glue-laminated (glulam) structures.

1031.2 MATERIAL—

(a) Structural Timber. Douglas Fir-Larch, Hem-Fir, Southern Pine, Beech, Birch, Hickory, Mixed Maple, Red Maple, Northern Red Oak, Red Oak, Mixed Oak, White Oak, and Yellow Poplar. Provide Select Structural, No. 1 or No. 2 grade lumber and timber. Provide sawn lumber and timber conforming to the Specifications for Structural Timber, Lumber and Piling, AASHTO M 168. Certify as specified in Section 106.03(b)3.

Accept only pieces consisting of sound wood, free from decay. Avoid boxed heart timber.

Use structural timber complying with the American Softwood Lumber (ASL) Standard PS 20-70 for manufacture of dressed-sized lumber and timber products. Grade Douglas Fir-Larch and Hem-Fir using West Coast Lumber Inspection Bureau (WCLIB) or Western Wood Products Association (WWPA) inspection rules. Grade Douglas Fir-Larch (North) and Hem-Fir (North) using National Lumber Grades Authority (NLGA) inspection rules. Grade Southern Pine according to Southern Pine Inspection Bureau (SPIB) inspection rules. Grade Beech-Birch-Hickory, Mixed Maple, Red Maple, Northern Red Oak, Red Oak, Mixed Oak, and White Oak according to Northeast Lumber Manufacturer's Association (NELMA) grade rules. Grade Yellow Poplar according to Northern Softwood Lumber Bureau (NSLB) rules.

Adequately protect structural timber during transport.

Accept only kiln dried dimension lumber at 15% average moisture content, and 19% maximum moisture content.

Accept only solid sawn timbers that have been air seasoned or dried to an average moisture content not exceeding 19%.

Accept only softwood glue-laminated timbers with a maximum 16% moisture content.

Preservative treat lumber and timber by pressure treatment process according to the AWPA C1, “All Timber Products - Preservative Treatment by Pressure Processes.”

Treat structural timbers for highway/bridge construction according to AWPA C14, “Wood for Highway Construction - Preservative Treatment by Pressure Processes.”

Minimum retention of creosote preservative for wood species not covered under AWPA C14 is 11.6 pounds per cubic foot.

Treat piles as specified in Section 1005.2(a) and according to the AWPA C3, “Piles - Preservative Treatment by Pressure Processes.”

Provide treated lumber and timber products with permanent symbol imprints or documentation to identify the treating company, treatment type, year of treatment, and certification of conformance with AWPA. Certify as specified in Section 106.03(b)3.

Accept treated structural timber that conforms to appropriate recommended AWPA treatment requirements.

(b) Adhesives (Glulam Fabrication). Provide adhesives conforming to ANSI/AITC A190.1, “Structural Glued Laminated Timber,” Section 4.4. Provide wet-use adhesives. Certify as specified in Section 106.03(b)3.

(c) Hardware. Furnish bolts, nuts, washers, timber connectors, drift pins, dowels, nails, screws, spikes, other metal fasteners, and wire rope as necessary. Provide bolts and nuts as specified in Section 1105.02(c)1. Provide machine head bolts and nuts of regular hex series and coarse thread series, Class 6g and 6H (Class 2) tolerances, all conforming to applicable ANSI Standards. Provide cast iron Ogee, malleable iron, plate, or cut washers, as indicated. Galvanize all hardware except cast and malleable iron. Certify as specified in Section 106.03(b)3.

(d) Galvanizing. Section 1105.02(s). Galvanize hardware after fabrication.

(e) Structural Steel. Section 1105.02(a)

(f) Painting. Paint all structural steel, except hot-dip galvanized material, as specified in Section 1060.

(g) Laminated Girders and Deck Panels.

1. Fabrication.

1.a Mechanically Laminated Panels. Perform all possible fabrication of mechanically laminated members before preservative treatment.

Treat mechanically laminated girders and deck panels for highway construction according to AWPA C14.

1.b Glued laminated Members. Fabricate structural glued laminated softwood timber according to ANSI/AITC 190.1, "Structural Glued Laminated Timber," and AITC-117, "Manufacturing, Standard Specifications for Structural Glued Laminated Timber of Softwood Species."

Treat glued laminated timbers for highway construction according to AWPA C14.

2. Tolerances. Provide laminated structural members with net width, depth, and length as indicated on the structural drawings, and with tolerances according to the ANSI/AITC A190.1 (AITC 113, "Standard for Dimensions of Structural Glued Laminated Timber") or tolerances as follows:

- **Width.** ±1/8 inch of the indicated width.
- **Depth.** ±1/8 inch per foot of indicated depth.
- **Length.** ±1/8 inch up to 20-foot length with a ±1/8-inch allowance for every 20 feet of additional length.
- **Squareness.** Provide a cross section for all glued laminated structural members which is square within ±1/8 inch per foot of depth of member unless a special shape is indicated.
- **Beam Camber.** ±1/4 inch for lengths up to 20 feet. Add ±1/8-inch allowance for each additional 20-foot length.

Provide industrial appearance grade glued laminated timbers according to AITC 110, "Standard Appearance Grades for Structural Glued Laminated Timber."

Accept only glued laminated timbers in standard dressed widths according to AITC 113.

(h) Membrane Waterproofing. Section 680

(i) Superpave Asphalt Mixture Design.

- **Asphalt Wearing Course.** Section 413.2

(j) Timber Piles. Section 1005.2(a)

(k) Cement Concrete. Class A and Class AA. Section 704.

(l) Wood Preservative. AASHTO M 133. Certify as specified in Section 106.03(b)3. Use only oil-borne preservatives with hardwood lumber and timber.

1031.3 CONSTRUCTION—

(a) Storing and Handling. Store lumber and timber neatly in piles on skids above ground. Protect from exposure to the elements if stored for prolonged periods of time. Store material so that it can be readily inspected.

Handle in a manner to avoid injury or breakage. Handle treated lumber with nylon or other non-damaging rope slings. Do not use cant hooks, peaveys, or other sharp instruments in handling treated timber. Provide corner protection for banded material. The Department will reject treated lumber unduly injured in handling.

(b) Workmanship. Cut all lumber and timber accurately, and frame to a close fit, to provide for even bearing of joints over the entire contact surfaces. Make joints without shimming. Field drill only as indicated or as allowed.

1. Bored Holes. Treat all bored, drilled, or reamed holes with approved field treatment according to AWPA M4, "Standard for the Care of Preservative-Treated Wood Products." Plug unfilled holes, after field treatment, with treated timber plugs.

Bore holes in untreated lumber 1/16 inch in diameter less than the pin or dowel. Bore holes 1/16 inch in diameter larger than the bolt. Bore holes for lag screws not larger than the base of the thread. Bore holes in small timbers with the same diameter as the spike shank when necessary to prevent splitting. Do not field drill or nail, except for railing.

2. Installation of Connectors. Provide one of the following timber connector types, as indicated: split ring, shear plate, or spike grid. Install split ring and shear plate types in precut grooves of dimensions as indicated or as recommended by the manufacturer. Force spike grids into the wood so that timbers are in firm contact. Use pressure equipment that does not damage the wood. High-strength bolts or rods fitted with low friction ball-bearing washers made for this purpose may be used. Replace the high-strength bolts with specified bolts for the final installation. Embed all connectors of this type at a joint simultaneously and uniformly.

Cut connector grooves in timber concentric with the bolt hole, conforming to the cross-sectional shape of the rings, and providing a snug fit. Supply an inside groove diameter larger than nominal ring diameter so that the ring will expand slightly during installation. (See Table A)

3. Bolts and Washers. Use a washer of the size and type indicated under all bolt heads (except for timber bolts with economy type heads) and nuts that would otherwise come in contact with wood.

After final tightening, lock the nuts of all bolts.

(c) Substructure. Construct as indicated, and as follows:

1. Bent Piles. Drive piles as accurately as possible in the correct location, vertical or to the batter indicated, and as specified in Section 1005.3.

Make cut-offs accurately to ensure uniform bearing between the sills and piles of a bent. Treat cut pile ends according to AWPA M4.

2. Framed Bents. Bed mudsills firmly and evenly upon solid bearing material, and tamp into place. Construct concrete pedestals for the support of framed bents, as specified in the applicable portions of Section 1001.3. Finish pedestals carefully to provide full and even bearing for sills or posts.

Provide for true and even bearing of sills on mudsills, piles, or pedestals. If possible, remove all earth from contact with sills to provide for free air circulation around them.

3. Bearing Sill Caps. Place timber caps to secure an even and uniform bearing over the tops of the supporting posts or piles, and to secure an even alignment of their ends. Secure all sills as indicated. For sills secured using drift bolts, place drift bolts approximately in the center of the post or pile.

4. Bracing. Properly align bents before placing bracing. Bolt the ends of bracing through the pile, post, or cap. Furnish bracing of sufficient length to provide a minimum distance of 8 inches between the outside bolt and the end of the brace.

TABLE A
Typical Dimensions of Timber Connectors
(dimensions in in.)

Split Rings		
Size	2 1/2 in.	4 in.
Split ring		
Inside diameter at center when closed	2.500	4.000
Thickness of metal at center	0.163	0.193
Depth of metal (width of ring)	0.750	1.000
Groove		
Inside diameter	2.56	4.08
Width	0.18	0.21
Depth	0.375	0.50
Bolt diameter	1/2	3/4
Bolt hole diameter	9/16	13/16
Washers, standard		
Round, cast or malleable iron, diameter	2 5/8	3
Round, mild steel		
Diameter	1 3/8	2
Thickness	3/32	5/32
Square plate, mild steel		
Length of side	2	3
Thickness	1/8	3/16

Shear Plates				
Size	2 1/2 in.	2 1/2 in.	4 in.	4 in.
Shear plate material	Pressed steel	Light gage	Malleable	Malleable
Diameter of plate	2.62	2.62	4.03	4.03
Diameter of bolt hole	0.81	0.81	0.81	0.94
Thickness of plate	0.172	0.12	0.20	0.20
Depth of flange	0.42	0.35	0.64	0.64
Use steel straps or shapes, for use with shear plates, designed according to accepted engineering practices.				
Hole diameter in straps or shapes for bolts	13/16	13/16	13/16	15/16
Circular dap dimensions				
A	2.63	2.63	4.03	4.03
B	—	1.07	1.55	1.55
C	0.81	0.81	0.81	0.94
D	—	0.65	0.97	0.97
E	0.19	0.13	0.27	0.27
F	0.45	0.38	0.64	0.64
G	0.25	0.14	0.22	0.22
H	—	0.34	0.50	0.50
I	2.25	2.37	3.49	3.49
Bolt hole—diameter in timber	13/16	13/16	13/16	15/16
Washers, standard				
Round, cast or malleable iron, diameter	3	3	3	3 1/2
Round, medium steel, minimum				
Diameter	2	2	2	2 1/4
Thickness	5/32	5/32	5/32	11/64
Square plate				
Length of side	3	3	3	3
Thickness	1/4	1/4	1/4	1/4

(d) Superstructure. Construct as indicated, and as follows:

1. Timber Stringers. Place stringers for bridge decks better edge down. Provide for even bearing of the floor on the stringers. Use butt joints for outside stringers, centered over caps of floor beams. Lap interior stringers to take bearing over the full width of cap or floor beams at each end.

Frame cross-bridging between stringers neatly and accurately, and fasten securely. Provide for full bearing of each end of cross-bridging members against the sides of stringers. Unless otherwise directed, place cross-bridging at the center of each span and at supports.

2. Glued laminated Timber Stringers. Place stringers according to beam fabricators' "TOP" mark. Provide for even bearing of the deck on all stringers at piers as indicated, but allow no less than 1/2 inch clearance between butt ends to allow for air circulation.

Treat all field drilled holes or reamed holes before installation of hardware according to AWPA M4. Treat all field-drilled holes before installing diaphragms.

Provide for close fit (full bearing) of diaphragm between stringer beams. Place diaphragms or cross bracing as indicated.

3. Wheelguards, Rail, and Barrier. Frame and align wheel guards, rail posts, rails, and barriers accurately and as indicated.

4. Panel-to-Panel Connections. Provide a snug fit for all panel-to-panel connections on interconnected decks. Field drill or ream connections only if directed. Treat all field-drilled or reamed holes according to AWPA M4.

(e) Surface Treatment of Timber. Do not paint wood treated with oil-borne preservatives.

Using pressure process, treat portions of rail posts that are to be embedded in earth or concrete and where faces of timber bulkheads will be in soil contact, with a 11.9 pounds per cubic foot retention of creosote preservative for softwoods and 11.6 pounds per cubic foot to 11.9 pounds per cubic foot retention of creosote for hardwoods.

Apply a two-coat finish sealer to treated structural timber railings where prolonged exposure to direct human contact is likely. Acceptable sealers include latex epoxy, urethane, shellac, or other finishes with effective coating agents that adhere to treated rails.

When framing, cutting, or boring of treated timber is performed after treatment, swab all cuts, daps, and holes thoroughly with two applications of accepted wood preservative treatments according to AWPA M4.

(f) Post-Tensioning. Perform post-tensioning operations as directed.

Stress to 100% of the required tensioning force at the time of installation (Stage 1). Restress to 100% of the required tensioning force 1 week after completion of Stage 1 (Stage 2). Restress to 100% of the required tensioning force 4 to 8 weeks after completion of Stage 2.

Pressure inject protective sheathing with noncorrosive material or with material containing a corrosion inhibitor.

(g) Superpave Asphalt Mixture Design, Asphalt Wearing Surface. Clean the deck of the heavier excretions and surface residues of the treatment solution before constructing the asphalt leveling course.

Spread a blotter of fine material (silt and sandy silt) over the surface. Use a mixture consisting of 20% crushed material passing a 2.36 mm (No. 8) sieve and 80% material passing a 150 µm (No. 100) sieve. Spread at a rate of 5 kg/m^2 to 8 kg/m^2 (10 pounds per square yard to 15 pounds per square yard). Broom off the blotter material. Repeat process until the surface is free of exudates.

Construct the Superpave Asphalt Mixture Design, leveling course as indicated and as specified in Section 413.3. Use only non-vibratory rollers for compaction of the Superpave Asphalt Mixture Design, leveling course.

For stressed-laminated timber decks, prepare the Superpave Asphalt Mixture Design, leveling course surface and construct waterproofing membrane as indicated.

Construct the Superpave Asphalt Mixture Design, surface course as specified in Section 413.3. Use only non-vibratory rollers for compaction of the Superpave Asphalt Mixture Design, surface course.

Provide geotextile Class 4 fabric as specified in Section 735, for glued laminated timber decks. No leveling course is necessary for glued laminated decks.

1031.4 MEASUREMENT AND PAYMENT—Lump Sum

(a) Fabricated Structural Steel. Section 1050.4

(b) Structural Timber. Cubic Foot

(c) Membrane Waterproofing. Section 680.4

(d) Guide Rail. Section 620.4

(e) Geotextiles, Class 4. Section 212.4

(f) Piles. Section 1005.4

(g) Superpave Asphalt Mixture Design.

- **Asphalt Wearing Course.** Section 413.4

(h) Cement Concrete. Section 1001.4

SECTION 1032—HARDWOOD GLULAM TIMBER STRUCTURES

1032.1 DESCRIPTION—This work is the construction of structures with hardwood glue-laminated (glulam) timber.

1032.2 MATERIAL—

(a) Structural Timber. Section 1112.02(a)

(b) Adhesives. Section 1112.02(b)

(c) Hardware. Section 1031.2(c)

(d) Galvanizing. Section 1031.2(d)

(e) Structural Steel. Section 1105.02(a)

(f) Painting. Section 1031.2(f)

(g) Geotextiles. Section 735

(h) Superpave Asphalt Mixture Design.

- **Asphalt Wearing Course.** Section 413.2

(i) Timber Piles. Section 1005.2(a)

(j) Cement Concrete. Class A and Class AA. Section 704

(k) Wood Preservative. Section 1112.02(d)

1032.3 CONSTRUCTION—

(a) Storing and Handling. Section 1031.3(a)

(b) Workmanship. Section 1031.3(b)

(c) Substructure. Section 1031.3(c)

(d) Superstructure. Section 1031.3(d)

(e) Surface Treatment of Timber. Section 1031.3(e)

(f) Superpave Asphalt Mixture Design, Asphalt Wearing Surface. Section 1031.3(g)

1032.4 MEASUREMENTS AND PAYMENT—

(a) Fabricated Structural Steel. Section 1050.4

(b) Structural Timber. Cubic Foot

(c) Steel Guide Rails. Section 620.4

(d) Geotextile, Class 4. Section 212.4

(e) Piles. Section 1005.4

(f) Superpave Asphalt Mixture Design.

- **Asphalt Wearing Course.** Section 413.4

(g) Cement Concrete. Section 1001.4

SECTION 1039—CONCRETE BRIDGE DECK SURFACE PREPARATION, HYDRODEMOLITION

1039.1 DESCRIPTION— This work is bridge deck surface preparation after scarification using hydrodemolition to provide a rough and bondable surface and to remove unsound concrete. This work includes the removal and disposal of concrete and debris, vacuuming, shielding, water control, jack hammering and chipping, and work necessary for preparing the deck for completing concrete bridge deck repairs and the placement of a new latex modified concrete wearing surface as indicated and directed.

1039.2 MATERIAL— Not used.

1039.3 CONSTRUCTION—

(a) General. Submit a hydrodemolition water control plan to the Structure Control Engineer for review and approval for control and filtering of water discharged during the hydrodemolition operation. Include in the submission the maximum and minimum water pressure (pounds per square inch) and water usage (gallons per minute) the hydrodemolition machine will provide. Provide settlement basins or devices to allow only visibly clear water from leaving the project site. Protect scuppers, inlets, and downspouts from material that would cause plugging. Provide free flowing, unobstructed drainage structures at the completion of this operation.

Provide a technical field representative on the project site during the calibration and the hydrodemolition surface preparation operation.

(b) Equipment.

1. Hydrodemolition Equipment. The hydrodemolition equipment is required to be a computerized, self-propelled machine that utilizes a high-pressure water jet stream to provide a rough and bondable surface while removing unsound concrete, rust and concrete particles from exposed reinforcement during the hydrodemolition operation.

1.a Calibration. Completely remove construction debris, scarification debris and dust from the bridge deck surface before calibration.

Calibration is required each time hydrodemolition surface preparation is performed and as required to achieve the results specified.

Before commencement of the hydrodemolition surface preparation operation, calibrate the hydrodemolition equipment on an area of sound concrete (7 foot x 7 foot) as designated by the Structure Control Engineer to demonstrate that the hydrodemolition equipment can provide a rough and bondable surface. Calibrate hydrodemolition equipment to remove no more than 1/4 inch of concrete (original deck surface to peaks of roughened surface) in sound areas.

Move the hydrodemolition equipment to a second area (7 foot x 7 foot) that is unsound as designated by the Structure Control Engineer to demonstrate that the hydrodemolition equipment can provide a rough and bondable surface while removing unsound concrete in one pass. Adjust the settings as required within the limits established below to achieve total removal of unsound concrete.

Provide verification of the following settings to the Representative:

- Water pressure gauge (psi)
- Water usage (gpm)
- Machine staging control (step)
- Nozzle size
- Nozzle speed (travel)

The hydrodemolition surface preparation production may begin after the Structure Control Engineer accepts the calibration and production settings. Maintain and provide the calibration and production settings to the Representative before and during hydrodemolition surface preparation production.

If unsatisfactory results are obtained, stop hyrodemolition until the equipment deficiency or malfunction is

corrected. Provide another hydrodemolition unit for calibration if onsite equipment deficiencies cannot be corrected at no additional cost to the Department. No additional contract time will be provided for equipment deficiencies, malfunctions or recalibration of another hydrodemolition unit if required.

2. Pneumatic hammers. In areas inaccessible to hydrodemolition units or where the provided coverage is insufficient, use pneumatic hammers not exceeding 30 foot-pounds, operated at no more than a 45 degree angle from horizontal. Hand held water blasting equipment capable of delivering a minimum of 25 gpm at 10,000 psi are also allowed. Use chipping hammers not exceeding 15 foot-pounds or hand held water blasting equipment when removing concrete within one inch of the reinforcement steel.

(c) Surface Preparation Before Hydrodemolition. Provide shielding, as required, to ensure containment of dislodged concrete within the removal area to protect property and the traveling public from flying debris on, adjacent to, and below the work site.

Perform scarification as specified in Section 1041 on the bridge deck before hydrodemolition. Remove construction debris, scarification/milling debris, and dust completely from the bridge deck surface before commencement of the hydrodemolition surface preparation operation.

(d) Hydrodemolition. Perform hydrodemolition surface preparation over the entire top surface of the bridge deck or locations indicated to provide a rough and bondable surface and to remove unsound concrete in one pass. Verify and document removal every 30 feet along the cutting path. Do not allow vehicles other than approved construction equipment on those sections of deck where hydrodemolition has begun. Prevent contamination of the deck by providing protection for hydrodemolished portions of the deck.

Stop the surface preparation operation if it is determined that sound concrete is being removed in excess of 1/4 inch (scarified deck surface to peaks of roughened surface in sound areas) or unsatisfactory results are being obtained, as determined by the Representative. Perform recalibration or changes in equipment and methods before resuming the operation.

(e) Cleaning. Clean the hydrodemolition debris with a vacuum system equipped with fugitive dust control devices and capable of removing wet debris and water in the same pass. Cleaning includes but is not limited to fine material, powder, dust, water, and particles in pockets, voids, and crevices that would hinder an overlay from bonding with the substrate. Use oil-free compressed air to remove excess water and to dry the deck. Perform cleaning before debris and water dries on the deck surface. Remove material allowed to dry at no additional cost to the Department.

(f) Deck Sounding Verification. After the hydrodemolition surface preparation operation has been performed and the deck is dry and clean, resound the deck to ensure unsound material has been removed with the exception of Type 3 concrete bridge deck repair removal areas. Perform the remaining removal for Type 3 concrete bridge deck repair areas as specified in Section 1040 and as directed. Unsound concrete is defined as existing bridge deck concrete that is deteriorated, spalled, or determined by the Representative to be unsound. Remove remaining unsound concrete, patching material, or existing unsound overlay, as determined by the Representative, with pneumatic hammers or hydrodemolition at no additional cost to the Department. Use pneumatic hammers to provide a rough and bondable surface in areas that are inaccessible to hydrodemolition equipment. Remove unsound concrete or original deck surface found after the hydrodemolition surface preparation operation at no additional cost to the Department.

(g) Reinforcing Steel. Protect exposed reinforcement bars from bending by providing adequate supports. Splice or replace reinforcing steel damaged, bent, or dislodged by the hydrodemolition operations with the same size bar at no additional cost to the Department. Repair reinforcing steel distorted as a result of contractor operations at no additional cost to the Department. Remove portions of heavily corroded reinforcement steel where less than 1/2 of the effective cross-sectional area remains. Replace with the same type and size of bars as specified in Section 1002.3 and as directed.

The requirement to provide a minimum 3/4 inch clearance around reinforcement bars that are more than 1/2 diameter exposed is waived, provided the existing substrate concrete is sound. Where more than 1/2 diameter of the reinforcement bar is exposed, and the bar is corroded around the circumference, adjacent concrete is rust stained, or the bar is debonded from the substrate concrete, chip away concrete or water blast to provide a minimum 3/4 inch clearance.

1039.4 MEASUREMENT AND PAYMENT— Square Yard of deck area regardless of the number of passes.

SECTION 1040—CONCRETE BRIDGE DECK REPAIR

1040.1 DESCRIPTION—This work is removing and patching unsound bridge deck concrete as indicated and directed. Unsound concrete is defined as existing bridge deck concrete that is deteriorated, spalled, or determined by the Representative to be unsound. This work applies to approach slabs and barrier when indicated or directed. Concrete Bridge Deck Repair is classified into three types as follows:

(a) Type 1. Areas where unsound concrete removal extends no deeper than the top mat of reinforcement bars without exposing the top mat. Type 1 repairs are only performed when a latex overlay is indicated.

(b) Type 2. Areas where unsound concrete removal exposes the top mat of reinforcement bars and extends no deeper than the bottom mat without exposing the bottom mat.

(c) Type 3. Areas where unsound concrete removal exposes the bottom mat of reinforcement bars or the full depth of the deck is unsound. This includes deck overhang areas; and areas where curb, barrier, or deck ends need to be patched as part of the repair. Type 3 repairs over adjacent box beams extend to the top of the beam.

1040.2 MATERIAL—

(a) Patching Material.

- Class AAAP Cement Concrete—Section 704, except use No. 8 coarse aggregate.
- Class AA Cement Concrete—Section 704, except use No. 8 coarse aggregate. For use in barrier repairs only.
- Latex Modified Concrete (LMC)—Section 1042.2(f)
- Accelerated Structural Concrete (ASC)—Section 704, except use No. 8 Coarse Aggregate. Do not use ASC unless indicated or directed.
- Bag Mix—When the quantity of concrete is smaller than the minimum delivery requirement from a mix supplier, a Bulletin 15 approved bag mix with No. 8 coarse aggregate may be used. Submit the bag mix data sheets for review and do not use until accepted.
- Concrete Bonding Compound—Type II, Grade 2, ASTM C881 epoxy as specified in Section 706
- Wearing Surface Material for Patching—Section 1042.2

(b) Reinforcement Bars. Section 1002.2

1040.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) Deck Sounding and Delineation of Repair Areas. Provide a chain drag 3 feet in width with chain drops spaced every 6 inches for Department use. Sound the entire bridge deck with the chain drag in the presence of the Representative. When scarification and a latex overlay are indicated without hydrodemolition, sound the entire deck after scarification in the presence of the Representative. The Representative will delineate the repair areas.

(b) Equipment.

1. Hand Tools. Use hand tools for removal including hammers and chisels. Use hand tools to remove final particles of unsound concrete or to provide necessary clearances around reinforcement bars.

2. Pneumatic Hammers.

- Do not exceed 30 foot-pound hammers.
- Do not exceed 15 foot-pound hammers to remove final particles of unsound concrete, to provide necessary clearances around reinforcement bars, or below the bottom mat of steel overtop of concrete beams.
- Do not operate pneumatic hammers or mechanical chipping tools at an angle in excess of 45 degrees relative to the surface of slab.
- Do not use pointed or narrow chisels overtop of beams, provide 2 inch minimum width chisels.
- Do not place pneumatic hammers in direct contact with reinforcing steel.

3. Water Blasting Equipment. Provide water blasting equipment with a minimum rated capacity of 5,000 pounds per square inch.

(c) Surface Preparation and Concrete Removal. Provide satisfactory protective shielding during removal operations. During removal for Type 3 repairs, provide shielding to prevent debris from falling below the deck. Prevent damage to underlying beams.

Outline the unsound delineated areas with a 3/4-inch deep saw-cut. Remove unsound concrete with hand tools and pneumatic hammers. Notify the Representative if unsound concrete extends beyond the delineated areas. Extend repair areas as directed.

Remove portions of damaged or heavily corroded reinforcement bars, and replace with the same type of bars, as specified in Section 1002.3 and as directed.

For Type 1 repairs, perform Type 1 removal only when scarification and a latex overlay are indicated without hydrodemolition. When a latex overlay is not indicated, perform Type 1 repairs as Type 2 repairs.

For Type 2 repairs, remove concrete to a depth that provides a minimum of 3/4-inch clearance around all reinforcement bars in the top mat, regardless of concrete deterioration. If portions of the bottom mat of reinforcement bars are exposed during removal, remove full-depth and perform a Type 3 repair as directed.

Satisfactorily repair damage to the structure beyond the limits of this work due to construction operations at no additional cost to the Department.

(d) Cleaning. Provide satisfactory protective shielding during cleaning operations for repair areas. After concrete removal operations are complete, remove remaining debris and loose materials. Abrasive blast exposed reinforcement bars to clean white metal. Air-blast repair areas with oil-free compressed air, ensure abrasive blast material is removed, and remove contaminants detrimental to the bond of the patching material. Epoxy coat exposed reinforcement bars. Protect cleaned areas from contamination.

(e) Concrete Bonding. Coat contact surfaces of repair areas with concrete bonding compound. Do not coat surfaces to receive a new overlay. Remove concrete bonding compound from surfaces to receive an overlay at no additional cost to the Department.

1. Epoxy Bonding Compound. Place concrete against contact surfaces while epoxy bonding compound is still tacky to ensure bond between contact surfaces and fresh concrete. Wire brush or sandblast hardened epoxy before recoating with fresh epoxy.

2. Other Bonding Compound. Place concrete against contact surfaces within the compound manufacturer's recommended time frame. When recommended time frame has expired, follow manufacturer’s recommendations for recoating contact surfaces.

(f) Patching.

1. Type 1. Perform Type 1 repairs as Type 2 repairs.

2. Type 2. Patch Type 2 bridge deck repair areas with modified Class AAAP cement concrete, LMC or ASC if indicated or directed. Patch Type 2 barrier repairs with Class AA cement concrete or ASC if indicated or directed. Vibrate concrete with a pencil vibrator. Finish patches to match the existing deck surface elevation. Before the concrete becomes nonplastic, tine the surface as specified in Section 501.3(k)4. Finish barrier patches to match adjacent barrier contours. Do not tine barrier patches.

3. Type 3. Patch and finish Type 3 repair areas the same as Type 2 repairs. In addition, use removable formwork of sufficient strength to prevent lateral or vertical deflection. Provide side forms including drip-strip and chamfering.

4. Patching in Preparation of Latex Overlay Placement.

4.a Type 1. Patch Type 1 repair areas concurrently with the overlay placement with the same material used for the overlay. Place overlay as specified in Section 1042.3.

4.b Type 2, Concurrent with Overlay. Patch Type 2 repair areas up to 4 inches in depth concurrently with the overlay placement with the same material used for the overlay. Place overlay as specified in Section 1042.3.

4.c Type 2, Patching before Overlay Placement. If Type 2 repair areas exceed 4 inches in depth, patch before overlay placement. Perform scarification before patching. If indicated, perform hydrodemolition before patching. Patch repair areas with modified Class AAAP cement concrete, LMC or ASC if indicated or directed. Vibrate concrete with a pencil vibrator. Finish patches to match the scarified or hydrodemolitioned deck surface elevation. Provide a rough texture on patch surfaces. After patches have attained a minimum compressive strength of 3,000 pounds per square inch, remove laitance from patch surfaces by water blasting.

4.d Type 3. Do not place Type 3 patches concurrently with overlay. Perform scarification before patching. If indicated, perform hydrodemolition before patching. Use removable formwork of sufficient strength to prevent lateral or vertical deflection. Provide side forms including drip-strip and chamfering. Patch repair areas with modified Class AAAP cement concrete, LMC or ASC if indicated or directed. Vibrate concrete with a pencil vibrator. Finish patches to match the scarified or hydrodemolitioned deck surface elevation. Provide a rough texture on patch surfaces. After patches have attained a minimum compressive strength of 3,000 pounds per square inch, remove laitance from patch surfaces by water blasting.

(g) Curing Patches.

1. Normal Curing. Water cure bridge deck patches as specified in Section 1001.3(p)3.b.2. Cure barrier patches with curing compound as specified in Section 1001.3(p)3.a or water cure as specified in Section 1001.3(p)3.b.1. After 28 days, remove laitance and contamination on the surface by water blasting. Apply a penetrating sealer after water blasting as specified in Section 1019 and according to the manufacturer's recommendations. When a latex overlay is indicated, do not apply penetrating sealer to bridge deck patching performed before overlay.

2. ASC. Cure as specified in Section 1001.3(p)3.d. When a latex overlay is indicated, do not apply curing compound to bridge deck patching performed before overlay.

3. Bag Mixes. When bag mixes are accepted for use as a substitute for modified Class AAAP cement concrete or LMC for bridge deck patches or modified Class AA cement concrete for barrier patches, cure as specified in Section 1040.3(g)1. When bag mixes are accepted for use as a substitute for ASC, cure as specified in Section 1040.3(g)2.

(h) Live Loads. As specified in Section 1001.3(q)2.c, Table C.

1040.4 MEASUREMENT AND PAYMENT—

(a) Patching. Square Foot
For the type indicated.

(b) Reinforcement Bars. Section 1002.4

(c) Penetrating Sealer. Penetrating sealer is incidental to the patching items.

SECTION 1041—SCARIFICATION

1041.1 DESCRIPTION—This work is scarifying existing concrete bridge decks in one or multiple passes as indicated to the overall uniform depth, in preparation for placing a concrete or mortar wearing surface or before performing hydrodemolition surface preparation.

1041.2 MATERIAL—Not used.

1041.3 CONSTRUCTION—

(a) General. Submit for acceptance the proposed method and equipment used for scarification of concrete surfaces. Before scarification, perform a precondition survey of the existing concrete bridge deck cracks to locate potential reflective cracks in the wearing surface. Perform a bridge deck survey as specified in Section 1042.3(b).

Do not perform scarification on new concrete until a compressive strength of 3,300 psi is attained. Verify the cover of the top mat of reinforcement bars before scarification. Scarify the existing concrete bridge deck the number of uniform depth passes indicated to the required overall removal depth. When hydrodemolition is not indicated, perform scarification in 1/4 inch maximum uniform depth passes. When hydrodemolition is indicated, perform scarification in 1/4 inch or 1/2 inch uniform depth passes as indicated.

If the overall removal depth indicated was not achieved, perform additional scarification to the overall removal depth at no additional cost to the Department. When existing overlays are present or are indicated for removal, do not demobilize the scarification equipment until the Representative verifies the removal depth and complete removal of existing overlays up to 1/2 inch to the top mat of reinforcement bars. Do not scarify within a 1/2 inch clearance of the top mat of reinforcement bars. Clean the deck surface as directed for verification of the removal depth and to ensure existing overlays were completely removed or the deck has been removed to 1/2 inch of the top mat of reinforcement bars.

In areas inaccessible to scarification equipment, use pneumatic hammers not exceeding 30 foot-pounds, operated at no more than a 45 degree angle from horizontal to remove the required depth indicated. Do not use triple-headed tampers fitted with star drills less than 2 inches in diameter.

Completely remove by hand, power broom, or vacuum all broken concrete and laitance resulting from the scarification operation. Do not flush debris. Remove debris at the end of each work day. Clean debris from scuppers and downspouts as needed. Do not allow construction vehicles or equipment, other than power brooms, on the scarified deck surface, unless the surface is adequately protected to prevent contamination.

(b) Equipment. Scarify using a self-propelled machine capable of preparing 1,000 square yards per day. The equipment used for scarification is required to remove the single pass depth indicated across the cutting path. A micromill milling machine is required when scarifying before placing a polyester polymer concrete overlay.

1041.4 MEASUREMENT AND PAYMENT—Square Yard for the single pass depth indicated.

Payment will only be made for the surface area of each uniform single pass depth indicated and required to achieve the overall removal depth regardless of the number of passes made with the scarifying equipment.

SECTION 1042—LATEX MODIFIED MORTAR OR CONCRETE WEARING SURFACE

1042.1 DESCRIPTION—This work is construction of a latex modified mortar or concrete wearing surface on bridge decks, approach slabs or indicated surfaces. The indicated or specified depth of the wearing surface is the minimum.

1042.2 MATERIAL—

(a) Cement. Type I, IP, IS, or II (MH), Section 701.1.

(b) Fine Aggregate. Type A, Section 703.1.

(c) Coarse Aggregate. Type A, No. 8, Section 703.2.

(d) Water. Section 720.1

(e) Latex Emulsion Admixture. Section 711.3(e)

(f) Latex Modified Mortar (LMM) or Concrete (LMC) Mix Design. Use latex modified mortar for depths less than 1 1/4 inches. Use latex modified concrete when the depth is 1 1/4 inches or more.

Provide a concrete technician as specified in Section 704.1(d)2. Provide testing facilities and equipment as specified in Section 704.1(d)3.

The term "latex," as used in this Section, refers to latex modified mortar or concrete, unless otherwise specified. Provide latex conforming to the following requirements:

Latex Modified Mortar or Concrete Mix Design Requirements	Requirements	
	Mortar	Concrete
Cement Content, bags/cu. yd.	8.0	7.0
Latex Emulsion Admixture Modifier, gal/bag of Cement	3.5	3.5
Air Content, % of Plastic Mix (AASHTO T 152)	1 - 7	1 - 7
Water/Cement Ratio, by Weight	0.35 - 0.40	0.30 - 0.40
Slump[1], inches (AASHTO T 119)	4 - 6	3 - 7
Percent Fine Aggregate as Percent of Total Aggregate, by Weight	100	60 ± 5
Cement/Fine Aggregate/Coarse[2] Aggregate Ratio, by Weight	1:3.25	1:2.5:2.0 to 1:2.9:1.6
5-day Compressive Strength (psi) (PTM Nos. 604 & 611) [3]	3,000	3,000
28-day Compressive Strength (psi) (PTM Nos. 604 & 611) [3]	3,500	3,500

[1] Discharge the sample from the mixer and transport it to a point unaffected by vibration. Deposit the sample on the deck in a suitable container and do not disturb for five minutes. Then, remix the sample and perform the slump test according to AASHTO T 119.

[2] Dry basis, Aggregate Specific Gravity = 2.65. The dry weight ratios are approximate and should produce good workability, but due to gradation changes, the ratios may be adjusted within limits by the Representative.

[3] Cure specimens according to PTM No. 611, Section 11.1, except strip after the first 48 hours (± 2 hours), and air cure as specified in Section 1042.3(d) Table A.

Accelerated Latex Modified Concrete Mix Design Requirements	
Cement	Type I, IP, or II, Section 701.1 or other rapid setting cement accepted by the DMM/DME
3 Hour Minimum Compressive Strength	3,000 psi
12 Hour Minimum Compressive Strength	3,000 psi

1. Compatibility Testing During Mix Design. Verify the compatibility of the mix components during mix design and ensure that the mix provides sufficient time of workability to satisfactorily finish and texture the surface. Re-verify compatibility whenever there is a change in mix components. Provide a technical expert from the latex admixture manufacturer for the design process, if directed.

(g) Mix Designs Using Potentially Reactive Aggregates. Section 704.1(g)

1042.3 CONSTRUCTION—

(a) Equipment. Obtain acceptance of equipment for the deck preparation, mixing, placing, and finishing of the latex wearing surface, before start of wearing-surface work. Include equipment specifications in the QC Plan specified in Section 1042.3(c).

1. Surface Preparation Equipment. Of the following types:

1.a Abrasive Blasting or Water Blasting Equipment. Capable of removing partially loosened chips of concrete and removing rust and corrosion from reinforcement bars. Provide water blasting equipment with a minimum rated capacity of 5,000 pounds per square inch.

1.b Power-Driven Hand Tools. Section 1040.3(b)

1.c Scarification. Section 1041.

1.d Hydrodemolition. Section 1039.

2. Proportioning and Mixing Equipment. Provide self-contained, mobile equipment, capable of continuous mixing, with the capacity to deliver a minimum of 6 cubic yards of latex per hour, and subject to the following:

2.a Mixing Equipment. Provide equipment with a metal plate or plates permanently attached in a prominent place, plainly marked with the gross volume of the unit in terms of mixed mortar, operating speed, auger mixing angle, and the weight-calibrated cement constant of the machine, in terms of a revolution counter or other output indicator, all as rated by the manufacturer.

2.b Compartments. Provide separate compartments to carry the necessary ingredients needed for the production of latex modified mortar or concrete. Cover aggregate bins at all times. Provide cement bins free of moisture and contamination at all times. Provide suitable means to carry water and additives on the truck and to incorporate the additives with the mixing water in the mix.

2.c Feed Systems. Provide a unit with a feeder system mounted under the compartment bins to deliver the ingredients to the mixing unit. Provide each bin with an accurately controlled, individual gate to form an orifice for volumetrically measuring the material drawn from each respective bin compartment. Maintain belt feeders and scrapers to prevent leakage of materials onto the deck.

Set the cement bin feeding mechanism to discharge continuously, and at a uniform rate, a given volumetric weight equivalent to cement during the mixing operation. Coordinate the aggregate feeding mechanisms

with the cement feeding mechanisms to deliver the required proportions.

2.d Mixing Unit. Provide an auger-type mixing unit, incorporated into the truck's discharge chute or other suitable mixing mechanism, capable of producing latex of uniform consistency and discharging the mix without segregation.

2.e Dials and Measuring Devices. Equip the unit with an accurate revolution counter indicator allowing the reading of the volumetric weight equivalent to cement discharged during the mixing operation. Equip the counter with a ticket printout to record this quantity. Use aggregate dials that allow the setting of required openings for volumetric proportioning.

Equip the unit with a cumulative water meter and a water flow gauge to accurately indicate the discharge rate of water by volume (gallons per minute) entering the mix. Provide an approved device on the mixing unit for the Representative to use to check the rate of flow of the latex modified admixture entering the mix along with the total amount of latex modified admixture contained in the mix. Coordinate the water and additive measuring devices with the cement and aggregate feeding mechanisms. Equip the flow meters with scales appropriate for the type and amount of material being added.

Mount a tachometer on the mixing unit to indicate the drive shaft speed.

Place required indicating devices in full view and near enough to be accurately read or readjusted by the operator while latex is being produced. Provide the operator with convenient access to controls.

2.f Calibration. Provide a unit constructed to allow convenient calibration of the gate openings and meters. Have the calibration conducted by the supplier of the latex in the presence of the Representative, and recalibrate after every 100 cubic yards of production for each unit. Document the calibration of Form CS-4342 and keep with the mobile mixer. Have the supplier of the latex make satisfactory arrangements with the Representative at least 7 calendar days in advance of calibration. Provide platform scales calibrated annually. Calibrate using the maximum water/cement ratio, cement, and aggregates listed on the approved mix design. Verify compatibility of components and mix workability time while performing a yield test at the conclusion of the calibration process, if directed.

Conduct a recalibration in the event of a change in source of aggregates. Conduct additional calibration as directed. Have each approved unit carry a copy of the calibration certificate. In addition to calibration, perform a yield test according to AASHTO T 121, if directed.

An additional check may be made using the following procedure:

With the cement meter set on zero and controls set for the desired mix, activate the mixer discharging mixed material into a 1/4 cubic yard container (36 inches by 36 inches by 9 inches). When the container is level-struck full, making provision for settling the material into corners, the cement meter is required to show a discharge of 2 bags of cement for modified mortar (8 bags per cubic yard mix) or 1.75 bags of cement for modified concrete (7 bags per cubic yard mix).

2.g Mixing and Delivery Control. Proportion, measure, and batch cement and aggregates by a volumetric weight equivalent method. In operation, the entire measuring and batching mechanism is required to produce the specified proportions of each ingredient. Establish volume/weight relationships during the calibration of the measuring devices. Provide tolerances in proportioning the various ingredients as follows:

- Cement, weight % 0.0 to +4.0
- Fine Aggregate, weight % ±2.0
- Coarse Aggregate, weight % ±2.0
- Water, weight or volume % ±1.0
- Latex, weight or volume % ±2.0

During mixing, maintain the drive shaft speed as indicated by the tachometer at operating speed ± 50 rpm. Set the auger mixer angle in the range determined by the manufacturer. Do not exceed one-half hour for the interval between the continuous placement of successive batches. Equip the mixer to spray water.

2.h Loading. Charge aggregate bins no more than 6 hours before time of scheduled placement unless otherwise approved by the Representative. Ensure the aggregate is maintained in a uniform wet condition before loading. Determine the amount of free water on the aggregates at the time of loading by performing aggregate moisture tests according to AASHTO T 255 or ASTM C70. Adjust mix proportions to account for the amount of available free water. Empty bins and recharge if not utilized within 6 hours or if conditions contribute to variable moisture content of the aggregate. Stock aggregates in a manner that prevents contamination.

Upon arrival at the project site, empty bins of aggregate that were charged before coming to the current project. Empty the cement bin and latex tank unless use on a previous project can be verified by the Representative, or , in the presence of the Representative, obtain a sample of the liquid latex admixture and cement being used in the mixture and deliver the samples to the Representative for testing. The Representative will submit the samples to LTS for testing. Circulate and mix latex tank as recommended by the latex manufacturer.

3. Placing and Finishing Equipment. Provide finishing equipment as specified in Section 1001.3(k)6.c. Provide hand tools for placing and brushing-in freshly mixed latex and for distributing latex over the bridge deck surface before striking off with the mechanical finishing equipment. Use approved hand-operated vibrators and screeds to place and finish small areas of work. Do not use 2-cycle engine vibrators or equipment on the prepared deck. Conduct final finishing operations immediately behind the finishing machines or screeds from work bridges of rigid construction, not in contact with the surface of the concrete, set on rails, and easily moved.

(b) Surface Preparation. Before scarification, hydrodemolition, or removal of portions of the deck surface, survey existing gutter lines and breakpoints every 25 feet including each metal expansion dam along the length of the bridge deck.

Not more than 7 days before the placement of the overlay, scarify the deck surface, to the depth indicated, as specified in Section 1041.

When the indicated surface preparation includes scarification without hydrodemolition, perform scarification, then remove remaining unsound concrete and repair as specified in Section 1040.

When the indicated surface preparation includes scarification and hydrodemolition, perform hydrodemolition after scarification to provide a rough and bondable surface and to remove unsound concrete, as specified in Section 1039. Perform Type 3 concrete bridge deck repairs after hydrodemolition, as directed and as specified in Section 1040.

Before placement of the latex overlay, complete Type 3 deck repairs and Type 2 deck repairs exceeding 4 inches in depth as specified in Section 1040. Type 2 deck repairs that do not exceed 4 inches in depth can be placed concurrently with the latex overlay.

Abrasive blast exposed reinforcement bars to remove rust, contaminants, and pockets of corrosion. Do not apply epoxy coating to reinforcement bars.

Not more than 24 hours before placement begins, clean the entire surface including edges of previously placed lanes of latex, to remove trowel-cut surfaces and promote bond. Clean the surface thoroughly by water blasting, and air blasting using clean, oil-free compressed air to remove dust, slurry, blast media, weak or fractured concrete, petroleum stains, leaves, paint, debris, oil, or other foreign materials detrimental to achieving bond, if necessary. Protect the entire prepared deck surface against contamination by covering with clean full width polyethylene sheeting until the overlay operations are completed. Include cleaning methods in the QC Plan, as specified in Section 1042.3(c).

Allow 48 hours of curing to elapse before performing scarification, hydrodemolition, or chipping on adjacent concrete within 6 feet of previously placed latex.

Raise expansion dams and scuppers if indicated before placing the wearing surface.

(c) Placing and Finishing.

1. Quality Control (QC) Plan. Prepare and submit a field operation QC Plan for review and acceptance according to Form CS-1042. Do not proceed with latex placement until the QC Plan has been accepted. Include in the QC Plan, testing and sampling frequencies and target points to initiate corrective measures. Include key personnel and relevant experience, method of operations, a sketch describing the equipment, and showing complete details of supports for the equipment.

2. Pre-latex Placement Meeting. At least 2 weeks before overlay placement, schedule a pre-latex placement meeting to review the specification, method and sequence of placing latex, quality control testing, and method of protective measures, to control the concrete evaporation rate.

3. Finishing Equipment. Provide anchorage for supporting rails for horizontal and vertical stability. Do not treat screed rails with parting compound to facilitate their removal.

Adjust screeds to finished grade before placing the wearing surface. For superelevated bridges, adjust screed guides to compensate for the curvature.

Determine the finished grade by referencing the survey data obtained before surface preparation. Raise the existing grade or match existing grade, as indicated. Provide a final setting of the screeds such that a smooth riding surface is achieved. Do not lower the screed to compensate for wear on the existing deck or for over scarification or hydrodemolition. Before placing latex, perform a dry run by passing the finishing equipment over the deck area to check the clearance between the bottom of the screed and the prepared surface. Demonstrate that the fogging equipment is working properly during the dry run. Remove concrete that does not clear the screed by the minimum depth of wearing surface.

4. Latex Placement and Finishing. Immediately before placement of the latex, thoroughly wet the clean surface for a period of not less than one hour. Vacuum standing water in depressions, holes or areas of concrete removal. Maintain prepared deck in a damp, puddle-free condition. Use a fogger/mister to dampen visible dry spots before the latex placement.

Brush/broom damp vertical surfaces with latex grout. For horizontal surfaces not prepared with hydrodemolition that will be in contact with the latex overlay, brush/broom damp horizontal surfaces with latex grout. When using latex concrete, collect and discard excess aggregate. Do not over-extract grout from the mix to the point that the grout becomes diluted. If directed, apply a second brushed/broomed coat of grout to areas where grout is diluted by excessive surface moisture. Immediately remove material from the deck that is not properly mixed or proportioned, or lacks component material, and regrout the area. Ensure brushed/broomed surfaces receive a thorough, even coating of latex grout and that the rate of progress is limited so that the brushed/broomed material does not become dry before it is covered with additional material, as required for the final grade.

Place and strike-off the mixture to approximately 1/4 inch above final grade. Vibrate latex in front of finishing machine. For hydrodemolitioned surfaces, snake vibrator through latex at no more than 12 inch passes. Vibrate edges, adjacent to joint bulkheads and expansion dams, in depressions, and in areas of bridge deck repair. Fill and consolidate each Type 2 deck repair placed concurrently with the overlay before the advancement of the overlay placement operation. Finish to final grade with the approved finishing equipment. Hand-finishing with a float may be required along the edge of the placement or on small areas of repair. Edge-tooling is required at joints, metal expansion dams, curbs, and previously placed lanes. Place latex continuously and complete the finishing of each area within 15 minutes after the initial brooming. Provide finish with a closed surface, free of pock marks, ridges, tears, and other defects. Place latex at a minimum rate of 20 linear feet of deck per hour, in a longitudinal direction.

When placing latex against latex that has not achieved initial set, but has formed a surface crust or film, remove the surface crust until plastic latex is exposed, place fresh latex against the exposed surface and consolidate both until homogeneous.

Separate screed rails and construction bulkheads from the newly placed material by passing a pointing trowel along their inside face. Do not separate metal expansion dams from the wearing surface. Ensure that this trowel cut is made for the entire depth and length of rails after the mixture has stiffened sufficiently.

Conduct operations behind the finishing machines or screeds from work bridges suspended above the wearing surface. Provide work bridges of rigid construction. Do not allow work bridges to come into contact with the surface of the latex.

Perform straightedge testing, surface correction and edging while the latex is still workable as specified in Section 501.3(k)3. After the straightedge testing and surface corrections have been completed and before the latex becomes nonplastic, manually texture/tine the surface as specified in Section 501.3(k)4 if mechanical texturing is not indicated. Cure the wearing surface as soon as possible without marking the fresh latex. After the latex has hardened, test the surface again as specified in Section 501.3(o). Resound the deck if directed.

When mechanical texturing is indicated, perform as specified in Section 1001.3(k)6.f. Do not begin grooving operations until directed, the latex has reached a compressive strength of 3,000 psi according to PTM No.604, the grooving equipment live loads can be applied as specified in Section 1042.3(g), and until the surface tolerance has been checked and high points are removed as specified in Section 501.3(o).

Provide adequate lighting, as indicated on the field operation QC Plan, for placement not completed in the daylight. Ensure lighting allows proper placement, testing, and inspection operations of the entire surface area and until curing covers are placed over the surface area.

(d) Curing and Protection. Begin curing as soon as the latex has been placed, finished, and textured, if applicable. Do not use membrane-forming or monomolecular curing compounds:

1. Curing Temperatures, Curing Days and Records of Temperature. Sections 1001.3(p)1 and as follows: Maintain cure temperatures of 45F or greater throughout the wet and dry cure period. Do not count as a curing day, a day on which the curing temperature drops below 45F. If the curing temperature falls below 35F during the curing period, the Department will consider the work unsatisfactory and it will be rejected. Protect the overlay using methods as specified in Section 1001.3(p)4 during cool weather and Section 1001.3(p)5 during cold weather.

2. Water Cure. Saturate curing covers before use and keep in a saturated condition for the curing period. Soak burlap for a minimum of 48 hours before placement. Re-wet burlap as needed before placement. Promptly cover the surface with a double layer of clean, wet burlap within 15 feet of strike-off from the finishing machine. Place burlap so each strip overlaps one-half its width. Minimal marking of the surface from curing covers is allowed. Maintain burlap in a fully wet condition using misting hoses, fogging machines that span the entire burlap covered surface, or other approved devices until the concrete has set sufficiently to support foot traffic. At that time, place soaker hoses on the burlap to maintain continuous saturation of burlap over the entire deck surface. At a minimum, place soaker hoses at grade breaks and high sides of superelevations to ensure continuous saturation. Secure burlap to prevent lifting or displacement due to adjacent construction operations or wind. Cure the surface according to Table A.

3. Dry Cure. After water curing, remove the curing covers and dry cure for an additional period according to Table A. Maintain the surface of the overlay in a dry condition for the entire dry cure period. Cover the surface with waterproof coverings as required. If the overlay surface becomes wet during the dry period, extend the dry cure period to the equivalent time that the overlay surface was wet.

TABLE A
Curing Times and Application of Live Load

Overlay Type	Depth	Water Cure (hours)	Dry Cure (hours)	Live Load Application Total Cure Time MIN (hours)	Live Load Application Comp. Strength MIN (psi)
LMM or LMC	≤ 2 inches	48	72	120	3,000
	> 2 inches	48	96	144	3,000
Accelerated LMC, 3 Hour	All	3	None	3	3,000
Accelerated LMC, 12 Hour	All	12	None	12	3,000

(e) Limitations of Operations. Place the latex during periods where the ambient and substrate deck temperatures are between 45F and 85F. At ambient temperatures above 80F, conduct the overlay placement at night or early morning hours. If the ambient temperature is expected to reach 80F 24 hours before the overlay placement, take steps necessary, but not limited to the following to mitigate the mix component temperatures that are acceptable to the Representative:

- cover the latex admixture tanker and cement tanker with wet burlap or station the latex admixture tanker and cement tanker in shaded areas;
- condition aggregates with cool water, cover with light-colored tarps and/or stockpile in shaded areas;
- charge the water tank on the mobile mixer with cool water as close to the time of placement as possible, or condition with ice;
- park mobile mixes in shaded areas or cover with wet burlap before the placement.

Place latex at a plastic latex mixture temperature between 50F and 85F. Stop the placement if the Representative determines that a satisfactory surface finish is not being achieved.

Install a bulkhead in case of a major delay in the placement operation resulting in the formation of a surface film.

During minor delays, protect the placement from drying with several layers of wet burlap.

Take adequate precautions to protect freshly placed latex from rain. Stop placement operations when it starts to rain. The Representative may order removal of latex damaged by rainfall.

Do not place latex when the evaporation rate exceeds 0.06 pound per square foot per hour according to ACI 305R, Figure 2.1.5. Wind breaks, sunshades, or fogging may be used to reduce evaporation to below the maximum allowable rate.

Discontinue placement when the Representative determines that flash set of the latex does not provide a suitable placement or finish. Submit redesign and corrective action plan as directed.

(f) Testing and Acceptance.

1. Concrete Field Testing Technician. Section 704.1(d)2.a

2. Testing Facilities and Equipment. Section 704.1(d)3

3. QC and Acceptance Testing.

3.a QC Sampling and Testing of Plastic Latex. Perform testing according to the accepted QC Plan. Furnish a copy of the QC Plan to be maintained in the Department's field office.

Test each 5 cubic yards of latex for plastic air content, temperature, and slump. Continue testing the load until control is established. Do not wait for the completion of the initial test before collecting subsequent samples. Perform slump tests as specified in Section 1042.2(f) and air content tests according to AASHTO T 152. Notify the Inspector when sampling and QC testing are to be performed. The Inspector will witness the sampling and QC testing. Report test results to the Inspector promptly. Coordinate and facilitate changes as needed in a timely manner.

Do not incorporate latex into the work that does not conform to specification requirements. Immediately separate and remove nonconforming material from the deck surface.

3.b Acceptance Testing. Latex will be accepted on a lot-by-lot basis. Test for plastic air content according to AASHTO T 152; temperature; and compressive strength according to PTM No. 611 and PTM No. 604. Each lot will consist of 20 cubic yards or a day's placement, whichever is less.

The Inspector will select acceptance samples (n=1) according to PTM No. 1. Obtain samples of fresh latex at the point of placement under the direction and supervision of the Inspector and according to PTM No. 601. Acceptance testing of plastic concrete will be performed at a site near the point of placement, as selected by the Inspector. Latex will be tested for yield as directed. Latex not conforming to specification requirements at the point of placement will be rejected.

If the results of testing the plastic latex conform to specification requirements, mold a sufficient number of acceptance cylinders for 5-day compressive strength tests. Compressive strength cylinder molds of 4-inch diameter by 8-inch height may be substituted for cylinder molds of 6-inch diameter by 12-inch height. Perform compressive testing according to PTM No. 604. The Inspector will identify the cylinders as acceptance cylinders. Field cure cylinders as specified in Section 1042.2(f). The compressive strength of the sample will be determined as the average of the compressive strength of two individual cylinders. The lot will be accepted when the 5-day compressive strength meets or exceeds 3,000 pounds per square inch.

3.c Bond Tests.

3.c.1 Scarified Surfaces (no hydrodemolition). When the indicated surface preparation includes scarification without hydrodemolition, perform a vertical pull bond test according to ASTM C1583 between 24 hours and 72 hours after curing is complete and the latex has attained a minimum compressive strength of 3,000 psi. Perform a minimum of one vertical pull bond test on each span or day’s placement, whichever is smaller, at a location or locations as designated. If multiple tests are taken in a span, the test result is the average of the tests for that span. The required minimum bond strength between the latex overlay and substrate is 250 psi. If the initial vertical pull bond test results do not meet the minimum requirement of 250 psi, perform up to three additional vertical pull bond tests per span where the minimum requirement of 250 psi was not met. After additional testing, if the average of the test results for a span do not meet the minimum requirement of 250 psi, the bond between the substrate and latex overlay in each span not meeting this requirement is considered defective work, and the latex overlay must be removed and replaced at no additional cost to the Department. Repair bond test locations with nonshrink grout, as specified in

1001.2(d).

3.c.2 Hydrodemolitioned Surfaces. When the indicated surface preparation includes hydrodemolition and the overlay exhibits cracking or surface tears and potential debonding, perform bond tests as specified in Section 1042.3(f)3.c.1 as directed.

(g) Application of Live Loads. After latex placement, do not allow heavy equipment or vehicular traffic on the latex surface until the end of the period according to Table A, and until the latex has achieved the minimum strength specified in Section 1042.3(d), Table A.

(h) Defective Work. Sections 105.12 and 1001.3(u), and as follows:

When latex overlays exhibit cracking or surface tears, perform an investigation with the Representative to determine the type of cracking, source of cracking, and extent of cracking. Measure the width, depth, and length of each crack and establish the locations of the ends of each crack with respect to permanent reference points. Coring may be necessary if crack depths cannot be accurately determined using a mechanical probe. If coring is required, obtain two cores at each location, submit one core to an independent laboratory for analysis of the cracks and submit one core to the Representative for analysis of the cracks at the LTS.

If the investigation indicates the type of cracking to be nonstructural cracks (plastic shrinkage, drying shrinkage, temperature related, or surface tears caused by finishing and texturing) that are evidence of defects in materials or workmanship, repair surface cracks and tears greater than 1/4 inch depth and between 0.007 inch and 0.016 inch width at no additional cost to the Department. Use a high molecular weight methacrylate penetrating crack sealer, a low viscosity epoxy resin, or other suitable material to repair the surface cracks and tears.

Submit for review, a detailed Quality Control and Action Plan that includes, at a minimum, the proposed crack sealing material data sheet from the manufacture and conditions for use, including ambient and substrate temperature and moisture conditions. Do not perform crack sealing before the Quality Control and Action Plan has been reviewed by the Representative.

Keep cracks clean, covered, and dry until the crack sealing operation is performed to the satisfaction of the Representative.

Unless directed in writing by the District Executive, remove and replace wearing surface deficient in surface tolerance as specified in Section 501.3(o); defective in air content as specified in Section 1042.2(f); defective in compressive strength as specified in Section 1042.3(f)3.b; failing to bond to the substrate; bonded to unsound concrete; exhibiting nonstructural cracks or tears greater than 1/4 inch depth and greater than 0.016 inch width; or showing surface defects resulting from the effects of rain, improper finish, improper cure, or honeycombing, which, in the Representative's opinion, cannot be repaired.

1042.4 MEASUREMENT AND PAYMENT—

(a) Latex Modified Mortar or Concrete Wearing Surface. Square Yard

As indicated, for the type specified, for the item indicated.

Survey prior to surface preparation and bond tests are incidental to this item.

The Department will pay for grade adjustments of expansion dams and scuppers, scarification, and hydrodemolition separately.

When hydrodemolition is not indicated, the Department will pay for bridge deck repairs separately under the respective type of concrete bridge deck repair items.

When hydrodemolition is indicated, the Department will pay for Type 3 deck repairs and Type 2 deck repairs exceeding 4 inches placed and cured before the overlay placement.

(b) Latex Modified Mortar or Concrete, Variable Depth. Cubic Yard

The limits of payment are the peaks of the roughened deck surface elevation to the bottom of the Latex Modified Concrete Wearing Surface.

For material costs only for furnishing latex modified mortar or concrete to the work site. Labor and equipment costs to place the material are incidental to the Latex Modified Concrete Wearing Surface work.

SECTION 1043—SHOTCRETE

1043.1 DESCRIPTION—This work is the production, application, and construction of pneumatically applied shotcrete according to ACI 506. Shotcrete may be produced by either dry-mix or a wet-mix process.

1043.2 MATERIAL—

(a) Shotcrete.

1. Cement. Section 701

2. Supplementary Cementitious Materials. Section 724.4. Use a quantity of silica fume from 5% to 10%, by weight of the total cementitious material. For pre-packaged dry mix shotcrete, use silica fume that is pre-blended by the manufacturer.

3. Water. Section 720.1

4. Aggregates. Type A, Section 703. For shotcrete mix designs using potentially reactive aggregate, evaluate aggregate for reactivity and if using aggregates that are deemed potentially reactive use according to Section 704.1(g). Conform to the composite gradation envelope in Table A. Other gradations according to ACI 506, Table 2.1 may be approved by the Representative.

TABLE A
Aggregate Gradation

Sieve Size	Total Percent Passing
1/2-inch	100
3/8-inch	90 - 100
No. 4	70 - 85
No. 8	50 - 70
No. 16	35 - 55
No. 30	20 - 35
No. 50	8 - 20
No. 100	2 - 10

5. Admixtures. Section 711.3.
Use a migrating corrosion inhibitor according to AASHTO M 194, from a manufacturer listed in Bulletin 15. Provide a dosage according to the manufacturer's recommendations.

6. Fibers. ASTM C 1116, Type II or III. Provide a minimum dosage of 1.5 pounds per cubic yard. Use fibers that are a minimum of 1/2-inch length, monofilament or collated-fibrillated microfibers.

7. Mix Design Performance Requirements. Proportion shotcrete to meet the mix design requirements in Table B.

TABLE B
Shotcrete Mix Design Requirements

Test Description	Test Method	Age (Days)	Specified Requirements
Maximum Water/Cementitious Materials Ratio	-	-	0.40
Air Content - As Shot (%)*	AASHTO T 152	-	4 ± 1.5
Slump at Discharge into Pump (inches)	AASHTO T 119	-	3 1/2 ± 1 1/2

Minimum Compressive Strength (psi)	PTM No. 611	7 28	3,600 4,500

*compensate for air entrainment loss during shooting according to ACI 506

8. Design Basis. Section 704.1(c) and ACI 506. Aggregate and cement may be batched by weight or volume according to AASHTO M 157 or AASHTO M 241. For pre-packaged dry-mixes, provide mixes according to ASTM C 1480, and from a manufacturer listed in Bulletin 15.

(b) Reinforcement. Section 709, as indicated. Use annealed iron wire ASTM A 684 for fastening.

(c) Burlap. Section 711.1(d).

(d) Liquid Membrane-Forming Curing Compound, Clear or White. Section 711.2(a).

(e) Wedge Expansion Anchors. As indicated, from a manufacturer listed in Bulletin 15.

1043.3 CONSTRUCTION—

(a) General. Apply shotcrete according to ACI 506 and ACI CP-60.

Assign a shotcrete crew supervisor that has at least 5 years experience in shotcrete repair work on projects of similar size and character. Provide nozzlemen who are certified by the ACI for application of the proposed shotcrete process for both vertical and overhead surface and who have successfully completed three projects, of similar size and character.

Submit written documentation to the Structure Control Engineer at least 10 working days before start of shotcrete work, which provides the following:

- Proof of experience for shotcrete crew supervisor and nozzlemen. Submit three references for crew supervisor and nozzlemen from persons who were responsible for supervision of these projects.
- Mix designs and test records, showing all material sources and indicating conformance to project specifications for all shotcrete materials.
- Details of proposed forming, bracing, falsework, or temporary support systems.
- A field QC plan

Provide in the field QC plan at a minimum, the following:

- A list of the proposed shotcreting equipment, including water supply pumps, valves and mixing equipment. Provide brand name, model and capacity of proposed pump or gun and air compressor.
- Details of proposed means of preparing existing concrete substrate in areas to receive shotcrete.
- Details of proposed means of controlling line, grade, and reinforcement cover.
- Details of proposed methods for control and disposal of waste materials, including demolition slurries, blasting grits, concrete debris, waste shotcrete, rebound, and overspray.
- Details of the proposed curing procedures

Do not start shotcreting work until the Structure Control Engineer has reviewed and approved all submittals.

(b) Preparation of Structure. Thoroughly clean the surfaces and voids of rust, scale, grease, loose and disintegrated particles, and material that might impair the bond between the surfaces to be covered and the shotcrete mixture. Remove unsound concrete and mortar, as directed. After removal of unsound material, clean sound surface.

Clean existing reinforcement to SSPC-SP6 cleaning standards. Saturate the prepared concrete substrate with clean water the day before shotcrete application. Bring wetted surfaces to a saturated surface dry (SSD) condition before application of shotcrete. Do not apply shotcrete to a dry surface, or to a surface with free surface water.

(c) Placing Reinforcement. Provide reinforcement, including wire fabric meeting the general and storage requirements of Sections 1002.3(a) and 1002.3(b). Lap adjacent sheets of wire fabric a minimum length of 4 inches for 2-inch mesh and a minimum length of 6 inches for 3-inch mesh. Fasten wire fabric together with wire ties at intervals of not more than 18 inches.

1. Steel Surfaces. Section 1017.3(b)1 or as indicated.

2. Concrete and Masonry Surfaces. In areas of buildup for the replacement of unsound material, unless otherwise indicated or directed, place a layer of wire fabric for each 3-inch layer of shotcrete or fraction thereof. More than one layer of fabric may be attached to an expansion anchor, provided the anchor is long enough.

Hold the wire fabric in place by means of wedge expansion anchors, either 1/4 inch diameter by 3 to 3 1/4 inches in length, or 3/8 inch diameter by 3 3/4 to 4 inches in length. Use longer 3/8-inch diameter anchors where necessary, unless otherwise indicated. Space 1/4 inch diameter anchors approximately 20 inches center-to-center in each direction, starting 3 inches from the outside edges of the areas to be shotcreted. Space 3/8-inch diameter anchors approximately 30 inches center-to-center in each direction, starting 6 inches from the outside edges of the areas to be shotcreted. Fasten the fabric to the wedge expansion anchors away from the prepared surface, with 1 inch clear below the finished surface of the repair.

Where existing reinforcement is exposed due to removal of deteriorated concrete, wire fabric may be tied to this reinforcement at 18-inch intervals, to form a cage to position and support the fabric within 1 inch of the finished surface of repair.

Avoid excessive wire fabric layers, which may create planes of weakness or internal stresses.

(d) Weather Restrictions.

1. Cold Weather. Unless otherwise allowed in writing, discontinue shotcreting operations when the descending air temperature, away from artificial heat, falls to 40F or less. Do not resume operations until the air temperature, away from artificial heat, rises above 40F.

For mix proportioning in cold weather, do not let water with a temperature above 90F come in direct contact with the cement, until the cement has been mixed with the aggregates. Place shotcrete when the mix temperature is between 50F and 100F. Do not use materials containing frost, lumps, or crusts of hardened materials. Do not place shotcrete on surfaces which are less than 40F.

2. Hot Weather. When the air temperature in the immediate vicinity of operation rises to 90F or above, take thermometer readings of the plastic concrete at 1/2-hour intervals and at the conclusion of the mixing cycles. Discontinue shotcrete operations if the plastic concrete temperature exceeds 90F for wet mix or 100F for dry mix. Lower the temperature of reinforcement and receiving surfaces below 100F before shooting.

3. Protection from Elements. Protect all shotcrete applications and completed surfaces from damage due to environmental conditions such as wind and rain.

(e) Batching and Supply.

1. Wet-Mix Shotcrete. Mix pre-packaged dry mix materials with water added at site according to Section 704.3. For plant or truck mixed material, produce according to Section 704.2.

Apply all shotcrete within 90 minutes after addition of mix water to the batch. Do not use shotcrete that has exceeded 45 minutes without agitation. Utilize shotcrete delivery equipment capable of delivering a steady stream of uniformly mixed material to the discharge nozzle at the proper velocity and rate of discharge.

2. Dry-Mix Shotcrete. Mix dry material with equipment as specified in ACI 506. Apply all dry-mix shotcrete within 45 minutes of the first contact of cement with water. Discard aged materials and do not apply them in the work.

Provide shotcrete delivery equipment capable of delivering an uninterrupted flow of pre-dampened material to the discharge nozzle at sufficient velocity. Use a rotary gun or pressure vessel with pre-dampening equipment.

(f) Pre-construction Trial. Perform a pre-construction trial to evaluate the ability of the proposed materials, shotcrete mixture, equipment, and crew to produce shotcrete conforming to the project specifications. Acceptance of the pre-construction trial results is required before application of any shotcrete on the project.

Perform the pre-construction trial with the certified nozzlemen proposed for use on the project. Nozzlemen who have not been pre-qualified may not apply shotcrete on the project. Use the same materials, shotcrete mixture and equipment proposed for use on the project and approximate working conditions, reinforcement and shooting positions (vertical and overhead).

Obtain 5 cores from each mock-up at locations selected by the Representative. At least two of the cores must contain reinforcement when the work represented by the panels contains reinforcement. The Representative will visually examine the cores for defects. If defects are evident, the Representative will grade the cores according to the requirements of ACI 506. A test mock-up with any single core grade exceeding Core Grade 3 or with more than two of the 5 cores having a Core Grade 3 will be considered a failure.

In addition to the mock-up, pre-qualify the shotcrete mixture by shooting a plain (non-reinforced) test panel, minimum 24 inches x 24 inches, according to ASTM C 1140. Perform compressive strength testing on 3 cores from the test panel, according to PTM No. 606. Mixture will be approved for application on the project if all 3 cores meet the 7 day minimum compressive strength of 3,600 pounds per square inch.

If the pre-construction test specimens fail to meet the project performance requirements, make the necessary adjustments in shotcrete materials, mixture design, or application, and re-shoot test panels. Do not start shotcrete work on the project until the pre-construction performance testing requirements have been met.

(g) Construction Testing. Shoot one construction test panel (Minimum 24 inches x 24 inches) per lot. Establish new lots daily. A lot is each 25 cubic yards of shotcrete production, or portion thereof. Shoot the test panel in the same position as the work being done.

Produce, store, handle, and field cure construction lot test panels in the same manner as the permanent work. Extract 3 cores from each test panel according to ASTM C 1140 for compressive strength testing. Perform 28 day acceptance testing on the extracted cores according to ASTM C 1140 and PTM No. 606. Acceptance of the lot represented will be based on the compressive strength testing of the 28 day acceptance cores. If the results of the average, (N=3) fails to meet a minimum 28 day compressive strength of 4,500 pounds per square inch, adjustments to payment will be made according to Section 110.10(d) using the minimum compressive strength requirements of Class AAA concrete.

(h) Shotcrete Application. All areas prepared for shotcrete application are to be reviewed and approved by the Representative before the application of any shotcrete.

For restoration and repair work, finish shotcrete to match existing surfaces. For finishing on bridge piers, caps, soffit, and abutments, trim shotcrete with a cutting rod or other suitable device to the specified line and grade.

Unless otherwise specified, finish shotcrete to a sandy texture as approved by the Representative using a rubber float or other suitable finishing tools. Tolerance of finished surface must not exceed 1/4-inch under a 10-foot straightedge in any direction. Abrupt surface irregularities must not exceed 1/8-inch.

Continuously remove accumulations of rebound and overspray using blowpipe, or other suitable devices in advance of deposition of new shotcrete. Protect all fixtures and adjacent concrete surfaces from build-up of rebound, overspray and shotcrete trimmings. Remove all such materials on a daily basis.

Construct construction joints to a 45 degree tapered edge. Cut plastic shotcrete with a trowel or other suitable tool to form a construction joint. Do not featheredge construction joints.

For large applications requiring multiple layers, remove curing compound on previously placed shotcrete surfaces by sandblasting. Install approved depth gauges to indicate the thickness of the shotcrete layers. Install depth gauges on 6-foot centers longitudinally and transversely with no less than two gauges per increment of surface area to receive shotcrete. Moisten all surfaces.

(i) Curing. Section 1001.3(p)3.b and as follows: On completion of finishing, water cure using double thickness burlap and/or fogging for 7 days. Keep shotcrete and burlap fully saturated during the entire curing period. Assure 100% contact between the burlap application and shotcrete material.

As an alternate, two applications of liquid membrane-forming curing compounds may be used only when water curing is not feasible, and approved by the Representative.

(j) Hot and Cold Weather Protection. Section 1001.3(p), and as follows: Maintain the air temperature of the shotcrete surfaces at 50F or greater for the first 4 days after application of shotcrete and above 40F for the last 3 days of the curing period. Do not count a day on which the minimum curing temperatures are not maintained as a curing day. Do not utilize cold weather curing until the Representative reviews the proposed means of maintaining the curing

temperature. Do not use unvented heaters that may cause carbonation. If at any time during the curing period, the curing temperature falls below 35F, the Department will consider the work unsatisfactory and will reject it.

(k) Shotcrete Acceptance and Repair. Shotcrete, not conforming to specifications, will be rejected.

Deficiencies during the shotcrete application process, such as, but not limited to the following, constitute a cause for shotcrete rejection:

- Failure to properly control and remove build-up of overspray and rebound
- Incomplete consolidation of shotcrete around reinforcing steel
- Incorporation of sand lenses, excessive voids, delaminations, sags or sloughing
- Failure to apply shotcrete to the required line, grade and tolerance

Perform remedial work to correct deficiencies while shotcrete is still plastic.

The hardened shotcrete will be examined by the Representative for any evidence of excessive plastic or drying shrinkage cracking, tears, featheredging, sloughs, or other deficiencies. The Representative will sound the material to check for delaminations. If delaminations are discovered during sounding, or if directed by the Representative, conduct bond pull-off tests according to ASTM C 900 at locations and a frequency selected by the Representative. The average of a set of three bond pull-off strengths must exceed 145 pounds per square inch, with no individual result less than 100 pounds per square inch. If the bond pull-off strength results fail to meet the specified requirement, the work will be rejected.

When test results or the assessment of plastic or hardened shotcrete indicate deficiencies or non-conformance to the specifications, the Representative will implement a program to evaluate the in-place shotcrete. Provide all labor, materials and equipment necessary to perform the evaluation at no cost to the Department. Correct deficiencies to the satisfaction of the Representative.

Remove and replace deficient or non-conforming shotcrete at no cost to the Department.

1043.4 MEASUREMENT AND PAYMENT—Square Foot

SECTION 1044—AESTHETIC COATING FOR CONCRETE SURFACES

1044.1 DESCRIPTION—This work is the cleaning and coating of new concrete surfaces with a coating system for aesthetic purposes only. Do not use this specification if protective performance is required against chlorides, water infiltration and/or concrete and rebar corrosion. A coating system may be paint, stain, or penetrating stain.

1044.2 MATERIAL—

(a) Coating System for Concrete. Use an approved coating system, as indicated on the contract documents, and from a manufacturer listed in Bulletin 15. Do not mix components or coats from different systems. Use the products of one manufacturer for the entire system.

1. Manufacturer's Recommendations. Submit comprehensive recommendations that include, but are not limited to surface preparation, surface preparation method(s), coating application method(s), and application conditions. Include the recommended method(s) for correction of damage to one or more coats, including correction of damage caused during handling, shipping, and erection; correction of deficient or excessive coating thickness: correction of runs, sags, peeling, and poorly adhered coating; and removal of contaminants that would be detrimental to succeeding coats.

(**b) Submittal Requirements.** Submit the following information to the District Executive a minimum of 21 calendar days before beginning the coating. Begin coating after the District Executive accepts the submittals. Include the following:

1. Coating Properties.

- Infrared curves, in microns, for each component of each coat and for mixed coat(s);
- Weight per gallon, at 75F, for each component of each coat;
- Viscosity in Krebs Units, at 77F, for each component of each coat; and
- Percent solids by weight of each component of each coat.

2. Coating Sample. Provide samples of each lot or batch of coating in quart containers.

3. Finished Coat Color Chip. Provide color chips of the indicated color.

4. Manufacturer's Technical Data Sheets. Provide technical data sheets, VOC, value with product test data, Safety Data Sheets (SDS), and specific application instructions for all coats. In the event of a conflict between the data/instruction sheets and this Specification, the Chief Structural Materials Engineer will determine the governing specification. Do not proceed with work until this information is received.

5. QC Plan. Submit a QC Plan. Include written procedures for review and acceptance of surface preparation, cleaning, and the application methods; including the inspection hold points.

6. Damage Prevention, Repair, and Application Procedures. Furnish a damage prevention plan that describes the procedures and protective material to use to prevent damage to coated items, method to remove coating from surfaces not designated for coating and method to clean-up a major spillage.

1044.3 CONSTRUCTION—

(a) General.

1. Protection of Structure, Persons, and Property. Conduct all work in compliance with applicable

occupational and environmental health and safety rules and regulations. When applying or repairing coating damage, protect pedestrians, vehicles, and other traffic, upon or under the structure; and surrounding property surfaces, buildings, and grounds. Protect against damage or disfigurement from surface preparation media and spatters, splashes, overspray, and smirches of coating or material. As necessary, furnish adequate canvas or other suitable containments materials, for protection.

Remove coating dropped on surfaces not designated for coating. Remove debris from cleaning operations, empty coating containers, and other refuse.

Use scaffolding and rigging conforming to OSHA regulations and providing safe and ready access to work areas for inspection purposes.

2. Form Oils, Release Agents, and Curing Compounds. Ensure compatibility with coating manufacturer.

3. Pollution Controls. Prevent environmental pollution including stream and air pollution caused by coating (spray and/or chips), dust, or other harmful materials.

Provide documentation to ensure all work be in conformance with Pennsylvania Code-Title 25 Environmental Protection Chapters 121-145 "Air Resources". Comply with County and local ordinances before the start of work.

All DEP permits and notifications, for fieldwork, are required before any in-stream work that may be necessary.

Adhere to all Special Provisions as required.

4. Coating Certifications. Provide a dated certification Form CS-4171 from the manufacturer stating that each batch of the coating system meets specifications. Include in the certification the product name for each coat of the supplied system and the production lot number of the certified batch.

5. Technical Representation. Furnish the services of a Technical Coatings Representative (Technical Representative) from the coatings manufacturer at the beginning of operations and when required by the Department.

(b) Test Panel. Before proceeding with production coating operations and the pre-application meeting, prepare a 2 foot by 2 foot test panel that is representative of the concrete surface with the specified coating material(s). Prepare the panel using the same cleaning, surface preparation, and application techniques that will be utilized during production. Submit the test panel to the Representative for initial color acceptance.

(c) Pre-Application Meeting. Before proceeding with production coating operations conduct a pre-application meeting with the Structural Materials Engineer, the Representative, and/or any other applicable representatives.

Determine, during this meeting, the maximum repair limits for repairing unsatisfactory coating as specified in Section 1044.3(e)10.

Provide a full size mock-up sample for review and acceptance, unless otherwise directed.

(d) Surface Preparation

1. Concrete Surface Condition. Remove/repair all laitance, efflorescence, bug holes, voids, and other surface conditions before and after surface preparation according to coating manufacturer's recommendations. Recondition repair areas before coating.

1.b. Potential Surface Contamination. When directed based on age and condition of surface, perform pH testing prior to surface preparation according to section 5.2 of ASTM F710. Remove contamination to levels recommended by the coating manufacturer. Perform another pH test after removal to verify manufacturer's cleaning method achieved the recommended level.

2. Cleaning. Where oil, grease, mildew, lubricants, petroleum products, efflorescence, drawing compounds, form oil, and other contaminants are present, remove according to manufacturer's recommendations. If the coating manufacturer recommends water jetting, perform work according to SSPC SP WJ 1, WJ 2, WJ 3, or WJ 4. Perform cleaning before surface preparation. If contamination remains after surface preparations, clean the surface again as recommended by the coating manufacturer. Perform water bead test according to ASTM F22, as directed by the Representative, to verify contaminant removal.

2.a Other Cleaning. Remove soil, concrete spatter, or other foreign matter by brushing with stiff fiber or wire brush, by scraping or by cleaning according to the coating manufacturer's recommendations.

3. Surface Preparation. Prepare surfaces per ASTM D4258, using the method of surface preparation recommended by the manufacturer. Prepare surface to provide an anchor pattern to meet minimum adhesion requirements according to Section 1044.3(e)9.a. Determine the anchor pattern depth by using International Concrete Repair Institute (ICRI) comparator plates according to Technical Guideline No. 310.2-1997 (formerly No. 03732).

(e) Coating

1. Surface Cleanliness and Age. Immediately before coating ensure all concrete surfaces are free of dust, dirt, grease, oil moisture, overspray, and other contaminants. All concrete must cure a minimum of 28 days before coating.

2. Handling. Deliver all coating and thinner in original unopened containers with the manufacturer's labels intact. The Representative may accept containers with minor damage, if containers are not punctured.

3. Storage. Store coating and thinner according to manufacturer's recommendations. Store coating and thinner in well-ventilated areas not subjected to temperatures in excess of the manufacturer's maximum storage temperature. If necessary, store in heated storage areas to maintain material temperature at or above the manufacturer's minimum storage temperature, listed on the product data sheet.

4. Mixing Coatings.

4.a. Primer. Mix the primer with a high shear mixer (such as a jiffy mixer), according to manufacturer's recommendations to a smooth, lump free consistency. Do not use paddle mixers or paint shakers. Mix in the original containers. Ensure that all of the coating solids that might have settled to the bottom of the container are thoroughly dispersed.

4.b. Subsequent Coats. Mix each subsequent coat, according to manufacturer's recommendations, to achieve and maintain a homogeneous mixture.

5. Thinning Coating. Thin coating only as recommended by the manufacturer. Do not thin once coating application has begun.

6. Conditions for Coating. Apply coating only on clean dry surfaces. Test for the presence of moisture using the plastic sheet method according to ASTM D4263 or by using electronic moisture meters according to ASTM F2170. Moisture acceptance criteria will be based on manufacturer's recommendations and as approved by the Representative. Do not apply coating when the temperature of the air, coating, or concrete is above or below that described in the technical data sheet; if not specified in the technical data sheet do not exceed 100F or go below 35F. Do not apply coatings when the air is misty or when conditions are otherwise unsatisfactory. Do not apply coating when relative humidity is above that described in the technical data sheet. Do not apply coating on damp or frosted surfaces or surfaces hot enough to cause the coating to blister, to produce a porous coating film, or to cause the vehicle to separate from the pigment. Apply coating only when the surface temperature is at least 5F above the dew point. Determine the dew point with the use of a psychrometer and psychometric tables or electronic psychrometer. Check environmental conditions before coating operations begin and at 4-hour intervals. If the dew point begins to rise and comes within 10F of the surface temperature, check environmental conditions every 15 minutes.

7. Application. Perform application after inspection acceptance of the surface. Apply coating within 12 hours of final moisture content and surface profile/cleaning acceptance. If the coating application does not occur within 12 hours of final moisture content acceptance or the surface temperature of the concrete falls below the dew point temperature, recheck the moisture content of the concrete surface.

When the approved system contains a primer, apply according to manufacturer's recommendations.

Apply the coating after fabrication, inspection, acceptance, and once the concrete has had a chance to cure according to the coating manufacturer's recommendations, but not less than 28 days.

Protect concrete surface from direct sunlight during coating application and curing, if required, to prevent exceeding manufacturer's temperature limits for air or concrete.

Verify that each coat has cured before applying the succeeding coat. Follow the manufacturer's recommendations for time to topcoat, unless a longer curing time is required.

In damp or cold weather, keep the shop work under cover until thoroughly dry or until weather conditions allow exposure.

For shop applied coatings, allow the coating to cure completely before loading and shipping.

Apply finish coats from the same lot number or batch number when possible.

7.a. Spray Application. If conventional (air) spray is used, provide suitable traps or separators to exclude oil and water from the air. Conduct blotter test(s) according to ASTM D4285 before coating application begins. Keep the coating thoroughly mixed by continuous mechanical agitations, when required by the manufacturer.

7.b. Roller Application. Use rollers that do not leave a stripped texture in the coating film. Use rollers only on flat, even surfaces to produce a coating film of uniform thickness with no skips, runs, sags, or thin areas.

7.c. Brush Application. Only use brushes if recommended by coating manufacturer. Manipulate the coating under the brush to produce a uniform thickness. Work the coating into corners and crevices. Move the brush in a series of small circles to thoroughly fill irregularities in the surface, then brush out and smooth by a series of parallel strokes until the coating film has an even thickness.

7.d. Coating Areas Not Readily Accessible. Thoroughly cover surfaces inaccessible to normal coating method by use of sheepskin daubers, spray, or other means to ensure thorough coverage.

8. Thickness of Coats. Apply coating to achieve the Dry Film Thickness (DFT), above the anchor pattern, according to manufacturer's recommendations. Verify coating thickness using coverage rate calculations and Wet Film Thickness (WFT) gauges. Perform WFT measurements every 300 square feet, or three per concrete sound panel.

When WFT measurements and/or coverage rate is not acceptable, perform nondestructive DFT measurements according to SSPC-PA 9; take and record a minimum of five spot measurements for each 108 square foot of coated surface area. Measure DFT using an ultrasonic thickness gage or other approved measuring device according to ASTM D6132. For multiple coat systems, perform DFT measurements after the application of each coat. Determine the DFT of subsequent coats by subtracting the average DFT of the underlying coat(s) from the cumulative readings. Increase the thickness of coating, if directed by the Representative, to ensure a finish that is uniform in color and appearance.

8.a. Primer (When Applicable). Apply primer to the DFT above the anchor pattern, according to the coating manufacturer's recommendations. A dense and uniform appearance is required after the applied coating has cured. For areas deficient in coating thickness, repair as recommended by the coating manufacturer.

8.b. Subsequent Coats (When Applicable). Apply subsequent coat(s), above the underlying coat(s) to achieve the DFT, according to the coating manufacturer's recommendations.

9. Inspection. Submit samples from each lot or batch of coating along with Form CS-4171 and Certificate of Analysis to the BOPD's LTS, when directed by the Representative. Provide unopened sample kits for testing, when unopened sample kits are not practical sampling will be done using ASTM D3925 as a guide.

9.a. Adhesion Acceptance Testing. Perform adhesion testing, on 10% of the coated items, according to Method A of ASTM D3359 when directed by the Representative. Adhesion ratings meeting condition 2A or better are acceptable. Perform adhesion test on formed or finished (flat) surfaces. Adhesion testing on textured surfaces is not required. Increase testing frequency, as directed by the Representative, if results are unacceptable.

9.b. Visual Acceptance Testing. Inspect 100% of coated surface for color consistency from a distance of 30 feet, unless otherwise specified. Determine color consistency by comparing an approved mock-up sample to each coated surface. Use the same color consistency for the mock-up as the approved test panel, as determined by the Representative.

10. Unsatisfactory Coating. Coating is unsatisfactory if:

- the coating lifts, blisters, wrinkles, or has excessive runs or sags,
- the adhesion is rated 1A or worse,
- evidence shows application was under unfavorable conditions,

- the workmanship is poor or impure,
- an unauthorized coating has been used,
- the Δ E color variation is 2.0 or more,
- the visual acceptance testing is unacceptable, or
- for other reasons determined by the Representative.

11. Repair of Unsatisfactory Coating. Repair each damaged coat according to manufacturer's recommendations for any repair. Submit repair procedures for approval by the Representative before starting repair application.

Remove unsatisfactory coating, clean surface, prepare surface, and recoat according to the manufacture's specifications. The Representative will approve the completed repair. Evaluate repaired areas at 30 feet for color acceptance.

12. Additional Stenciling for Coated Concrete. After the final coat has cured, stencil any required information to provide uniform block lettering using suitable contrasting paint.

13. Storage, Shipping, and Handling. Protect the coating from damage and staining. Use covering and proper storage, handling, shipping, and erection techniques. Install padding or other acceptable material on dunnage to protect coated surfaces from damage and staining.

Prior to shipping display in a manner, that will allow the Representative access to all sides of the coated items for inspection and acceptance.

1044.4 MEASUREMENT AND PAYMENT—Square Yard

Construction of the test panel and mock-up is incidental to this work.

SECTION 1046—EPOXY OVERLAY

1046.1 DESCRIPTION - This work is construction of a multiple layer wearing surface of epoxy and aggregate on in-service bridge decks.

1046.2 MATERIAL –

(a) Polymeric Resin Binder. Provide a thermosetting polymer resin compound comprised of 100% solids which holds the aggregate firmly in position once all components are combined. All components will come from a single manufacturer listed in Bulletin 15 and conform to Table A. Cure specimens at 73F ±2F, relative humidity 50% ± 2% and test specimens at 73F ±2F.

Table A
Binder Requirements

Property	Requirement	Test Method
Viscosity (poises)	10 – 70	ASTM D 2556-14, Model RVT Brookfield, Spindle No. 3 at 20 rpm
Gel Time (minutes)	15-45 minutes	ASTM C 881, para. 11.2 modified, 70 ml sample
Ultimate Tensile Strength (psi)	2,000-5,000 at 7 days	ASTM D 638
Ultimate Tensile Elongation (%)	30-70 at 7 days	ASTM D 638
Absorption (%)	1 max. at 24-hrs.	ASTM D 570
Compressive Strength (psi)	1,000 min. at 3 hours 5,000 min. at 24 hours	ASTM C 109, 50 mm square mortar cube with plastic inserts
Permeability to chloride ion (coulombs)	100 max. at 28-days	AASHTO T277
Thermal Compatibility (Mixed with aggregate)	No delamination	ASTM C884
Infrared spectrum	Established for each component by the Manufacturer	AASHTO T237, paragraph 4 and 5

(b) Fine Aggregate. Provide aggregate approved by the binder manufacturer. This aggregate consists of angular silica sand, basalt, or other highly siliceous metamorphic or igneous rock. Provide aggregate free of dirt, clay, asphalt, and other foreign or organic materials conforming to Table B.

Table B
Aggregate Requirements

Property	Requirement	Test Method
Moisture Percentage (%)	Less than 0.2	AASHTO T 255
Mohs Scale Hardness	7 min.	Mohs Hardness Test
Aggregate Gradation Requirements - Sieve Analysis		
Sieve Designation	**Total Percent Passing**	
(No. 4)	100	
(No. 8)	30-75	
(No. 16)	0-5	
(No. 30)	0-1	

(c) Certification: Certify binder resin as specified in Section 106.03(b)3.

For aggregate, provide independent testing from an AASHTO certified laboratory to verify the Table B requirements are met. Independent testing must be less than 12 months old at the time aggregate is furnished to the project. Submit the Independent testing results for local approval as specified in Section 106.02(a)2.c.

1046.3 CONSTRUCTION

(a) Qualification of the Installer. Submit a minimum of three projects including the installer's contact information having a cumulative minimum of 1,000 square yards of epoxy overlays placed within the past 3 years. Include contact information for the three projects. An installer not meeting the minimum requirements will be allowed to perform the installation operation if approved in writing by the binder manufacturer.

(b) Quality Control.

1.Quality Control (QC) Plan. As specified in Section 106.03(a)2.a, submit a project specific QC Plan for acceptance before material placement. Include key personnel, equipment, materials, proposed methods of installation and operation, and the following:

1.a Designated QC Plan Administrator. Provide a designated QC Plan Administrator having full authority to institute any action necessary for the successful operation of the QC Plan and is responsible for the following:

- Identify and provide contractor procedures for:
    - Documenting areas and quantities used of binder and aggregate of each layer at each epoxy overlay site to verify application rates conforming to Table C.
    - Documenting the temperature of each component of the binder before use.
    - Moisture control methods for the aggregate.
    - Cleaning and maintenance schedule for machinery and equipment.
    - Corrective actions for unsatisfactory construction practices and deviations from the specifications. Any deviation from the accepted QC Plan will be cause for immediate suspension of operations.
- Contractor performance of required field QC sampling, testing and record keeping in conformance with the approved QC Plan and contract documents.
- Maintain and make available upon request, complete records of sampling, testing, corrective actions, and QC inspection results.

1.b Manufacturer's Technical Representative. A manufacturer's technical representative responsible for the following:

- Train and provide recommendations to construction personnel in the safe handling and proper application of materials before placing the epoxy overlay.
- Required to be onsite for the first 2 days of installation if the installer does not meet the minimum requirements as specified in Section 1046.3(a).
- Required to be onsite if corrective work is necessary.

- Required to be onsite if directed.

2. Documentation. Provide the following documentation of the preparation and application of the overlay:

- Deck patching location(s)
- Surface preparation – surface profile level or depth, cleanliness, substrate pull off test locations and results
- Moisture test results
- Environmental conditions at the time of placement – include ambient air temperature, deck temperatures and weather conditions
- Product Data Sheets (PDS)
- Safety Data Sheets (SDS)
- Material information:
    - Resin – manufacturer, component expiration dates, proportioning method and rate, and yield computations for each layer
    - Aggregate – type of aggregate and yield computation as well as visual inspection of surface covering
- Final adhesion testing locations and results
- Document all repairs needed because of defective work

(c) Pre-Epoxy Overlay Placement Meeting. At least 2 weeks before overlay placement, schedule a pre-epoxy overlay placement meeting to review the specification, method and sequence of placement, quality control plan, and protective measures.

(d) Delivery and Storage of Materials. Order, stock, and store material necessary to perform overlay application before field preparation. Store materials in a clean, dry environment according to the manufacturer's recommendations. Do not expose the aggregate to rain or moisture. At the storage area, post SDS, PDS, and other information from the manufacturer pertaining to health hazards, worker protection, and safe practices for the storage, handling, and disposal of the materials.

Provide the manufacturer's name, date of manufacture, batch/lot number, trade name, quantity, and mixing ratio on each binder storage container. Provide producer name, date of shipment, batch/lot number, weight, and independent lab test reference number on containers with aggregate.

(e) Equipment. Equipment is subject to acceptance. Provide the following:

(1) Surface Preparation Equipment.

- Shotblasting equipment capable of removing all loose, disintegrated concrete, dirt, paint, oil, asphalt, laitance, carbonation, and curing materials from the deck surface.

- Sandblasting equipment capable of removing all oxidation, dirt, paint, oil, and asphalt from the metal expansion joints.

- Provide a self-propelled vacuum capable of picking up dust and other loose material from the shotblasting and sandblasting operation.

- Provide air compressors capable of producing a minimum of 180 cubic feet per minute and 80 pounds per square inch of clean, dry compressed air and equipped with an oil/water separator to remove dust and loose material.

- Do not use scarifiers, milling machines, or sandblasting instead of shot-blasting, unless approved by the Engineer.

(2) Mechanical Application Equipment.

- An epoxy distribution system capable of accurate and complete mixing of the epoxy resin and hardening agent, verification of the mix ratio, and uniform and accurate distribution of the epoxy materials at the specified rate on 100% of the work area. Provide equipment approved by the epoxy-based overlay manufacturer.
- A mechanical aggregate spreader capable of uniform and accurate application of the dry aggregate over 100% of the work area.
- Provide a self-propelled vacuum truck;
- An air compressor capable of producing oil free and moisture free compressed air to remove all dust and loose material.
- Hand tools to facilitate the placement of the surface treatment as specified in this specification and the manufacturer's recommendations.

(3) Hand Mixing and Manual Application. Hand mixing is not allowed unless accepted by the Representative.

- Provide calibrated containers for proper proportioning of the base and hardening components.
- Provide a clean, dry container large enough to blend and mix the proper proportions of base and hardening components.
- Provide a powered, paddle-type mixer for blending the base and hardening components.
- Provide squeegees, rollers, or brooms suitable for applying the mixed epoxy-based resin on the bridge deck surface at the specified application rate as specified in Table C.
- Provide shovels, hand spreaders, and other hand tools suitable for applying the aggregate at the specified rate.
- Provide brooms or air compressors equipped with an oil/water separator to remove excess aggregate after each layer of the overlay has cured.

(f) Surface Preparation. Sound the existing bridge deck surface to identify areas of unsound concrete in the presence of the Representative. Record locations of all areas determined to be unsound and provide documentation to the Representative. Remove unsound concrete and repair the areas as specified in Section 1040 and as directed. Do not use patching material containing magnesium phosphate. Do not apply epoxy overlay on concrete surfaces or repairs less than 28 days of age.

Perform pull tests to determine the suitability of the concrete surface according to ASTM C1583. Select locations to perform testing at a minimum of one location per span per lane or maximum of 4,000 square feet per lane, whichever is smaller. Include at least one test on newly repaired deck areas. The minimum acceptable bond strength on normal weight concrete cannot average less than 250 pounds per square inch.

No more than 24 hours before overlay placement begins, clean the bridge deck surface by shotblasting all surfaces to remove all curing compounds, loosely bonded mortar, surface carbonation, and deleterious material. Comply with the International Concrete Repair Institute (ICRI) standard for Concrete Surface Preparation (CSP) Level 5-7 or surface macrotexture depth of 0.04 to 0.08 inch according to PTM No. 751. Provide the necessary

concrete surface profile chips to visually verify the surface preparation. After shotblasting, vacuum sweep or air wash all surfaces to remove all dust, debris, and deleterious material.

In areas inaccessible by the shotblasting equipment (i.e., along curbs and median walls) use sandblasting or walk behind grinders or both to prepare the surface to the satisfaction of the manufacturer and Representative.

If cracks are present, remove loose material with compressed air and pre-treat cracks 1/4 inch or greater in width with the mixed binder. Do not overfill cracks. If cracks are overfilled shotblast or grind the material to make it flush with the adjacent pavement after the binder material is cured. Install the epoxy overlay after the binder in the pretreated cracks has gelled.

Construct the epoxy overlay so the final surface of the overlay is as shown on the standard drawings for expansion joints and dams. Shotblasting or concrete grinders may be used to create the proper profile. Prepare the concrete surface to provide a profile on both sides of the joint as specified in Section 501.3(o).

(g) Placing the epoxy overlay. If required, place a test strip of the overlay off the project site. Test strip should not exceed 100 square feet. Use the test strip for equipment calibration and establishing procedures and techniques for the actual overlay placement on the bridge deck.

Cover exposed areas not receiving overlay, such as curbs, sidewalks, railings, parapets, inlets, expansion dams, and along limits between adjacent lanes, if phasing application, or daily termination point with suitable coverings.

In phased construction, place joints between phases in neat lines parallel to the centerline of roadway. Stagger and overlap joints a minimum of 2 inches between successive layers so no ridges appear.

The deck surface must be dry before the application of the epoxy overlay. Do not place overlay if visible moisture is present on the concrete surface. Affix a sheet of transparent plastic to indicate the presence of moisture for a minimum of 2 hours depending on temperature, cloud cover, and conditions according to ASTM D4263 (modified to a minimum of 2 hours).

Use equipment to continuously mix, meter, and monitor the binder. If recommended by the binder manufacturer, use a heated metering pump. Mix the binder according to the manufacturer's recommendations.

Hand squeegee the mixed binder onto the prepared pavement surface using a serrated edge squeegee at uniform application rates as specified Table C.

Table C
Epoxy Overlay Application Rates

Course	Epoxy Rate	Aggregate Rate*
1	Not less than 0.22 gal./sq. yd	Not less than 10 lbs./sq. yd
2	Not less than 0.45 gal./sq. yd	Not less than 14.5 lbs./sq. yd

*Apply aggregate to completely cover the epoxy

Immediately after the binder application, mechanically spread the aggregate onto the wet, uncured binder at a uniform rate as specified in Table C. Do not allow loose aggregate or excessive dust onto any part of the adjacent, active travel lanes.

Hand spreading aggregate is allowed as a secondary method if mechanized equipment cannot be used due to access or geometry, as accepted.

Completely cover the wet, uncured binder with aggregate to achieve a uniform surface with no exposed binder remaining visible on the surface. Spread the aggregate without displacing the wet binder film during placement.

Remove excess aggregate from each course after the course has completely cured. Use brooms, vacuums, compressed air free from oil and water, or other approved methods to remove the excess aggregate. Do not remove excess aggregate until removal can be performed without tearing or damaging the surface.

Minimize walking or standing on the binder.

Locations identified by the Representative that did not receive a uniform and sufficient application of aggregate will be considered defective work. Remove and replace as specified in Section 1046.3(k).

Perform adhesion testing according to ASTM C1583 on the final layer. Test results will be the average of three tests on a test patch not less than 4.5 square feet. The minimum tensile adhesion strength cannot average less than 250 pounds per square inch. Perform a test patch at the same frequency as required for the initial pull tests conducted on the prepared concrete surface. Test each area at least 24 hours after the indicated minimum cure time for the second course.

If a failure occurs on an adhesion test, perform additional adhesion testing immediately before and immediately after the failed area. Continue testing until satisfactory test results are achieved. Remove and replace the failed area(s) at no additional cost to the Department.

(h) Curing. Do not allow vehicular traffic on the first course. Do not allow vehicular traffic on any course during the cure period.

Cure each course for the minimum cure period as specified in Table D unless longer periods are recommended by the manufacturer. Cure times are based on the average temperature of deck surface, resin, and aggregate components.

Table D
Curing Times

Course	60F- 64F	65F-69F	70F-74F	75F-79F	80F-84F	85 +F
1	4 hours	3 hours	2.5 hours	2 hours	1.5 hours	1 hour
2+	6.5 hours	5 hours	4 hours	3 hours	3 hours	3 hours

(i) Aggregate Cleanup. Collected aggregate can be reused if it is clean, uncontaminated, and dry. If contaminated aggregate is mixed with virgin aggregate, all the aggregate in the container will be considered contaminated and not acceptable for use in the epoxy overlay.

Between 30 and 45 days after placing the epoxy overlay, reclaim loose aggregate using a vacuum sweeper. Completely clean scuppers and expansion dams of accumulated aggregate. Use means of cleaning that does not damage neoprene glands in strip seal expansion dams. This reclaimed aggregate cannot be reused.

(j) Limitations of Operations. Follow the limits for all temperature and ambient conditions in the accepted QC plan and the manufacturer's requirements. Do not place epoxy overlays from October 1 to April 30, unless allowed in writing by the District Executive.

Do not apply the overlay at surface, air, or resin and aggregate component temperatures lower than 60 F. Do not apply the epoxy-based concrete overlay if the temperature is expected to drop below 55F within 8 hours after application or if the mixed epoxy-based resin gels in less than 10 minutes.

(k) Defective Work. Section 105.12 and as follows:

If temperatures fall below 60F, the Engineer will require a longer curing period. If, at any time during the curing period, the temperature falls below 50F, the work may be considered unsatisfactory and rejected.

Protect freshly applied overlays from sudden or unexpected rain. Stop all application operations if it starts to rain. The Representative may order removal and replacement of any material damaged by rainfall or contractor operations that cannot be satisfactorily repaired.

Remove the rejected or damaged epoxy-based concrete overlay in rectangular sections by milling or saw cutting to the top of the concrete deck surface. Remove and replace at no additional cost to the Department.

(l) Acceptance.

Table E
Acceptance and Payment Factor Per Each Individual Layer of Epoxy Overlay

Binder Rate	**Item Pay Factor (%)**
100% or more of the minimum binder rate	100% payment for the layer. *
> 80% and < 100% of minimum binder rate	60% payment for the layer. *
< 80% of minimum binder rate	remove and replace. *

*The payment for each layer will be independent.

1046.4 MEASUREMENT AND PAYMENT—Square Yard

Payment includes surface preparation, furnishing, applying all courses, and final cleaning.

Repairs to the bridge deck will be paid separately for type of concrete bridge deck repair as indicated.

SECTION 1050—STEEL BRIDGE SUPERSTRUCTURE

1050.1 DESCRIPTION—This work is the construction of a steel bridge superstructure and/or the furnishing and installation of fabricated structural steel for repair, rehabilitation, or modification of steel structures.

1050.2 MATERIAL—

(a) Deck and Barriers.

- Cement Concrete Structures—Section 1001.2
- Preformed Neoprene Compression Joint Seal—Section 1008.2
- Pedestrian Railing—Section 1012.2
- Aluminum Bridge Hand Railing—Section 1023.2
- Steel Bridge Hand Railing—Section 1022.2
- Protective Barrier—Section 1015.2
- Protective Fence—Section 1016.2
- Protective Coating for Reinforced Concrete Surfaces—Section 1019.2(a)
- Armored Preformed Neoprene Compression Dam—Section 1021.2
- Tooth Expansion Dam with Drain Trough—Section 1020.2
- Reinforcement Bars—Section 1002.2
- Neoprene Strip Seal Dam—Section 1026.2

(b) Fabricated Structural Steel. Section 1105

(c) Paint.

- Shop Painting—Section 1060.2
- Field Painting—Section 1070.2

(d) Neoprene Bearing Pads. Sections 1113.02 and 1113.03(g)

(e) High-Load Multi-Rotational Bearings. Section 1111

(f) Polymer Modified Mortar for Beam Seat Leveling. Section 1080.2(e)

1050.3 CONSTRUCTION—

(a) General. The superstructure consists of all indicated portions of the bridge above the bridge seat and includes bearings, bearings and anchors set in the substructure, abutment backwalls, cheekwalls, bridge drainage down to but not including the drain box, and portions of wings and appurtenances above the horizontal construction joint nearest the bridge seat. Do not ship fabricated materials without approved shop drawings marked “Accepted”. For fabricated

structural steel repairs, verify dimensions in the field before fabrication. Repair damage due to construction operations to portions of the structure to remain, at no additional cost to the Department.

(b) Superstructure. Construct the superstructure, as indicated, as shown on the Standard Drawings, and as follows:

- Fabricated Structural Steel—Section 1105
- Cement Concrete Structures—Section 1001.3
- Reinforcement Bars—Section 1002.3
- Preformed Neoprene Compression Joint Seal for Bridges—Section 1008.3
- Tooth Expansion Dam with Drain Trough—Section 1020.3
- Neoprene Strip Seal Dam—Section 1026.3
- Armored Preformed Neoprene Compression Dam—Section 1021.3
- Pedestrian Railing—Section 1012.3
- Aluminum Bridge Hand Railing—Section 1023.3
- Steel Bridge Hand Railing—Section 1022.3
- Protective Barrier—Section 1015.3
- Protective Fence—Section 1016.3
- Protective Coating for Reinforced Concrete Surfaces—Section 1019.3(a) or Section 1019.3(c)2 as indicated.

(c) Erection.

1. Handling and Storing Materials. Place material stored at the job site on skids. Keep it clean and properly drained. Place girders and beams upright and shore them. Support long members, such as columns and chords, on skids placed near enough together to prevent injury from deflection. If the contract is for erection only, check material turned over against the shipping lists and promptly report in writing any shortage or injury discovered. The Contractor is responsible for the loss of any material while in the Contractor's care, or for any damage caused to it after being received by the Contractor.

2. Falsework Design and Construction. Design and construct falsework according to AASHTO LRFD Bridge Construction Specification 11.2.2, 11.6.1, AASHTO Publications (Guide Design Specifications for Bridge Temporary Works and Construction Handbook for Bridge Temporary Works) and as specified in Section 105.03(c).

2.a General. Provide all tools, machinery, and equipment necessary to erect the falsework. Falsework is considered to be any temporary structure that supports structural elements of concrete, steel, masonry, or other materials during their construction or erection. Form travelers, as used in segmental cantilever construction, are considered to be a combination of falsework and forms. Have a Professional Engineer registered in the State sign and seal the working drawings for the falsework if the height of falsework exceeds 14 feet or if traffic, other than workers involved in constructing the bridge, will travel under the bridge. Furnish falsework of sufficient rigidity and strength to safely support all forces imposed, and to produce, in the finished structure, the lines and grades indicated.

2.b Design Loads. Ensure that the design load for falsework consists of the sum of dead and live vertical loads, and any horizontal loads. At a minimum, include in the dead loads the gravitational force of the falsework and

all construction material to be supported. Assume the combined density of concrete, reinforcing and prestressing steel, and forms to be not less than 160 pounds per cubic foot of normal density concrete or 130 pounds per cubic foot of low-density concrete that is supported.

For live loads, include the actual force of any equipment to be supported, applied as concentrated forces at the points of contact and a uniform force of not less than 20 pounds per square foot applied over the area supported, plus 75 pounds per linear foot applied at the outside edge of deck overhangs.

For the design of the falsework bracing system, use the sum of the horizontal forces due to equipment, construction sequence, including unbalanced hydrostatic forces from fluid concrete, stream flow when applicable, and an allowance for wind. Use wind loads and distribution of wind loads to girders according to AASHTO Guide Specifications for Wind Loads on Bridges During Construction. However, do not allow the horizontal force to be resisted in any direction to be less than 2% of the total dead load.

Do not exceed the load-carrying capacity of the structure, or portion of structure, according to AASHTO LRFD Specifications Article 3.4.2 by imposing forces on existing, new, or partially completed portions of structures due to construction operations. For the compressive strength of concrete, f'c, in computations of the load-carrying capacity, use the lesser of the actual compressive strength at the time of loading or the specified compressive strength of the concrete.

2.c Clearances. Unless otherwise provided for roadways that are to remain open to traffic, supply minimum dimensions for clear openings through falsework at least 5 feet wider than the width of the approach traveled way, measured between barriers when used, and 14 feet high, except over interstate routes and freeways use 14.4 feet for the minimum vertical clearance.

2.d Construction. Do not proceed with construction of falsework until the erection plan as specified in Section 1050.3(c)3 is accepted. Construct falsework and set it to grades that allow for its anticipated settlement and deflection, and for the vertical alignment and camber indicated or directed for the permanent structure. Use variable depth camber strips between falsework beams and soffit forms to accomplish this, if directed.

Use suitable screw jacks, pairs of wedges or other devices at each post to adjust falsework to grade, to allow minor adjustments during the placement of concrete or structural steel should observed settlements deviate from those anticipated, and to allow for the gradual release of the falsework. Provide tell-tales attached to the forms and extending to the ground, or other means, for accurate measurement of falsework settlement during the placing and curing of the concrete.

Support falsework or formwork for deck slabs on girder bridges directly on the girders so that there will be no appreciable differential settlement during placing of the concrete. Brace and tie girders to resist any forces that would cause rotation or torsion in the girders caused by the placing of concrete for diaphragms or deck. Do not weld falsework support brackets or braces to structural steel members or reinforcing steel unless specifically allowed.

2.e Removal. Section 1001.3(q)

3. Erection Plan. Submit an erection plan for acceptance, signed and sealed by a Professional Engineer registered in the State. Provide details for all anticipated phases and conditions during erection. Include details of falsework, temporary bents, bracing, guys, dead-men, lifting devices, and attachments to bridge members. Include the sequence of erection, location of cranes and barges, crane capacities, crane operator's license for the operator performing the crane work, location of lifting points on the bridge members, and weights of the members. If required, furnish calculations to demonstrate that allowable stresses are not exceeded and that member capacities and final geometry will be correct. Include delivery plan with erection plan. The delivery plan is to include delivery routes, ingress and egress to the site, and any modifications required for safe transport to the site. List equipment needed to unload or move bridge members. Do not proceed with erection until the erection plan has been accepted. Maintain an accepted copy of the erection plan onsite during erection operations.

3.a Pre-Erection Meeting. Before erecting falsework or permanent bridge members, conduct a pre-erection meeting a minimum of 14 calendar days before erection with the Professional Engineer of record for the erection plan, prime contractor, superintendent in charge of beam setting operation, crane operators or crane company representative, signal personnel, Structure Control Engineer, and onsite Representative to discuss the accepted erection plan. Conduct safety talk with crane operator as specified in Section 108.05(c)6.

3.b Conformance to Erection Plan. Ensure conformance to the erection plan. Any modification to or deviations from the accepted erection plan will require revised drawings, calculations, and verification of stresses and geometry.

3.c Erection Stresses. Account for any erection stresses that are induced in the structure as a result of the use of a method of erection or equipment which differs from that indicated or specified, and which will remain in the finished structure as locked-in stresses. Provide additional material, at no additional cost to the Department, to keep both temporary and final stresses within the allowable limits used in design.

Provide temporary bracing or stiffening devices to accommodate handling stresses in individual members or segments of the structure during erection. Use wind loads and distribution of wind loads to girders according to AASHTO Guide Specifications for Wind Loads on Bridges During Construction.

3.d Maintaining Alignment and Camber. During erection, support segments of the structure in a manner that will produce the proper alignment and camber in the completed structure. Install cross frames and diagonal bracing, as necessary during the erection process, to provide stability and ensure correct geometry. Provide temporary bracing, if necessary, at any stage of erection.

4. Bearings and Anchorage.

4.a General. This work consists of furnishing and installing bridge bearings. Bearing types include, but are not limited to, elastomeric pad, rocker, roller, pot, spherical, disk, and sliding plate bearings. Included as components of bearings are masonry, sole and shim plates, bronze or copper-alloyed bearing and expansion plates, anchor bolts, PTFE sheets or surfacing, lubricants and adhesives. The furnishing and installation of bedding materials used under masonry plates is also included in this work.

Construct bearings according to the indicated details. If complete details are not provided, furnish bearings that conform to the limited, indicated details and provide the design capacities for loads and movements shown or specified and the performance characteristics specified.

4.a.1 Working Drawings. If complete details for bearings and their anchorages are not indicated, prepare and submit working drawings for the bearings. Show all details of the bearings and of the materials proposed for use on such drawings, and have the drawings approved before fabrication of the bearings is begun.

4.a.2 Packaging, Handling, and Storage. Before shipment from the point of manufacture, package bearings in such a manner to ensure that during shipment and storage the bearings will be protected against damage from handling, weather, or any normal hazard. Clearly identify each completed bearing's components; securely bolt, strap, or otherwise fasten its components to prevent any relative movement; and mark on its top its location and orientation in each structure in the project, in conformity with the plans. Do not dismantle bearings at the site unless absolutely necessary for inspection or installation.

Store all bearing devices and components at the work site in an area that provides protection from environmental and physical damage. Ensure that bearings are clean and free of all foreign substances when installed.

4.a.3 Manufacture or Fabrication. Unless otherwise specified or indicated, furnish the surface finish of bearing components that come into contact with each other or with concrete, but are not embedded in concrete, as specified in Section 1105.03(q).

4.a.4 Construction and Installation. Install bearings to the positions indicated. At the time of installation, set bearings to the dimensions prescribed by the manufacturer, the Representative, or as indicated. Adjust bearings as necessary to take into account the temperature and future movements of the bridge.

Set bridge bearings level, in exact position, and to have full and even bearing on all bearing planes.

For bearing surfaces located at improper elevations or set not level and true to plane, either grind the surface, grout pack bearings, or modify the bearing such that intended bearing placement is as originally designed with the least amount of bearing modification.

Use a filler or fabric material as specified in Section 1113.03(h) to bed on the concrete metallic bearing assemblies not embedded in the concrete.

Set elastomeric bearing pads directly on properly prepared concrete surfaces without bedding material.

For bearings seated directly on steel work, machine the supporting surface so as to provide a level and planar surface to place the bearing.

4.b Preparation of Bearing Areas. Prepare bearing areas as specified in Section 1001.3(k)9 and furnish bedding material as specified in Section 1113.03(h).

4.c Elastomeric Bearings. Elastomeric bearings include unreinforced pads (consisting of neoprene only) and reinforced pads with steel or fabric laminates. Furnish bearings with the dimensions, material properties, neoprene grade and type of laminates indicated.

4.c.1 Setting Bearing Pads. Set bearing pads as specified in Section 1080.3(c)2 and as indicated. Where elastomeric bearings are used at piers of continuous bridges, provide full contact between the beam, the bearing pad, and the beam seat, unless the plans indicate that a lift-off condition is expected when the beam is initially set on the pad.

4.c.2 Resetting Bearing Pads. If indicated, reset expansion bearings after all dead loads have been placed. Submit a plan showing and describing the jacking procedure for review and acceptance at least 2 weeks before proceeding with the jacking operations. Provide calculations showing actual and allowable bearing stresses in the bearing plates and bearing areas at the jacking locations. Have the plans and calculations sealed and signed by a Professional Engineer registered in the State.

Before resetting, truck mixers and slip-forming equipment, necessary for placement of barriers and sidewalks, will be allowed on the structure. Do not allow other construction equipment or traffic on the structure until the bearings are reset. Coordinate the resetting operation with the installation of on-bridge hardware, including conduits, utilities, expansion dams, and drainage, to prevent damage to these components when the beams are jacked and lowered.

Furnish jacks with a working capacity at least equal to the jacking forces indicated. Jack beams at expansion bearings to achieve a 1/16-inch gap between the bottom of beam or sole plate and the top of the entire bearing pad. Place jacks at jacking points indicated. Unless indicated otherwise, jack all beams simultaneously. Limit the differential rise between all beams to 1/8 inch during jacking. After jacking, center the pad beneath the sole plate or beam bearing area as indicated. Lower the beams onto the bearings in the same manner as they were jacked.

Reset bearings when the ambient temperature is above 20F and below 85F.

4.d Anchor Bolts.

4.d.1 Fabrication. Furnish threaded and headed anchor bolts to secure a satisfactory grip upon the material used to embed them in the holes.

4.d.2 Setting Anchor Bolts. Set by template to the indicated elevation and alignment. As an alternate, set in preformed holes 3 inches larger than the bolt diameter. Clean the holes, set and fix the bolts, and fill the holes with nonshrink grout, as specified in Section 1001.2(e). Use drilled holes, as a substitute for preformed holes, in abutments and solid piers only. Protect the holes against water entry during freezing periods.

Limit the threaded projection above the nut to between 3/16 inch and 1 inch.

4.e Setting Bearings. As shown on the Standard Drawings and as follows:

Align masonry plates and set them so they will be centered with the rockers, rollers, sole plates, and bearing plates, at 68F and under full dead load. Make adjustment for the difference in temperature, from 68F, at time of erection. Compensate for the change in length of the bottom chord, or flange, due to the later addition of dead loads.

Maximum deviation of the top of rockers from a vertical position, and maximum eccentricity of the parts of sliding bearings, is 0.0001(L) + 0.25 inch, where L, in inches, is the horizontal distance between the expansion bearing and the fixed bearing.

4.f Spherical Bearings. Fabricate, test, and install spherical bearings as indicated.

4.g Separate Contracts for Substructure and Superstructure. If the substructure and superstructure are built under separate contracts, proceed as follows:

4.g.1 Substructure Contractor. Accurately place the anchor bolts and grind the bearing areas to the correct plane and elevation.

At the completion of the substructure, make an as-built survey to accurately show the as-built versus the

plan location of all substructure centerlines, girder centerlines, anchor bolt group centerlines, anchor bolts, bearing elevations, and any other elements or items that may affect the layout or placement of the work to be furnished by the superstructure contractor. Show all of the pertinent as-built survey information, including dimensions, elevations, and angles on suitable drawings, as specified for shop drawings, together with the corresponding design drawing information for direct comparison. Submit the original drawings, or equal, to the Department as soon as practical after completion of the survey. Conduct the survey and have the survey drawings signed by a Surveyor or Professional Engineer registered in the State.

Provide documented evidence to show that the bearings can be set properly within the tolerances specified in Section 1050.3(c)4.

4.g.2 Superstructure Contractor. Use the as-built survey information, furnished by the substructure contractor, for the accurate layout of the connecting parts of the work.

Verify location, level, and elevation of all bearing seats and anchor bolts as soon as possible. Verify, before the fabrication of any metal work, in cases where the substructure is completed before award of the superstructure contract, or before erection of the metal work, in cases where fabrication has been started before completion of the substructure.

Furnish and install bedding, bearings, and nuts and washers for anchor bolts.

4.h High-Load Multi-Rotational Bearings. If required, construct as follows:

Provide complete erection and installation procedures for acceptance before installation.

Evenly support bearings over their upper and lower surfaces under all erection and service conditions.

Lift bearings by undersides only or by specially designed lifting lugs.

Take care to avoid damage to and contamination of bearing surfaces during installation.

Align the centerlines of the bearing assembly with those of the substructure and superstructure. On guided bearings take special care to properly align the guiding mechanism with the designated expansion direction of the structure.

Leave bearing straps or retaining clamps in place as long as possible to ensure parts of bearing are not inadvertently displaced relative to each other. Take care to remove straps or clamps before any normal structural movement takes place, such as post-tensioning.

Set offsets of upper and lower bearing parts as indicated. Under dead load, the distance between the upper and lower bearing plates will not be out of parallel by more than 1/8 inch measured from edge to edge.

Make the mating surface of the superstructure level within a slope of 100:1. Have no local irregularities exceeding 1/16 inch.

During welding of sole plates to girders, limit the temperature of the metal adjacent to neoprene and PTFE to a maximum of 300F. Use temperature indicating markers.

4.h.1 Bearing Seats. Provide bedding material for steel bearings as specified in Section 1113.03(h).

5. Straightening Material. If allowed, straighten plates, angles, other shapes, and built-up members. Use methods that will not produce fracture or other injury to the metal. Straighten distorted non-fracture critical members by mechanical means or, if allowed, by carefully planned procedures and supervised application of a limited amount of localized heat. Heat-straighten Grades HPS 70W and HPS 100W steel members only under rigidly controlled procedures, each application subject to approval. Do not allow the maximum temperature to exceed the following values:

Steel Grade	Distance from Weld	Max. Temp.
HPS 70W	> 6 inches	1,050F
HPS 70W	< 6 inches	900F
HPS 100W	> 6 inches	1,100F
HPS 100W	< 6 inches	950F

In all other steels, do not allow the temperature of the heated area to exceed 1,150F as controlled by temperature indicating crayons or other approved methods.

Ensure that parts to be heat-straightened are substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat.

Evidence of fracture following straightening of a bend or buckle will be cause for rejection of the damaged piece.

6. Field Assembly. Accurately assemble the parts according to the erection plan, and follow any match-marks. Carefully handle the material so that no parts will be bent, broken, or otherwise damaged. Do not hammer members if it will injure or distort them. Clean bearing surfaces and surfaces to be in permanent contact before the members are assembled. Fill one-half of the holes of splices and field connections with bolts and cylindrical erection pins (half bolts and half pins) before installing and tightening the balance of high-strength bolts. Fill three-fourths of the holes of splices and connections carrying traffic during erection before installing and tightening the balance of high-strength bolts.

Fitting-up bolts may be the same high-strength bolts used in the installation. If other fitting-up bolts are used, supply fitting-up bolts of the same nominal diameter as the high-strength bolts, but supply cylindrical erection pins 1/32 inch larger.

7. Connections Using High-Strength Bolts. Make connections as specified in Section 1105.03(j) and as follows: (Note: Do not use ASTM F3125 Grade 490 bolts unless approved for use by the Chief Bridge Engineer or the Chief Bridge Engineer's designee, on a project by project basis.)

7.a General. Obtain the "snug tight" condition as defined in Section 1050.3(c)7.d for any method of final tightening except direct-tension-indicator (DTI) tightening or tightening of alternate design fasteners.

Assemble fasteners of appropriately assigned lot numbers together when installed. Protect such fasteners from dirt and moisture at the job site. Take only as many fasteners as are anticipated to be installed and tightened during a work shift from protected storage. Return fasteners not used to protected storage at the end of the shift. Do not clean lubricant from fasteners that is required to be present in as-delivered condition. Before installation, clean and relubricate fasteners for slip-critical connections which accumulate rust or dirt resulting from job site conditions. If relubrication is required, use a lubricant recommended by the fastener manufacturer.

Provide a Skidmore-Wilhelm Calibrator, or other equivalent bolt tension measuring device, at each job site, during erection. Perform periodic testing (at least once each working day if calibrated wrench method is used) to ensure compliance with the installation test procedures specified herein for turn-of-the-nut tightening, calibrated wrench tightening, installation of alternate design bolts, and direct tension indicator tightening. Bolts that are too short for the Skidmore-Wilhelm Calibrator may be tested using DTI devices. In that case, calibrate the DTI devices in the Skidmore-Wilhelm Calibrator using longer bolts, according to PTM No. 429 as applicable.

Install fasteners together with washers of size and quality specified, located as required below, in properly aligned holes, and tighten by any of the methods specified in Sections 1050.3(c)7.d through 1050.3(c)7.g to at least the minimum tension specified in Table A, when all the fasteners are tight. When it is impractical to turn the nut, tighten the fastener by turning the bolt while the nut is prevented from rotating. If impact wrenches are used, provide adequate wrench capacity and sufficient air supply to perform the required tightening of each bolt in approximately 10 seconds.

Do not reuse ASTM F3125 Grade A 490 fasteners or galvanized ASTM F3125 Grade A 325 fasteners. Reuse other ASTM F3125 Grade A 325 fasteners only if approved by the Representative. Do not consider as reuse touching up or retightening previously tightened bolts that may have been loosened by the tightening of adjacent bolts provided the snugging up continues from the initial position and does not require greater rotation, including the tolerance, than that required by Table B.

7.b Rotational-Capacity Tests. Perform the rotational capacity test on each bolt/nut/washer assembly lot, as specified in Section 1105.02(d)7d, immediately before the start of bolt installation in the fabrication shop or at the project site. Document test results according to PTM No. 427. If testing and installation is performed in the fabrication shop, submit test results to the BDTD, SMS at the MTL. If testing and installation is performed at the project site, submit test results to the Representative. All job-site rotational capacity tests are to be performed by the fabricator or Contractor, as applicable at the site of bolt installation, and witnessed by the Inspector.

Hardened steel washers are required under the turned element (nut) or as directed by the Representative as part of the test, although they may not be required in the actual installation. Mark fastener containers for each assembly lot after testing to indicate their acceptance.

7.c Requirement for Washers. Where the outer face of the bolted parts has a slope greater than 20:1 with respect to a plane normal to the bolt axis, use a hardened beveled washer to compensate for the lack of parallelism.

For American Standard Beams and Channels use hardened beveled washers that are square or rectangular, that conform to ASTM F436, and that taper in thickness.

Where necessary, clip washers on one side to a point not closer than 7/8 of the bolt diameter from the center of the washer.

Hardened washers or plate washers are required for all connections using ASTM F3125 Grade A 325 bolts and ASTM F3125 Grade A 490 bolts unless indicated.

Use hardened washers under the element turned in tightening when the tightening is to be performed by turn-of-the-nut method and calibrated wrench method.

Hardened steel washers are required under the turned element as part of rotational-capacity tests, even if they are not required in the actual installation.

Where ASTM F3125 Grade A 325 bolts equal to or less than 1.0 inch in diameter are to be installed in oversize or short slotted holes in an outer ply, a hardened washer conforming to ASTM F436 will be used.

Where ASTM F3125 Grade A 325 bolts equal to or less than 1.0 inch in diameter are to be installed in long slotted holes in an outer ply, provide a single plate washer or continuous bar of at least 5/16-inch thickness with standard holes. Furnish washers or bars of sufficient size to completely cover the slot after installation. Use a single hardened washer conforming to ASTM F436 with a minimum thickness of 5/16 inch, or use washers or bars of structural grade material but need not be hardened. Do not use multiple hardened washers or bars to achieve a thickness of 5/16 inch.

As an alternate satisfying the requirements for washers, use alternate design fasteners conforming to the requirements specified in Section 1050.3(c)7.c.1, if approved, with a geometry that provides a bearing circle on the head or nut with a diameter equal to or greater than the diameter of hardened washers conforming to the requirements of ASTM F436. Such fasteners may be used in standard size round holes without washers.

7.c.1 Alternate Fasteners. If alternate fasteners are allowed, proceed as specified in Section 1050.3(c)7.f and as follows:

If allowed, use other fasteners or fastener assemblies that conform to the materials, manufacturing, and chemical composition requirements of ASTM F3125 Grade A 325 and that conform to the mechanical property requirements of the same specifications in full-size tests, and that have body diameter and bearing areas under the head and nut, or their equivalent, not less than those provided by a bolt and nut of the same nominal dimensions specified in Section 1105.02(d). Such alternate fasteners may differ in other dimensions from those of the specified bolts and nuts.

7.d Turn-of-the-Nut Tightening. Immediately before the start of bolting operations, perform pre-installation verification testing according to PTM No. 429, and as follows:

Once per project per bolting crew, check a representative sample of not less than three of each diameter, length and grade to be used in the work at the start of work in a device capable of indicating bolt tension.

Using the test, demonstrate that the method for achieving the snug tight condition (see below) and for controlling the turns from snug tight to be used by the bolting crew develops a tension not less than 5% greater than the tension required by Table A. Perform periodic retesting if ordered by the Representative.

Following successful pre-installation testing, perform bolt installation as follows: Install bolts in all holes of the connection and bring them to a snug tight condition. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. Use a few impacts of an impact wrench or the full effort of a worker using an ordinary spud wrench to attain the snug tight condition (use the same method that was used for pre-installation verification).

Snug tighten the bolts of the connection by progressing systematically from the most rigid part of the connection to the free edges, and then retighten the bolts in a similar systematic manner as necessary until all bolts are simultaneously snug tight and the connection is fully compacted. Following this initial operation further tighten all bolts in the connection by the applicable amount of rotation specified in Table B. During the tightening operation, do not allow rotation of the part not turned by the wrench. Systematically tighten the bolts progressing from the most rigid part of the joint to its free edges.

7.e Calibrated-Wrench Tightening. Before the start of bolting operations, perform pre-installation torque calibration as stipulated in PTM No. 429 and as follows. Use calibrated wrench tightening only if installation procedures are calibrated on a daily basis and if a hardened washer is used under the element turned in tightening. Standard torques determined from tables or from formulas, which are assumed to relate torque to tension, are not acceptable.

When calibrated wrenches are used for installation, set them to deliver a torque which has been calibrated to produce a tension not less than 5% in excess of the minimum tension specified in Table A. Calibrate the installation procedures at least once each working day for each fastener assembly rotational-capacity lot combination that is being

installed in the work that day. Perform calibration in a device capable of indicating actual bolt tension by tightening three typical fastener assemblies from each rotational-capacity lot, bolts of each diameter, length, and grade, from the bolts being installed and with a hardened washer, from the washers being used in the work, under the element turned in tightening. Recalibrate wrenches if significant difference is noted in the surface condition of the bolts, threads, nuts, and washers. Verify during actual installation in the assembled steel work that the wrench adjustment selected by the calibration does not produce a nut or bolt head rotation from snug tight greater than that specified in Table B. If manual torque wrenches are used, turn nuts in the tightening direction while torque is measured.

When calibrated wrenches are used to install and tension bolts in a connection, install bolts and nuts, with washers in all holes of the connection and bring them to a snug tight condition. Following this initial tightening operation, tighten the connection using the calibrated wrench. Tighten the bolts by progressing systematically from the most rigid part of the joint to its free edges. Use the wrench to again tighten previously tightened bolts that may have been relaxed as a result of the subsequent tightening of adjacent bolts, until all bolts are tightened to the prescribed amount.

7.f Installation of Alternate Design Bolts. When fasteners are to be installed that incorporate a design feature intended to indirectly indicate the bolt tension or to automatically provide the tension specified in Table A and have been qualified as specified in Section 1050.3(c)7.c.1, check a representative sample of not less than three bolts of each diameter, length, and grade, at the job site in a device capable of indicating bolt tension. Include flat, hardened washers in the test assembly, if required in the actual connection, arranged as those in the actual connections to be tensioned. Use the calibration test to demonstrate that each bolt develops a tension not less than 5% greater than the tension specified in Table A. Follow the manufacturer's installation procedure for installation of bolts in the calibration device and in all connections. Perform periodic retesting when ordered by the Representative.

When alternate design fasteners that are intended to control or indicate bolt tension of the fasteners are used, install bolts in all holes of the connection and initially tighten them sufficiently to bring all plies of the joint into firm contact but without yielding or fracturing the control or indicator element of the fasteners. Then further tighten all fasteners, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, to properly tension the bolts, perform more than a single cycle of systematic partial tightening before final twist-off of the control or indicator element of individual fasteners. Replace any individual fastener assembly if twist off occurs before the final tensioning cycle.

7.g Direct Tension Indicator Tightening. Furnish DTIs conforming to the requirements as specified in Section 1105.02(d)6, and in sufficient numbers to allow for all required testing. When fastener assemblies using DTIs are proposed for use, perform preinstallation verification testing and subsequent fastener installation according to PTM No. 429 as applicable. Three verification tests are required for each combination of fastener assembly rotational-capacity lot, DTI lot, and DTI position relative to the turned element to be used on the project. Unless otherwise approved, install the DTI under the head of the bolt, and turn the nut to tension the bolt.

TABLE A
Required Fastener Tension
Minimum Bolt Tension in Pounds*

Bolt Size inches	ASTM F3125 Grade A 325	ASTM F3125 Grade A 490
1/2	12,000	15,000
5/8	19,000	24,000
3/4	28,000	35,000
7/8	39,000	49,000
1	51,000	64,000
1-1/8	56,000	80,000
1-1/4	71,000	102,000
1-3/8	85,000	121,000
1-1/2	103,000	148,000

* Equal to 70% of specified minimum tensile strength of bolts (according to ASTM Specifications for tests of full-size ASTM F3125 Grade A 325 bolts and ASTM F3125 Grade A 490 bolts with UNC profile threads loaded in axial tension) rounded to the nearest kip.

TABLE B
Nut Rotation from the Snug-Tight Condition(1),(2) Geometry of Outer Faces of Bolted Parts

Bolt length measured from underside of head to end of bolt	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 20:1. Bevel washer not used.	Both faces sloped not more than 20:1 from normal to bolt axis. Bevel washers not used.
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters(3)	2/3 turn	5/6 turn	1 turn

(1) Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be ±30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.
(2) Applicable only to connections in which all material within grip of the bolt is steel.
(3) No research work has been performed by the Research Council Riveted and Bolted Structural Joints to establish the turn-of-nut procedure if bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests, in a suitable tension device, simulating the actual conditions.

7.h Lock-Pin and Collar Fasteners. If approved for use, test and install lock-pin and collar fasteners using approved methods and procedures, and as specified in Section 1050.3(c)7.f.

Meet the requirements as specified in Section 1105.02(d)2 for the shank and head of high-strength steel lock-pin and collar fasteners. Provide each fastener with a solid-shank body of sufficient diameter to provide tensile and shear strength equivalent to or greater than that of the bolt indicated and a cold-forged head on one end, of type and dimensions approved; a shank length suitable for the material thickness fastened; locking grooves; breakneck groove; and pull grooves (all annular grooves) on the opposite end. Provide each fastener with a steel locking collar of proper size for the shank diameter used which, by means of suitable installation tools, is cold-swaged into the locking grooves forming a head for the grooved end of the fastener after the pull groove section has been removed. Provide a steel locking collar with a standard product of an established manufacturer of lock-pin and collar fasteners, as approved.

7.i Inspection. In the presence of the Inspector, inspect the tightened bolts using a 1,000 foot-pound manual dial calibrated torque wrench, according to PTM No. 429 and as follows, unless alternate fasteners or direct tension indicator devices are used, allowing verification by other methods: At the Representative's option, this inspection can be performed either by the Inspector or the Contractor. Inspection tests must be conducted daily. Testing performed by the fabricator or Contractor will be witnessed by the Representative.

Individually place three fastener assemblies of the same lot size, grade, size, configuration, and condition as those under inspection in a device calibrated to measure bolt tension. Perform this calibration operation at least once each inspection day. Provide a washer under the part turned in tightening each bolt, if washers are used on the structure. If washers are not used on the structure, furnish the material used in the tension measuring device which abuts the part turned of the same specification as that used on the structure. In the calibrated device, tighten each bolt to the specified tension by any convenient means. Apply the calibrated torque wrench to the tightened bolt to determine the torque required to turn the nut or head five degrees (approximately 1 inch at a 12-inch radius) in the tightening direction. Take the average of the torque required for all three assemblies as the job-inspection torque.

For final acceptance of connections installed using high-strength bolts, inspect 10% (2 minimum) of the bolts in the connection using a calibrated torque wrench. Select bolts to be inspected according to PTM No. 1. Then apply the job-inspection torque to each with the calibrated torque wrench turned in the tightening direction. If this torque turns no bolt head or nut, the bolts in the connection will be considered to be properly tightened. But if the torque turns one or more bolt heads or nuts, apply the job-inspection torque to all bolts in the connection. Tighten and reinspect any bolt whose head or nut turns at this stage, or retighten all the bolts in the connection and resubmit it for inspection.

8. Pin Connections. Use pilot and driving nuts in driving pins. Drive pins so that the members will take full bearing on them. Screw pin nuts up tight and burr the threads at the face of the nut with a pointed tool.

9. Misfits. The correction of minor misfits involving minor amounts of reaming, cutting, and chipping will be considered a legitimate part of the erection. However, errors in the shop fabrication or deformation resulting from

handling and transporting will be cause for rejection.

The Contractor is responsible for all misfits, errors, and damage. Make the necessary corrections and replacements to correct misfits, errors, and damage.

(d) Painting.

1. Fabricated Structural Steel. Apply coating system as specified in Section 1060.

2. Fabricated Structural Steel Repairs. Apply a coating system as indicated. The coating system can be shop applied as specified in Section 1060 or field applied as specified in Section 1070. Prepare and coat faying surfaces as specified in Section 1105.03(j)3. Use the same primer on faying surfaces as the primer being applied in the field to the existing steel. Do not mate surfaces of different primers.

1050.4 MEASUREMENT AND PAYMENT—

(a) Steel Bridge Superstructure. Lump Sum. The price includes the following component items.

- **Fabricated Structural Steel.** Pound. The cost of welds in excess of those indicated and allowed by the District Bridge Engineer, due to the Contractor's request, is incidental to the other fabricated structural steel work. The cost of all nondestructive testing, including equipment, supplies, and technicians is also incidental to the other fabricated structural steel work.
- **Cement Concrete Structures.** Section 1001.4
- **Preformed Neoprene Compression Joint Seal.** Section 1008.4
- **Pedestrian Railing.** Section 1012.4
- **Aluminum Bridge Hand Railing.** Section 1023.4
- **Steel Bridge Hand Railing.** Section 1022.4
- **Protective Barrier.** Section 1015.4
- **Protective Fence.** Section 1016.4
- **Protective Coating for Reinforced Concrete Surfaces.** Section 1019.4
- **Armored Preformed Neoprene Compression Dam.** Section 1021.4
- **Tooth Expansion Dam with Drain Trough.** Section 1020.4
- **Reinforcement Bars.** Section 1002.4
- **Neoprene Strip Seal Dam.** Section 1026.4
- **High Load Multi-Rotational Bearings.** Each. For the type indicated.
- **Neoprene Bearing Pads.** Each. For the type indicated.
- **Reset Expansion Bearings, Steel Superstructure.** Each

(b) Fabricated Structural Steel Repairs. Each or Pound as indicated.

1. Fabricated Structural Steel Repairs. Each. Access to the planned repair locations to perform and inspect the repairs is incidental to this item. Modifications of existing steel for the repairs are incidental to the repairs. Field cutting and grinding, field welding, weld testing, field drilling bolt holes, existing rivet/bolt/weld removal, bolt hole reaming, high strength field bolting, bolts, nuts, washers, welds, and weld materials incorporated into the finished work are incidental to the fabricated structural steel repairs.

2. Fabricated Structural Steel Repairs. Pound. Access to the planned repair locations to perform and inspect the repairs is incidental to this item. Modifications of existing steel for the repairs are incidental to the repairs. Field cutting and grinding, field welding, weld testing, field drilling bolt holes, existing rivet/bolt/weld removal, bolt hole reaming, and high strength field bolting are incidental to the fabricated structural steel repairs. The pay weight is based upon nominal weights for rolled and formed sections, nominal dimensioned plates, and other items, as listed in current AISC handbooks. Payment will be made only for actual new fabricated structural steel permanently installed in the rehabilitated structure excluding the weights listed in the following paragraphs:

The weight of the bolts, nuts, washers, welds, and weld materials incorporated into the finished work are incidental to the weight of the installed fabricated Structural steel.

The weight of the cuts, copes, bolt holes, or other material not incorporated into the finished work are incidental to the weight of the installed fabricated structural steel.

(c) Unforeseen Fabricated Structural Steel Repairs. Dollar. For projects anticipating unforeseen repairs, an item with a predetermined amount of money is included for unforeseen repairs. The item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount. This item includes access to the unforeseen repair locations to perform and inspect the repairs.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Unforeseen Repairs item as follows:

1. Contract Items. The Department will pay for performance of work, identified as having similar items listed in the contract, at the contract unit price.

2. Non-Contract Items. The Department will pay for the items of work not identified in the contract as follows:

- Negotiated Price. At price agreed upon with the Department before performing the work. If applicable, agreement is also required with FHWA.

- Force Account Basis. Section 110.03(d).

SECTION 1051—DOWNSPOUTING

1051.1 DESCRIPTION—This work is the furnishing and installation of downspouting.

1051.2 MATERIAL—As shown on the Standard Drawings and as follows:

- Fabricated Structural Steel—Section 1105, galvanized as specified in Section 1105.02(s).
- Fiberglass Pipe and Fittings—ASTM D 2996 RTRP with a 30,000 pounds per square inch, minimum short-time rupture strength hoop tensile stress. Use concrete gray as the final color of the reinforced fiberglass pipe, unless otherwise specified. Use a coating that protects the pipe from ultraviolet damage. Use manufacturer recommended paint and fittings.
- PVC Schedule 40 Pipe—ASTM D 1785

1051.3 CONSTRUCTION—Install downspouting, including the drain box, as indicated and as shown on the Standard Drawings.

1051.4 MEASUREMENT AND PAYMENT—Linear Foot

SECTION 1052—METAL CURB DRAIN

1052.1 DESCRIPTION—This work is construction of an aluminum or steel drain facility to dispose of bridge deck drainage by free drop through curb barrier.

1052.2 MATERIAL—

(a) Aluminum. ASTM B308/B308M, Alloy 6061-T6. Certify as specified in Section 106.03(b)3.

(b) Structural Steel. Section 1105.02(a)2

(c) Zinc Chromate Primer. Federal Specification TT-P-645. Certify as specified in Section 106.03(b)3.

(d) Galvanizing. Section 1105.02(s)

1052.3 CONSTRUCTION—Construct in accordance with Standard Drawing BC-751M, as indicated, and as directed.

(a) General. Fabricate the drain from either C8 by 4.25 aluminum channels, or C8 by 11.5 steel channels, welded together with full penetration welds to form a rectangular section. Alternatively, fabricate a rectangular section, 8 inches by 4 1/2 inches out of 3/16-inch steel plates.

(b) Aluminum Drain. Coat all surfaces of the drain to be in contact with concrete with two coats of asphalt paint or zinc chromate primer.

(c) Steel Drain. Galvanize the entire drain after welding according to ASTM A123.

1052.4 MEASUREMENT AND PAYMENT—Incidental to concrete bridge barrier.

SECTION 1060—SHOP PAINTING STRUCTURAL STEEL

1060.1 DESCRIPTION—This work is the cleaning and priming of structural steel in the shop, using a self-curing, inorganic, zinc-rich primer, and the application of intermediate and finish coats in the shop and in the field.

(a) Prequalification. When shop painting structural steel, use only Bulletin 15 approved paint shops that are certified by the AISC under its Sophisticated Paint Endorsement (SPE) quality program or by the Society for Protective Coatings (SSPC) under its QP3 quality program. Use Shops certified to the "enclosed shop" category. Use shops that are fully certified for the duration of time they are performing surface preparation and coating application. Apply complete coating system in an "enclosed shop" except for touch up painting.

For shop removal and disposal of hazardous coating, including but not limited to lead based paint, use only shops certified to SSPC-QP3 and listed in Bulletin 15 as approved paint shops.

1060.2 MATERIAL—

(a) Coating System for Plain Carbon Steel. Use an approved, proprietary, self-curing, inorganic, zinc system, from a manufacturer listed in Bulletin 15, consisting of a self-curing, inorganic zinc primer, an epoxy or urethane intermediate coat, and an aliphatic urethane finish coat, Do not mix components or coats from different systems. Use the products of one manufacturer for the entire system.

1. Submittal Requirements. Submit the following information to the District Executive:

- Infrared curves (2.5 microns to 15 microns) for the zinc primer, intermediate coat, and finish coat including curves for the vehicle (binder) of each component and for the mixed paint;
- Mass per liter (weight per gallon), at 77F, for zinc primer vehicle and the intermediate and finish coat paints;
- Viscosity in Krebs Units, at 77F, for the zinc primer vehicle and the intermediate and finish coat paints;
- Percent solids by weight of the zinc primer vehicle and the intermediate and finish coat paints;
- Percent of metallic zinc by weight in the cured zinc primer coat, dry film;
- Percent of metallic zinc by weight in the zinc pigment component;
- Finish coat color chips for selection of color by the District Bridge Engineer; and
- Technical data sheets, safety data, and specific application instructions for all coats. In the event of a conflict between the data/instruction sheets and these Specifications, the Specification requirements will govern. Work will not be allowed to proceed until this information is received.

2. Technical Representation. Furnish the services of a paint or a painting technical representative from the paint manufacturer at the beginning of operations and when required.

3. Damage Prevention and Repair Procedures. Furnish a damage prevention plan with the structural steel shop drawings that describes the procedures and protective materials to be used to prevent damage to paint coats. Have the plan cover the period of time from when paint coats are applied in the shop until erection is completed in the field.

Furnish the manufacturer's recommended surface preparation, coating application, and coating repair procedures. Include the manufacturer's recommended surface preparation methods, coating material, application methods, and application conditions. Include the manufacturer's recommended methods for correction of damage to one or more coats, including correction of damage caused in handling, shipping, and erection; correction of deficient or excessive coating thickness; correction of runs, sags, peeling, and poorly adhered coating; and removal of zinc salts and other contaminants that would be detrimental to succeeding coats.

(b) Coating System for Galvanized Steel. Use an approved two-coat paint system, from a manufacturer listed in Bulletin 15, consisting of an epoxy polyamide as an intermediate coat and an aliphatic urethane as a finish coat. Select colors for the intermediate and finish coat before fabrication. Do not use the system prime coat. Do not mix components from different systems. If a wash primer is used, provide the manufacturer's certification of compatibility with the selected paint system.

- Furnish submittals as specified in Section 1060.2(a)1 for intermediate and finish coats. Furnish technical representation as specified in Section 1060.2(a)2. Furnish damage prevention and repair procedures as specified in Section 1060.2(a)3.

1060.3 CONSTRUCTION—

(a) General.

1. Protection of Structure, Persons, and Property. When applying the full intermediate and finish coats in the field or when repairing coating damage in the field, protect pedestrians, vehicles, and other traffic, upon or under the bridges; the bridge superstructure and substructure; and surrounding property surfaces, buildings, and grounds. Protect against damage or disfigurement from surface preparation media and spatters, splashes, overspray, and smirches of paint or material. As necessary, furnish adequate canvas or other suitable containment materials, for protection.

For field coating work, remove paint dropped on surfaces not designated to be coated. Remove debris from cleaning operations, empty paint containers, and other refuse.

2. Pollution Controls. Prevent environmental pollution including stream and air pollution caused by paint, paint sprays, paint chips, dust, or other harmful materials.

Comply with the regulations of the DEP and the State Fish Commission.

Do not proceed with work until the Department receives written acknowledgement that the regional office of the DEP was contacted and is aware of the controls to be exercised to complete the work in compliance with its regulations. No extension of contract time will be allowed for delays caused by failure to make a timely submission for this acknowledgement. Do not claim for costs to comply with requirements of regulatory agencies.

Conviction of a criminal summary complaint issued by the DEP may be cause for suspension of prequalification.

(b) Surface Preparation.

1. Solvent Cleaning. Where oil and grease are present remove according to the SSPC Surface Preparation Specification using No. 1 Solvent Cleaning (SSPC-SP1). Perform cleaning before blasting. If contamination remains after blasting, reclean with solvent.

2. Other Cleaning. Remove soil, concrete spatter, drawing compounds, salts, or other foreign matter by brushing with stiff fiber or wire brushes; by scraping; by cleaning with solutions of biodegradable cleaners, provided such cleaners are followed by a fresh water rinse or by a combination of these methods. Satisfactorily remove detrimental deposits from new weld areas. When directed remove water soluble salts, by high pressure water blast cleaning (gage pressure of 800 psig, minimum).

3. Blast Cleaning. Blast clean all steel to a near-white condition, as defined in SSPC-SP 1085. Determine the near-white blast condition by use of a Maryland Pictorial Standard, if shot blast is used; or SSPC-VIS 1-89, if sand or grit is used. Blast clean to leave an anchor pattern, 1 1/2 mils to 3 1/2 mils deep, in a dense, uniform pattern of depressions and ridges. Determine pattern depth by the Keane-Tator Surface Profile Comparator, or Testex Replica Tape. Grind laminations raised by the blasting operation to a flush surface and reblast the ground area to obtain the specified anchor pattern.

4. Preparing Galvanized Surfaces for Painting. Prepare entire surface according to SSPC-SP1. Remove unsightly areas including rough and/or heavy galvanizing as directed according to SSPC-SP2 and SSPC-SP3. Apply wash primer, compatible with galvanizing and selected paint system, or brush-off blast the entire surface as indicated on the approved drawings. Do not use steel shot for brush-off blast. Use a blast media with a low level of aggressiveness, such as crushed walnut shells, corn cobs or bi-carbonate of soda for example, but not inclusive.

5. Cleaning Concrete. After completing the superstructure work, remove rust stains on the substructure concrete, using an acceptable concrete rust remover, in the manner recommended by the manufacturer of the rust remover. Flush with water after application of rust remover.

(c) Painting.

1. Mixing Paints.

1.a Primer. Mix the primer with a high shear mixer (such as a jiffy mixer), according to the manufacturer's recommendations to a smooth, lump free consistency. Do not use paddle mixers or paint shakers. Mix in the original containers. Continue mixing until all of the metallic powder or pigment is in suspension. Ensure that all of the coating solids that might have settled to the bottom of the container are thoroughly dispersed.

1.b Subsequent Coats. Mix each subsequent coat to achieve and to maintain a homogeneous mixture.

1.c Strain the mixture through 30 mesh to 60 mesh screen openings to remove large particles. Equip paint containers with a mechanical agitator so the mixture is in motion throughout the application period.

2. Thinning Paint. Thin the paint, only as recommended by the manufacturer.

3. Conditions for Painting. Apply paint only on clean and dry surfaces and only during periods of favorable weather. Do not paint when the temperature of the air, paint, or metal is below 40F, and at no time below that described in the technical data sheet; when the air is misty; or when conditions are otherwise unsatisfactory. Do not paint damp or frosted surfaces or surfaces hot enough to cause the paint to blister, to produce a porous paint film, or to cause the vehicle to separate from the pigment. Paint only when the surface temperature is at least 5F above the dewpoint. Determine the dewpoint with the use of a psychrometer and psychrometric tables.

Allow each coat of paint to dry before applying the succeeding coat. Follow the manufacturer's recommendations for drying time, unless a longer drying time is required.

In damp or cold weather, keep the shop work under cover until thoroughly dry, or until weather conditions allow exposure.

4. Application. Apply primer and subsequent coats immediately after inspection and acceptance of the surface. Apply primer the same day the metal is cleaned. If the metal is blast cleaned and remains unpainted overnight, blast clean it again before priming.

Spray apply inorganic zinc-rich primer according to the manufacturer's recommendations. Striping of the inorganic zinc-rich primer is not required.

For application of the intermediate and finish coats, wet stripe all edges, bolts, welds, rivets, corners, crevices, and other irregularities either by brush or by a separate and distinct spray operation, before the application of the full coat. Provide safe access for inspection, as requested by the Representative, before application of the full coat over the striped areas. Do not apply the full coat until approval of the striping is provided.

Apply intermediate and final coats to areas of steel that will be inaccessible before the stage of construction that prevents access.

Apply the complete project site. Other types of prime coats may be substituted for the galvanized coating only if prior approval is received from the Department. Submit the written approval request at the preconstruction conference. Follow the paint manufacturer's recommendations to ensure compatibility between the prime coat and the intermediate coat and to ensure adhesion when the surface of the prime coat has been contaminated, for example, by bolt/nut lubrication.

5. Shop Painting. Apply the primer after shop fabrication, inspection and acceptance, but before shipment. Do not apply primer to galvanized surfaces.

Paint field contact surfaces and surfaces to be in contact with concrete with primer only. Do not paint within 2 inches of location of design field welds.

Coat machine-finished metal surfaces, subjected to movement, with either corrosion-preventive compound, conforming to the requirements of Military Specification MIL-C-16173D, Grade 2, or other acceptable material, as soon as possible after acceptance and before removal from the shop. Paint other surfaces of metal, either milled or finished, with primer. Certify the coating material as specified in Section 106.03(b)3.

Paint or stencil the required dates, weight markings, and erection markings only on previously primed or painted surfaces. Use a suitable paint that does not react with other primer or paint coats, and one that is not visible after the final field paint coat.

Allow the paint to dry completely before loading and shipping.

Protect the paint from damage and from contamination. Use coverings and proper storage, handling, shipping and erection techniques.

Repair damaged and contaminated coatings according to the manufacturer's recommendations.

6. Field Painting. Before paint is applied, clean dust and dirt and other contamination from the freshly painted surfaces.

If concreting or other operations have damaged the coatings, reclean and, if directed, repaint the damaged areas.

Clean unpainted surfaces, including bolts and field welded areas, as specified in Section 1060.3(b) and prime according to the recommendations of the manufacturer of the self-curing, inorganic zinc-rich system.

Painting of shear connectors is not required.

Do not apply field coats between October 31 and April 1 unless otherwise permitted in writing by the District Executive.

Apply intermediate and final coats according to the manufacturer's recommendations consistent with environmental constraints. Use acceptable brushes, rollers, spray equipment, or any combination of equipment that gives satisfactory results.

6.a Spray Painting. If air spray is used, provide suitable traps or separators to exclude oil and water from the air. Keep the paint thoroughly mixed by continuous mechanical agitation.

6.b Roller Painting. Use rollers that do not leave a stippled texture in the paint film. Use rollers only on flat, even surfaces to produce a paint film of even thickness with no skips, runs, sags, or thin areas.

6.c Brush Painting. Use flat brushes, not wider than 4 1/2 inches, or round or oval brushes.

Manipulate the paint under the brush to produce a uniform, even coat. Work the paint into corners and crevices. Move the brush in a series of small circles to thoroughly fill irregularities in the surface, then brush out and smooth by a series of parallel strokes until the paint film has an even thickness.

6.d Painting Inaccessible Areas. Thoroughly cover surfaces inaccessible to normal painting methods by use of sheepskin daubers, spray, or other means to ensure thorough coverage.

6.e Stenciling. After the final coat of paint has dried, stencil the following information on the inside face of the right fascia member at the near abutment ends unless directed otherwise:

- The bridge identification number,
- The month and year of completion,
- The specification identification of the cleaning method, and
- The list identification of the paint system.

Stencil using suitable black paint to provide uniform block lettering 2 inches to 3 inches high.

7. Thickness of Coats. The cumulative dry film thickness will be determined by use of a Magnetic Dry Film Thickness Gage, or the thickness of each coat will be determined by the use of a Tooke gage, or equal. Increase the thickness of coating, if directed by the Inspector-in-Charge, to ensure a finish that is uniform in color and appearance.

Apply the three-coat system as follows:

7.a Primer. Spray apply, as recommended by the manufacturer, in a single application, employing multiple spray passes, to a dry film thickness of 3 mils to 5 mils above the anchor pattern. The thickness will be determined with a Magnetic Dry Film Thickness Gage, and measured according to SSPC-PA2-73T. A dense and uniform appearance is required after the applied coating has cured. For areas deficient in coating thickness and areas exhibiting mudcracking, repair, as recommended by the manufacturer.

7.b Intermediate Coat. For an epoxy/urethane system apply the intermediate coat to a minimum dry film thickness of 4 mils.

For all other systems apply the intermediate coat to a minimum dry film thickness of 1 mil.

Use a color that contrasts with the colors of the zinc and finish coats.

7.c Finish Coat. For an epoxy/urethane system apply the finish coat to a minimum dry film thickness of 2 mils.

For all other systems apply the finish coat to a minimum dry film thickness of 3 mils.

8. Removal of Unsatisfactory Paint. The painting is unsatisfactory if rusting occurs; the paint coat lifts, blisters, wrinkles, has excessive runs or sags, or shows evidence of application under unfavorable conditions; the workmanship is poor; impure or unauthorized paint has been used; or for other reasons determined by the Representative. Remove unsatisfactory paint, clean the metal, and repaint, as specified.

1060.4 MEASUREMENT AND PAYMENT—Painting structural steel is incidental to the items of work painted.

SECTION 1070—PAINTING EXISTING STRUCTURAL STEEL

1070.1 DESCRIPTION—This work is surface preparation and coating of existing structural steel using a three-coat system. This work includes removal of existing coatings from the entire structure or zones as indicated, cleaning, soluble salt remediation, treatment of pack rust areas, and application of the three-coat system.

1070.2 MATERIAL—

(a) Coating System. Provide a three-coat organic zinc rich primer, epoxy intermediate, and urethane finish coat paint system listed in Bulletin 15 and the Northeast Protective Coatings Committee (NEPCOAT) Qualified Products List B. Provide caulking and penetrating sealer produced by the manufacturer supplying the coating for use in pack rusted areas. Provide written confirmation from the coating manufacturer that the caulking and penetrating sealer are compatible with the coating system if used as specified.

Verify the organic zinc rich primer has a Class B certification, certified within the last 7 years, from an AASHTO approved laboratory according to the Research Council on Structural Steel Connections (RCSC) Specification for Structural Joints Using High Strength Bolts Appendix A.

If a NEPCOAT List B three-coat system is proposed, but is not listed in Bulletin 15, obtain acceptance of the coating system as specified in Section 106.02(a)2.b before shipment to the project.

Obtain the coating system from one manufacturer. Do not mix components or coats from different systems of the same manufacturer or other manufacturers.

(b) Material Submittal Requirements. Provide the following submittals to the Structure Control Engineer a minimum of 30 calendar days before beginning surface preparation or coating operations. Do not begin surface preparation or coating operations until submittals have been accepted. Include the following:

1. Finish Coat Color Chips. Provide three new color chips conforming to the indicated AMS-STD-595A color number a minimum of 6-inch by 6-inch in size. If the color number indicates a finish other than semi-gloss, provide a semi-gloss finish coat. Do not obtain finish coat material until acceptance of the color and gloss level.

2. Coating Certifications. Provide coating certifications to the Representative and Chief Chemist of CMD.

- Provide Certificate of Testing from an AASHTO approved laboratory confirming the organic zinc rich primer has a Class B rating according to RCSC Specification for Structural Joints Using High Strength Bolts and has been tested within the last 7 years.

- For Bulletin 15 approved coating systems, certify as specified in Section 106.03(b)3 modified as follows: Submit a dated certification, Form CS-4171, from the manufacturer that each batch of the coating system meets specifications. Include in the certification, the product name for each coat of the system being supplied, and the production lot number of the batch being certified.

- If a non-Bulletin 15 approved NEPCOAT List B three-coat system is chosen and accepted, certify the material as specified in Section 106.03(b)3. PennDOT Construction and Material Management System (CAMMS) Test Report is to accompany each shipment to the project. The lot numbers on the CAMMS Test Report are to match the lot numbers shipped to the project.

3. Manufacturer's Technical and Safety Data. Provide current manufacturer's technical/product data sheets (PDS) and Safety Data Sheets (SDS) for each coating component. Additionally, provide PDS/SDS for the following; penetrating sealer, caulking, thinner/cleaners, soluble salt remover, and rust stain remover. Provide specific coating application instructions that list amount of thinning allowed including Volatile Organic Compounds (VOC) if thinned at those levels; minimum/maximum cure to recoat and full cure intervals based on time, temperature and relative humidity. Include manufacturer's information for determining recoat times and full cure times if the potential temperatures and relative humidity combinations are not listed on the technical product data/instruction sheets.

In the event of a conflict between the product data/instruction sheets or procedures and the specifications, the specifications will govern unless directed otherwise.

1070.3 CONSTRUCTION—

(a) General.

1. Quality Control (QC) Plan. Submit a QC Plan as specified in Section 106.03(a)2 and Section 106.03(b)2 to the Structure Control Engineer a minimum of 30 calendar days before beginning surface preparation or coating operations. Include procedures for inspections, tests, and documentation as specified in Section 1070.3(d)9. Do not begin surface preparation or coating operations until the QC Plan is accepted. Include the following with the QC Plan:

1.a. Cleaning, Painting, Penetrating Sealer and Caulking Installation Plans. Provide procedures for preparing and painting surfaces according to the requirements of this specification, including but not limited to the degree of surface cleanliness and surface profile to be achieved; abrasive type and size to be used; abrasive cleanliness verification; processes and equipment to be used for cleaning and painting limited access areas; mixing and thinning; film thickness, coverage, and continuity of each coat; drying times, cleanliness between coats; and preparation of surfaces with extended times between coats (defined as 80% of the published maximum recoat time or as otherwise defined by the manufacturer) or that have been exposed to out of season weather conditions. Include the equipment that will be used for cleaning and painting. Include the controls that will be exercised when applying coatings, especially zinc, with a roller or brush.

Provide application and installation instructions for penetrating sealer and caulking, including but not limited to the minimum/maximum joint width and depth that can be caulked/sealed; proper size and type of backer rod, if needed; application in lifts, if needed; caulk dry times before painting, and other installation instructions from the manufacturer. Include procedures for the treatment of pack rust including pack rust removal from crevices/gap areas as specified in 1070.3(c)4 and the application of penetrating sealer, stripe coats, and caulking as specified in 1070.3(d)5.

Provide coating repair procedures that comply with this specification and are approved by the coating manufacturer.

Provide a plan for conducting inspections and tests required by this specification and other tests that may be needed to confirm work performed complies with this specification and coating manufacturer requirements. Include a list of instrumentation to be used and confirmation the instruments are calibrated, and accuracy is verified according to the manufacturer's instructions. Include provisions for notifying the Representative when Hold Point inspections are reached and confirmation necessary repairs will be made and inspected. Provide samples of daily inspection reports.

If non-published technical instruction, guidance, letters, or information is submitted, provide a submission from an authorized, technically responsible manufacturer representative with a statement affirming the product warranty will not be affected.

Notify the Representative if a conflict between the manufacturer's technical data sheets, instructions or procedures and the contract specifications is identified. The contract specifications govern unless the manufacturer's technical data sheets, instructions or procedures are more stringent.

1.b Soluble Salt Remediation. Provide procedures for the detection and remediation of soluble salts and for recleaning and preparation of steel after remediation.

1.c Concrete Rust Remover. Provide procedures for removal of rust stains from concrete. Include application and removal of cleaner, alternate methods of removal such as pressure washing/blast cleaning, containment and disposal of the waste and wastewater.

1.d DEP Notification. Submit acknowledgment the regional office of the DEP was notified of the coating operations and is aware of the controls that will be exercised.

2. Technical Representation. Furnish the services of a technical representative from the coatings manufacturer at the Pre-Paint Meeting and as requested throughout operations.

3. Pre-Paint Meeting. Attend a Pre-Paint Meeting to discuss the specifications, QC Plan and surface preparation/coating operations after submittals have been accepted and a minimum of 14 calendar days before beginning operations. The following are required to attend: Prime Contractor Project Manager, Prime Contractor Superintendent, Coatings Contractor Foreman/Supervisor, Coatings Contractor Quality Control Inspector, Technical Representative from coatings manufacturer, Structure Control Engineer, Coatings Inspector and other individuals designated by the Department.

4. Protection of Structure, Persons, and Property. Conduct activities associated with surface preparation and coating work according to applicable Federal (OSHA), Environmental Protection Agency (EPA), State, and local (based on bridge location) safety regulations.

Use scaffolding and rigging conforming to OSHA regulations that provide safe ready access for workers and inspection purposes. The contractor is responsible to identify confined spaces and conform to OSHA regulations if performing work in confined spaces. The contractor is the controlling employer as defined by OSHA.

Protect pedestrian, vehicular, and other traffic on, under, and around bridge superstructures and substructures, as well as surrounding property and buildings against damage or disfigurement from all activities associated with the project work.

Remove paint from surfaces not designated to receive coatings. Remove project debris daily. Clean and remove abrasive blast media found outside of containment immediately. Conduct final removal of all project debris upon completion of the operations. Repair damage resulting from the project work to the satisfaction of the Representative at no additional cost to the Department.

5. Pollution Controls. Prevent environmental pollution including water, air, and soil pollution caused by surface preparation, paint spills or overspray, paint chips, dust, or other harmful materials as specified in Section 1072.

Conform to the regulations of the Pennsylvania DEP, Pennsylvania Fish Commission, Army Corp of Engineers, EPA, and local regulatory agencies.

If abrasive blasting is required, do not begin work until the Department receives and accepts documentation confirming an abrasive blasting permit was obtained. The Department will not extend the contract time for delays caused by a failure to make a timely submission of this acknowledgement.

Conviction of a criminal summary complaint issued by the DEP may be cause for suspension of prequalification.

6. Lighting. Provide artificial lighting both inside and outside containment if natural light is inadequate to allow proper visibility during cleaning, painting and inspection activities according to SSPC Technology Guide 12. Provide a minimum illumination of 50 foot candles (538 lux) for inspection and 20 foot candles (215 lux) for surface preparation and coating application, including working platforms, access, and entryways. Provide a minimum illumination in general work areas of 10 foot candles (108 lux). Design and operate exterior illumination to avoid glare that interferes with traffic, workers, and pedestrians. Provide a light meter for Department use with readings in lux or foot candles to verify the adequacy of illumination.

7. Hold Points. Specific inspection items throughout this Section are designated as a Hold Point. Do not proceed with operations beyond the Hold Point until Representative QA inspections/observations are performed and acceptance is provided. Permission to proceed beyond a Hold Point without QA acceptance will be granted solely at the discretion of the Representative. The Representative has the right to reject work performed without QA inspection/observation and acceptance.

(b) Surfaces to be Coated. Coat previously coated and new steel surfaces. Do not coat aluminum or galvanized metal surfaces, unless indicated. Do not apply intermediate and finish coats to faying surfaces or surfaces that will be in contact with concrete. Coat those surfaces with organic zinc primer only including top flanges and existing shear studs to remain. If new shear studs are indicated for existing stringers, floor beams, or girders, apply primer to the top flange then remove the primer at each shear stud location before installing. Install shear studs then spot prime shear stud welds and surrounding primer damaged by shear stud placement.

All faying surfaces are considered slip critical and primer applied to those surfaces must meet the requirements as specified in Section 1070.2(a) including but not limited to, the dry film thickness and minimum curing requirements listed on the Class B slip coefficient /creep resistance test certification before assembly of the faying connection. If black bolts are used, assemble connection then blast clean and coat bolts with three-coat system. Repair, feather, and recoat all surrounding coatings damaged by over blast as specified in Section 1070.3(d)7. Do not coat utilities or associated utility hangers and brackets unless indicated or directed. Coat limited access areas as specified in Section 1070.3(c)11.

(c) Surface Preparation.

1. Solvent Cleaning. Remove oil, grease, dust, dirt, drawing and cutting compounds, or similar contaminants on steel according to SSPC-SP1 Solvent Cleaning before surface preparation. If contamination remains after surface preparation, re-clean according to SSPC-SP 1 before painting. If grease, oil, dust, dirt, drawing and cutting compounds, or similar contaminants become deposited on any coat that will receive another coat, remove according to SSPC-SP1 before the application of the subsequent coat. If the primer or intermediate coat is exposed to vehicular exhaust, remove all hydrocarbon residue before application of the subsequent coat. If the removal of the contaminants utilizes water, manage and dispose of the water as specified in Section 1072. If water is used in the cleaning procedure, ensure surfaces, pockets, and corners are dry and clean before applying paint. Remove all flash rust resulting from the water cleaning process.

2. Other Surface Cleaning. Supplement solvent cleaning by hand or power tool cleaning as needed to remove

contaminants such as soil, concrete spatter, and other foreign matter. If biodegradable cleaning solutions are submitted and accepted for use, follow with a fresh water rinse. Comply with the requirement for removal of soluble salts as specified in Section 1070.3(c)8.

3. Weld Spatter, Sharp Edges, Flame-Cut Steel, and Holes. Remove slag, flux deposits, and weld spatter from newly installed steel. Grind resulting burrs smooth, including burrs around holes. Grind sharp edges, such as those created by cutting or shearing to an approximate 1/8 inch radius. Grind flame-cut steel to remove the hardened surface layer before blast cleaning. After surface preparation, inspect existing steel for thin, sharp edges (knife-edging). If present, grind edges to approximate 1/8 inch radius.

4. Pack Rust and Rust Scale Removal (Hold Point). Remove heavy corrosion (rust scale) and loose pack rust by hand and power tool cleaning or by abrasive blast cleaning before production abrasive blast cleaning. Ensure pack rust is removed to a minimum of 1/4 inch below the edge(s) of the steel members and the remaining pack rust is tight if probed with a dull putty knife. Exercise extreme care to avoid nicking or gouging the steel during removal. If nicks or gouges occur, the Representative may suspend activities until appropriate adjustments are made to prevent a recurrence. Notify the Representative of steel perforation, deformed steel at joints, broken rivets, or other similar defects revealed during abrasive blast cleaning of heavily rusted areas. The Representative will advise how the areas are to be addressed.

5. Test Areas (Hold Point). Select test section(s) on each structure of at least 9 square feet, in locations considered by the Representative to be representative of existing surface conditions and structural characteristics. Additionally, provide two 12 inch by 12 inch by 1/4-inch-thick carbon steel test plates to the Representative before production blast cleaning. Blast clean test sections and test plates using the same equipment, materials, and procedures that will be used for the production blast cleaning. Once accepted by the Representative, photograph the test sections for use as a jobsite standard, but in the event of a conflict between the jobsite standard and the written SSPC definition of the degree of cleaning required, the written definition prevails. Seal the test plates in plastic or air-tight containers with desiccant to prevent rusting and use to verify the accuracy of the dry film thickness gauges. If the test plates exhibit signs of rusting, reblast.

Additionally, the Representative will select a pack rusted test section. Clean, apply penetrating sealer, intermediate stripe coat, intermediate coat, caulk, and finish coat to pack rust test sections using the same equipment, materials, and procedures that will be used for production work.

If galvanized or black nut/bolt assemblies are to be coated, the Representative will select a representative connection as a test area. Clean and paint the connection as specified using the same equipment, materials, and procedures that will be used for production work.

Do not proceed with the production blast cleaning operations until the Representative accepts the surface preparation of each test section.

6. Blast Cleanliness (Hold Point). Blast clean steel according to SSPC-SP10 Near White Blast Cleaning.

Utilize clean, oil-free dry compressed air for abrasive blast cleaning. Conduct blotter test(s) according to ASTM D4285 a minimum of one time each shift for each compressor system in use to verify the air supply is free of moisture and oil contamination. Conduct the tests in the presence of the Representative. If contamination is evident, make changes as necessary to achieve clean, dry, air and re-inspect all surfaces prepared since the last acceptable test.

7. Abrasives and Surface Profile (Hold Point). Use recyclable abrasives that are clean, dry and properly sized to produce an angular, dense and uniform surface profile as specified in the product data sheets(s) for the coating being applied. Measure the surface profile depth according to SSPC-PA 17 using ASTM D4417 Method B, depth micrometer or Method C, replica tape. If the profile is outside of the specified range, obtain different abrasives and completely re-blast the steel to achieve the specified profile.

Use recyclable abrasives that are clean and dry to create the least amount of waste possible. Submit a technical data sheet from the recyclable abrasive manufacturer indicating the number of recycles possible with the material. Do not recycle abrasives beyond the manufacturer's recommended limits. Acceptable recyclable abrasives are aluminum oxide, silicon carbide, zirconium aluminum oxide, and steel grit. Requests to use expendable one time use abrasives such as garnet or coal slag meeting the requirement of SSPC-AB 1 may be considered on a case-by-case basis. Submit request to use expendable, one-time use abrasives to the Structure Control Engineer. Do not use requested abrasive until accepted. Do not use silica sand.

Use a reclamation system that removes fines, returns properly sized abrasive for reuse, and is equipped with dust collectors to ensure the discharge meets air quality requirements. Test the cleanliness of the recycled abrasive according to SSPC-AB 2. If the abrasive fails the tests, promptly replace the abrasive and make changes to the equipment as necessary to achieve compliance. Reclean contaminated areas.

Grind laminations and slivers in the steel that become visible after blast cleaning operations flush with the surface and re-blast the ground area to obtain the specified anchor pattern and cleanliness.

8. Soluble Salt Remediation. In the presence of the Representative, remediate soluble salts to the following levels:

Chloride	$< 7 \mu g/cm^2$
Ferrous Ion	$< 10 \mu g/cm^2$
Sulfate	$< 17 \mu g/cm^2$

Conduct soluble salt tests across the structure according to NACE SP0716 with special attention to corroded and pitted areas. Use the cell method of SSPC Guide 15 to collect the samples. Conduct this testing after abrasive blasting.

Provide the proposed method of soluble salt remediation in the QC Plan as specified in Section 1070.3(a)1. Include the process that will be used for recleaning the steel after testing.

If the soluble salts are removed using wet methods, remove the resulting flash rust before applying the coating.

9. Cleaning of Galvanized Nut/Bolt Assemblies (Hold Point). Use SSPC-SP 1, Solvent Cleaning, in conjunction with SSPC-SP 2, Hand Tool Cleaning to remove all grease, oil, dirt, dust, nut/bolt lubricant and other contaminants from nut/bolt assemblies (nuts, bolts and washers) before coating. Remove all lubricant, but slight discoloration from dye is allowed to remain, if after cleaning, it is not removed from rubbing vigorously with a white cotton cloth. The acceptance criteria for these areas will be established when conducting the test areas as specified in Section 1070.3(c)5.

10. Cleanliness Before Painting (Hold Point). Before painting, remove abrasive residue, dust, dirt, oil, grease, salts, or other foreign material from the surface. Pay specific attention to pockets and corners. Unless directed, conduct cleaning using standard methods, for example, bristle, fiber, or hair brushes; vacuuming; blowing with clean, dry, compressed air; or a combination thereof. If the paint contains lead or other toxic metals, use vacuums equipped with HEPA filtration. Blowing down with compressed air or brushing is allowed only if performed within a ventilated containment with the ventilation system in operation as specified in Section 1072.

Apply primer within 10 hours after the steel is cleaned. If the steel remains unpainted for longer than 10 hours, or if cleaned steel exhibits evidence of rust back, analyze for soluble salt contamination as specified in Section 1070.3(c)8. If soluble salts are present, remediate as specified in Section 1070.3(c)8. If soluble salts are not present, blast clean again before priming. Apply primer only after the Representative has accepted the prepared surface.

11. Cleaning Limited Access Areas (Hold Point). Perform cleaning to SSPC-SP10 in limited access areas such as inside box girder members or other irregularly shaped, complex configurations. Use short or angled blast nozzles, or other commercially available equipment as necessary, to properly clean the limited access areas. Limits are as indicated.

12. Cleaning Concrete. After completing the superstructure work, clean concrete of rust stains or coatings that resulted from the operations according to the accepted remediation method as specified in Section 1070.3(a)1.c. This can be by abrasive blasting to obtain a condition according to ASTM D4259, use of an acceptable concrete rust remover according to manufacturer's recommendations, or alternate accepted method. If concrete rust remover is used, flush with water after application and contain as specified in Section 1070.3(a)1.c.

13. Caulking Steel and Concrete Interface. If steel is cast into concrete, caulk all sides of steel where it penetrates the concrete surface. Use approved caulking material only.

(d) Coating.

1. Storage of Paints. Store paints under cover, out of direct sunlight and between 40F and 100F. Utilize a continuous temperature recording device to monitor storage temperatures. Should temperatures exceed the specified range, replace coatings at no additional cost to the Department. If the storage requirements of the manufacturer are more restrictive, comply with the more restrictive requirements.

2. Mixing and Thinning (Hold Point). Only use paint within the manufacturer's stated shelf life. Mix and thin paints according to the manufacturer's instructions until solids and metallic powder are thoroughly dispersed and a smooth, lump-free consistency is achieved. Do not over-mix or over-agitate during mixing such that air is entrained into the coating.

The mixing of partial kits is not permitted.

Use thinners and thinning amounts as recommended by the manufacturer. Do not thin such that the VOC of the coating exceeds Federal, State, or local VOC rules/regulations.

Strain mixed coating through a 30 to 60 mesh screen (or as indicated on product data sheet) upon completion of mixing. Comply with pot life and "sweat-in" times according to the coating manufacturer's recommendations before use.

3. Weather Conditions for Application of Coatings (Hold Point). Apply coatings to clean and dry surfaces during periods of favorable weather and if the specified conditions are met. If the requirements of the coating manufacturer are more stringent, comply with those requirements. Keep the coating work contained, protected from the elements, and within the specified temperature range until the coating is fully cured according to the manufacturer's requirements. The use of heating or dehumidification equipment is not allowed. If the potential exists for coatings not to reach full cure as specified in Section 1070.3(d)3.b, submit a plan to the Structure Control Engineer to monitor and maintain ambient conditions.

3.a Seasonal Restrictions. Do not apply coatings in the field between October 31 and April 1 unless allowed in writing by the Structure Control Engineer. For multi-season projects, only primer can remain uncoated until the following season.

3.b Temperature. Do not apply coatings if the temperature of the air, material, or surface inside or outside of the containment is below 40F or greater than 110F or is forecasted to drop below 40F or exceed 110F before the coating dries to full cure according to the times specified in the manufacturers' technical data sheet. If the requirements of the coating manufacturer are more stringent, comply with those requirements.

3.c Dew Point. Do not apply coatings if the temperature of the surface is less than 5F greater than the dew point based on the ambient air outside and inside of containment (both readings are required). If the requirements of the coating manufacturer, are more stringent, comply with those requirements.

3.d Relative Humidity. Do not apply coatings if the relative humidity is below or above the thresholds established in the manufacturer's product data sheets based on the ambient air outside and inside of containment (both readings required).

3.e Dampness. Do not apply coatings if the air is misty, the surfaces are damp or frosted, or if weather conditions outside and inside of containment are unsatisfactory.

In damp or cold weather, keep the coating work contained and protected until the coating is fully cured according to the manufacturer's instructions, before exposing to the elements.

4. Methods of Application. Apply all coats using equipment and methods, as recommended by the manufacturer, that produce a coating film complying with the specified requirements. Do not use a method of application disallowed by the manufacturer.

4.a Spray. Airless spray application is the primary method of application unless directed. If conventional air spray is used, provide suitable traps and separators to remove contamination from the compressed air supply. Conduct blotter test(s) according to ASTM D4285 a minimum of one time each shift for each compressor system in use to verify the air supply is clean and dry. Conduct tests in the presence of the Representative. For spray application of zinc primer, provide continuous mechanical agitation of the coating. Set the agitator to maintain a homogeneous mixture and prevent settling of solids and metallic zinc particles while not over-agitating the coating such that air entrainment occurs.

Do not allow solvents to enter spray lines for cleaning or any other purpose while coating application is in progress. Only use solvents to clean and flush spray lines after coating application is complete.

4.b Roller. Primarily used for stripe coating. May be used for small repair areas if allowed according to the coating manufacturer's product data sheet. Use rollers that do not leave a stippled texture in the paint film. Use rollers only on flat, even surfaces to produce a paint film of even thickness with no skips, runs, sags, or thin areas. Do not use rollers if prohibited by the manufacturer. If rolling with a zinc primer, stir the paint frequently during use to keep the zinc in suspension.

4.c Brush. Primarily used for stripe coating. May be used for small repair areas if allowed according to the coating manufacturer's product data sheet. Manipulate the paint under the brush to produce a uniform, even coat. Work the paint into corners and crevices. Move the brush in a series of small circles to thoroughly fill irregularities in the surface. Then, brush out and smooth by a series of parallel strokes until the paint film has an even thickness. Do not use brushes if prohibited by the manufacturer. When brushing with a zinc primer, stir the paint frequently during use to keep the zinc in suspension.

4.d Limited Access Areas. Use long frame roller handles, angled brushes, extended spray wands, or other means to thoroughly coat surfaces inaccessible to normal painting methods. Do not use methods of application, such as daubers, if prohibited by the manufacturer.

5. Application and Recoating Requirements.

5.a Removal of Contaminants. If concrete, salts, grease, oil, carbon based emissions, dirt, dust, or other

surface contaminations are present on prime, intermediate, or finish coats, clean the surface as specified in Section 1070.3(c)10 and the manufacturer's recommendations. Clean bare steel, prime, and intermediate coats before application of subsequent coats. Clean finish coat of rust stains, embedded debris, and other contamination to the satisfaction of the Representative.

5.b Cleaning After Seasonal Shutdowns or Extended Periods (Hold Point). If intermediate and finish coats are not applied before seasonal shutdowns or there is an extended period of time between coats (defined as 80% of the published maximum recoat time or as defined by the coating manufacturer), thoroughly pressure wash the surface before application of the next coat to remove grease, oil, grime, carbon based emissions, salts, dirt, dust, chalk and other surface contamination. If required by the coating manufacturer, roughen the surface before the application of the next coat.

Use clean, potable water at a minimum pressure of 2,000 pounds per square inch and maximum pressure of 5,000 pounds per square inch to remove dirt, dust, chalk, insect and animal nests, bird droppings and other foreign matter. Perform solvent cleaning according to SSPC-SP 1 if grease, oil, carbon-based emissions or other contaminants are on the surface.

If approved detergents are used in the cleaning water, rinse the surface clean with potable water and allow thorough drying before coating. Control the water used for cleaning on the project according to Sections 1072.

5.c Stripe Coats – All Areas Except Crevice/Gaps Receiving Pack Rust Treatment (Hold Point). Stripe coats are required to be a contrasting color. Follow manufacturer's requirements for tinting. Before or after application of the production prime coat, brush apply a stripe coat of primer to all nuts, bolts, welds, rivets, corners, crevices, and other irregularities. Thoroughly brush/work in stripe coat ensure complete coverage. Apply stripe coat of primer to remaining edges by brushing or rolling before or after application of production prime coat. Extend stripe coat 1 inch beyond the areas to be striped. Complete the stripe coat of primer within 48 hours of production prime coat application, if applying after production prime coat.

Before the application of the intermediate coat, apply a stripe coat of the intermediate coating to the same surfaces and in the same manner as the primer stripe coat. Do not apply the stripe or full coats until the previous stripe or full coat has dried to recoat according to the manufacturer's instructions.

A stripe coat is not required for the finish coat.

5.d Treatment of Pack Rust Areas (Hold Point). After pack rust removal and production blast cleaning, perform the following in crevices/gaps scheduled for pack rust treatment. In all cases, allow the caulking, penetrating sealer, and paint coats to dry according to manufacturer's recommendations before proceeding to the next step. Apply production primer application to surrounding steel while trying to avoid the crevice/gap to receive pack rust treatment. Overspray into the crevice/gap with primer is allowed. Do not apply the stripe coat of primer to the crevice/gap. Flood apply the penetrating sealer into the crevice/gap, so the material flows and wicks in. Remove excess penetrating sealer after flooding.

Brush apply a stripe coat of intermediate to the entire crevice/gap area before or after applying the full intermediate coat. After stripe and production intermediate coat application, caulk the crevice/gap to fully bridge and seal the area from moisture intrusion. If applied to multi-sided surfaces, apply caulk to the top and sides of crevice/gaps only. Allow a downward facing or bottom crevice/gap to remain uncaulked so moisture that may enter the crevice/gap can escape.

Apply finish coat.

6. Coating Thickness and Continuity (Hold Point). Apply each coat of the system according to the manufacturer's data sheet including the thickness ranges for each coat and dry times before the application of the next coat or stripe coat. Achieve a surface free of shadow-through, runs, sags, overspray, dry spray, pinholes, skips, misses, and other film discontinuities. Obtain a dense and uniform appearance for each coat.

Determine the dry film thickness of each coat according to SSPC-PA2 Coating Thickness Restriction Level 3, except measure each 100-square foot increment of the surface. Determine the thickness of each coat by subtracting the thickness of the underlying coats from the cumulative thickness measurements. If the thickness of an individual coat is in question, perform destructive dry film thickness measurements according to ASTM D4138 Procedure A, using a grooved cutting instruments such as a Tooke Gauge, or equal. Repair damage created by the cutting instrument at no additional cost to the Department.

If the thickness of any coat is less than specified, unless otherwise allowed, apply additional coating to achieve the specified thickness before applying the next coat.

If the thickness of any coat exceeds the specified maximum, or the surface exhibits runs, sags, dry spray, overspray, pinholes, or other discontinuities, remove the excessive thickness or discontinuity by sanding or abrasive blast cleaning. If the thickness is reduced to below the specified minimum, recoat the area. If the excessive thickness or discontinuity being removed is in the finish coat, apply a thin coat of finish material to achieve a smooth uniform appearance.

6.a Prime Coat. Apply the primer coating to a total dry film thickness (above the surface profile) in a single application, employing multiple spray passes, according to the manufacturer's technical data sheet.

6.b Intermediate Coat. Apply intermediate coating to a dry film thickness (above the primer) according to manufacturer's specified dry film thickness. Use an intermediate coat color that contrasts with the colors of the prime and finish coats.

6.c Finish Coat. Apply the finish coating to a dry film thickness (above the intermediate) according to manufacturer's recommendations.

Ensure touch up and repairs to outside face of fascia beams are uniform in nature blending into existing topcoat and void of flashing or checkerboard appearance. If spot touch up on the facia is visible, apply a full finish coat as directed to create a uniform and continuous appearance.

7. Removal/Repair of Defective Coating (Hold Point). A coat of paint is defective if: it is damaged; it lifts, blisters, peels, or wrinkles; it has runs or sags; the film exhibits any defect as specified in Section 1070.3(d)6, it shows evidence of application under unfavorable conditions; it does not meet the coating thickness and continuity requirements; rusting occurs; the workmanship is poor; impure or unauthorized paint has been used or if the coating has been damaged through the course of the project.

Remove/repair defective paint and recoat damaged or defective areas according to the manufacturer's technical data sheet, approved repair procedure, and as directed. If the defective paint or damage extends to bare steel or bare steel is exposed, clean the surface according to SSPC-SP10 or SSPC-SP11 as approved.

If the damage or defective paint does not expose the underlying steel, repair according to the manufacturer's technical data sheet and approved repair procedure.

For all repairs, roughen the existing coating around the repair area to ensure good adhesion. Feather the surrounding coating to expose a minimum of 1/2 inch of each coat or according to the manufacturer's approved repair procedure and provide a smooth transition into intact, adherent material for all coats.

8. Stenciling of Final Product. After the final coat of paint has dried to recoat, stencil the following information on the outside face of the fascia members at the near and far abutment ends (two in total) unless directed otherwise:

- Line 1: Month and year of completion and ECMS number
- Line 2: BR Key
- Line 3: BMS Number
- Line 4: Full or zone paint, type of coating system, and cleaning method
- Line 5: NEPCOAT number listed in Bulletin 15, and the manufacturers name

Examples:

Full Paint:	Zone Paint:
08-2018, ECMS 88335	09-2007, ECMS 70202
BR KEY: 712	BR KEY: 1436
02-0051-0110-0000	02-1019-0060-0149
FULL-OZEU, SSPC-SP10	ZONE-OZEU, SSPC-SP10
SSC(04)-03, Sherwin Williams	SSC(12)-04, Carboline

Stencil using indelible black paint compatible with the coating system and approved by the coating manufacturer. Provide uniform block lettering 2 inches to 3 inches high.

9. Contractor QC Inspection and QC Plan. Perform QC inspections and tests as described in the accepted QC Plan as specified in Section 1070.3(a)1. Document inspections and submit electronic daily QC reports to the Representative within 48 hours of inspection.

Provide a QC inspector that has a minimum NACE Level 1 certification, is solely dedicated to QC inspection, and does not engage in any production related activities.

Do not replace the QC inspector(s) assigned to the project without advanced notice to the Representative and acceptance of the replacement by the Representative.

During work, perform QC inspections necessary to ensure work is performed according to specifications and the manufacturer's instructions.

At a minimum, perform the following QC inspections:

- Ambient conditions;
- Compressed air cleanliness;
- Suitability of protective coverings and containment;

- Abrasive cleanliness (SSPC-AB 2);
- Surface cleanliness and profile;
- Soluble salt testing and removal;
- Coating storage, mixing, and application;
- Dry film thickness and continuity of each coat;
- Dry time, curing, and cleanliness of each coat;
- Touch up and repair of damaged or defective coats;
- Daily inspection of project site for cleanliness as defined in this specification including but not limited to blast media, hazardous/non-hazardous waste, and general refuse;
- Rust stain removal;
- Attend hold point inspections defined in Section 1070.3(a)7 and designated throughout this specification;
- Final condition and appearance;

10. Access for Representative Inspection. Facilitate Representative QA inspections/observations as required including providing safe access in close proximity to the work surface(s) where the inspections/observations need to be performed. Allow ample time for inspection activities.

1070.4 MEASUREMENT AND PAYMENT—Lump Sum.

(a) Painting Existing Structural Steel. Lump Sum. The price includes surface preparation and coating removal, pack rust/rust scale removal, soluble salt remediation, grinding of sharp edges, slivers, weld spatter, removal of concrete slurry, cleaning and application of the three-coat paint system. The price also includes removal of coatings from surfaces not designated to be painted; repair of damage resulting from the coating operation; removal of coating that does not meet specifications and recoating of those surfaces; and controls necessary to comply with the requirements of all applicable regulatory agencies.

(b) Penetrating Sealer and Caulking Application. Dollar. For projects including a separate item for penetrating sealer and caulking, the proposal will include a predetermined amount of money for furnishing and application of penetrating sealer and caulking. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount. This item includes access to the repair locations to perform and inspect the work. For projects that do not include a separate item for penetrating sealer and caulking, the material and work are incidental to the Painting Existing Structural Steel, Lump Sum Item.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Penetrating Sealer and Caulking Applications item as follows:

1. **Contract Items.** The Department will pay for the performance of work, identified as having similar items listed in the contract, at the contract unit price.

2. **Non-Contract Items.** The Department will pay for items of work not identified in the contract as follows:

   - **Negotiated Price.** At price agreed upon with the Department Representative before performing the work. If applicable, agreement is also required with FHWA.
   - **Force Account Basis.** Section 110.03(d).

SECTION 1071—SPOT PAINTING EXISTING STRUCTURAL STEEL

1071.1 DESCRIPTION—This work is spot painting existing structural steel as indicated and directed.

1071.2 MATERIAL— Section 1070.2 except as follows:

Section 1070.2(a) Coating System, replace with the following:

(a) Coating System. Provide a three-coat, aluminum-filled mastic paint system from a manufacturer listed in Bulletin 15. For faying surfaces, provide an organic, zinc-rich primer listed in Bulletin 15 and the Northeast Protective Coatings Committee (NEPCOAT) Qualified Products List B. Verify the organic, zinc-rich primer has a Class B certification, certified within the last 7 years, from an AASHTO approved laboratory according to the Research Council on Structural Steel Connections (RCSC) Specification for Structural Joints Using High Strength Bolts Appendix A.

Section 1070.2(b)1. Finish Coat Color Chips, replace with the following:

1. Finish Coat Color Chips. Provide three new color chips matching the existing structure color in its current condition to a color number from the AMS-STD-595A color chart. Provide samples that are a minimum of 6 inch by 6 inch in size. If the color number indicates a finish other than semi-gloss, provide a semi-gloss finish coat. Do not obtain finish coat material until acceptance of the color and gloss level.

1071.3 CONSTRUCTION— Section 1070.3 except as follows:

Section 1070.3(c)5. Test Areas (Hold Point), replace with the following:

5. Test Areas. Test Areas are not required for Spot Painting.

Section 1070.3(c)6. Blast Cleanliness (Hold Point), replace with the following:

6. Blast Cleanliness (Hold Point). Blast clean steel according to SSPC-SP10 Near-White Metal Blast Cleaning. Alternately, steel may be cleaned according to SSPC-SP11 Power Tool Cleaning to Bare Metal if surface profile requirements outlined in the product data sheet are followed. Utilize clean, oil-free, dry compressed air for abrasive blast cleaning. Conduct blotter test(s) according to ASTM D4285 a minimum of one time each shift for each compressor system in use to verify the air supply is free of moisture and oil contamination. Conduct the tests in the presence of the Representative. If contamination is evident, re-inspect all surfaces prepared since the last acceptable test. Roughen the existing coating around the area to be coated to ensure good adhesion. Feather the surrounding coating to expose a minimum of 1/2 inch of each existing coat and provide a smooth transition into intact, adherent material for all coats.

Section 1070.3(c)7. Abrasives and Surface Profile (Hold Point), replace with the following:

7. Abrasives and Surface Profile (Hold Point). Expendable, one-time use abrasives such as garnet or coal slag meeting the requirements according to SSPC-AB 1 may be used that produce a surface profile according to the product data sheet(s) for the coating being applied. Submit expendable, one-time use abrasives to the Structure Control Engineer for acceptance. Do not use silica sand.

Recyclable abrasives may be used that are clean, dry, and properly sized to produce a surface profile according to the product data sheets(s) for the coating being applied. Use recyclable abrasives that create the least amount of waste possible. Submit a technical data sheet from the recyclable abrasive manufacturer indicating the number of recycles possible with the material. Do not recycle abrasives beyond the manufacturer's recommended limits. Acceptable recyclable abrasives are aluminum oxide, silicon carbide, zirconium aluminum oxide, and steel grit.

Use a reclamation system that removes fines, returns properly sized abrasive for reuse, and is equipped with dust collectors to ensure the discharge meets air quality requirements. Test the cleanliness of the recycled abrasive

according to SSPC-AB 2. If the abrasive fails the tests, promptly replace the abrasive and make changes to the equipment as necessary to achieve compliance. Reclean contaminated areas.

Measure the surface profile depth according to SSPC-PA 17 using ASTM D4417 Method B, depth micrometer or Method C, replica tape. If the profile is outside of the specified range, obtain different abrasives and completely re-blast the steel to achieve the specified profile.

Grind laminations and slivers in the steel that become visible after blast cleaning operations flush with the surface and re-blast the ground area to obtain the specified anchor pattern and cleanliness.

1071.4 MEASUREMENT AND PAYMENT—Lump Sum

Penetrating Sealer and caulking are incidental.

SECTION 1080—PRESTRESSED CONCRETE BRIDGE SUPERSTRUCTURE

1080.1 DESCRIPTION—This work is the construction of a prestressed concrete bridge superstructure.

1080.2 MATERIAL—

(a) Deck and Barriers.

- Cement Concrete Structures—Section 1001.2
- Preformed Neoprene Compression Joint Seal for Bridges—Section 1008.2
- Pedestrian Railing—Section 1012.2
- Aluminum Bridge Hand Railing—Section 1023.2
- Steel Bridge Hand Railing—Section 1022.2
- Protective Barrier—Section 1015.2
- Protective Fence—Section 1016.2
- Protective Coating for Reinforced Concrete Surfaces—Section 1019.2(a)
- Armored Preformed Neoprene Compression Dam—Section 1021.2
- Tooth Expansion Dam With Drain Trough—Section 1020.2
- Reinforcement Bars—Section 709.1
- Neoprene Strip Seal Dam—Section 1026.2

(b) Beams and Bearings.

- Prestressed Concrete Bridge Beams—Section 1107.02
- Plain Steel Bars—Section 709.1(a)2
- Closed Cell Neoprene Sponge—Sections 1107.02(p)1 and 1107.03(e)3
- Plain and Laminated Neoprene Bearing Pads—Sections 1113.02 and 1113.03(g)
- Bedding Material for Bridge Shoes—Section 1113.03(h)
- Steel Bearings—Section 1107.02(j)
- Post Tensioning, when required—Section 1108.02
- Nonshrink Epoxy Grout for Shear Keys—Section 1080.2(g)
- Nonshrink Grout for Studs, Dowels, and Anchor Bolts—Section 1001.2(e)
- Epoxy Resin Protective Coating—Section 1019.2(b)

- High Load Multi-Rotational Bearings—Section 1111

(c) Nonshrink Grout. Use either a premixed, nonshrink grout, from a manufacturer listed in Bulletin 15 and certified as specified in Section 106.03(b)3, or mix as follows:

- One part Non-shrink Grout Admixture—Bulletin 15. Certify as specified in Section 106.03(b)3.
- Two parts Cement, Type IP, IS or II—Section 701
- Three parts Fine Aggregate, Type A—Section 703.1
- Water—Section 720.1

Required minimum compressive strength:

- 1,000 pounds per square inch at 24 hours
- 4,000 pounds per square inch at 28 days

Combine dry materials in the mixer, then agitate to mix. Add water slowly and mix for 3 minutes or less, or according to the manufacturer's instructions.

Mix as closely as possible to the site of the work and use each batch within 20 minutes. Do not retemper. Mold daily test cylinders according to PTM No. 521. Test cylinders according to PTM No. 604.

(d) Fabricated Structural Steel. Section 1105. At least 2 weeks before the start of fabrication, furnish to the Inspector-in-Charge a complete list of the names and addresses of firms that are to fabricate or supply incidental, fabricated structural steel items to be used in conjunction with, or as a part of, the prestressed concrete members.

(e) Modified Mortar for Beam Seat Leveling. Use mortar from a manufacturer listed in the Miscellaneous Section – Polymer Modified and Special Cements, Mortars, and Concrete in Bulletin 15 conforming to the following specifications:

- Polymer modified
- Non-shrink
- Non-sag consistency
- Application thickness range 1/8 inch to 1/2 inch
- Properties

Initial set time (AASHTO T 131)	1/2 hour minimum
Compressive strength (AASHTO T 106)	2,500 pounds per square inch—24 hours 3,500 pounds per square inch—7 days 5,000 pounds per square inch—28 days
Slant shear bond test (ASTM C882, Modified)	2,000 pounds per square inch—7 days
Freeze-thaw resistance (PTM No. 633)	8%—maximum loss by weight

Certify as specified in Section 106.03(b)3.

(f) Post-Tensioning Strand. Section 1108.02(g)

(g) Nonshrink Epoxy Grout for Shear Keys in Adjacent Prestressed Concrete Box Beam Bridges. Use Nonshrink Epoxy Grout as specified below:

Required minimum compressive strength:

- 4,000 pounds per square inch at 24 hours
- 5,000 pounds per square inch at 28 days

1080.3 CONSTRUCTION—

(a) General. The superstructure consists of all indicated portions of the bridge above the bridge seat and includes bearings, bearings and anchors set in the substructure, abutment backwalls, cheekwalls, shear blocks, bridge drainage down to, but not including, the drain box, and portions of wings and appurtenances above the horizontal construction joint nearest the bridge seat.

At the bridge site, beams will be inspected for possible damage**,** cracking, and twisting during shipment**,** and for camber, tolerances, and dimensions. Replace beams damaged by improper storing, handling, transporting, or erecting at no additional cost to the Department.

(b) Superstructure. Construct the superstructure as indicated, as shown on the Standard Drawings, and as follows:

- Fabricated Structural Steel—Section 1105
- Cement Concrete Structures—Section 1001.3
- Preformed Neoprene Compression Joint Seal for Bridges—Section 1008.3
- Pedestrian Railing—Section 1012.3
- Aluminum Bridge Hand Railing—Section 1023.3
- Steel Bridge Hand Railing—Section 1022.3
- Protective Barrier—Section 1015.3
- Protective Fence—Section 1016.3
- Tooth Expansion Dam with Drain Trough—Section 1020.3
- Reinforcement Bars—Section 1002.3
- Neoprene Strip Seal Dam—Section 1026.3
- Armored Preformed Neoprene Compression Dam—Section 1021.3
- High Load Multi-Rotational Bearings—Section 1050.3(c)4.h

(c) Erection.

1. Erection Plan. Submit an erection plan for acceptance, signed and sealed by a Professional Engineer registered in the State. Provide details for all anticipated phases and conditions during erection. Include details of falsework, temporary bents, bracing, guys, dead-men, lifting devices, and attachments to bridge members. Include the sequence of erection, location of cranes and barges, crane capacities, crane operator's license for the operator

performing the crane work, location of lifting points on the bridge members, and weights of the members. If required, furnish calculations to demonstrate that allowable stresses are not exceeded and that member capacities and final geometry will be correct. Include delivery plan with erection plan. The delivery plan is to include delivery routes, ingress and egress to the site, and any modifications required for safe transport to the site. List equipment needed to unload or move bridge members. Do not proceed with erection until the erection plan has been accepted. Maintain an accepted copy of the erection plan onsite during erection operations.

1.a Pre-Erection Meeting. Before erecting falsework or permanent bridge members, conduct a pre-erection meeting a minimum of 14 calendar days before erection with the Professional Engineer of record for the erection plan, prime contractor, superintendent in charge of beam setting operation, crane operators or crane company representative, signal personnel, Structure Control Engineer, and onsite Representative to discuss the accepted erection plan. Conduct safety talk with crane operator as specified in Section 108.05(c)6.

1.b Conformance to Erection Plan. Ensure conformance to the erection plan. Any modification to or deviations from the accepted erection plan will require revised drawings, calculations, and verification of stresses and geometry.

1.c Erection Stresses. Account for any erection stresses that are induced in the structure as a result of the use of a method of erection or equipment which differs from that indicated or specified, and which will remain in the finished structure as locked-in stresses. Provide additional material, at no additional cost to the Department, to keep both temporary and final stresses within the allowable limits used in design.

Provide temporary bracing or stiffening devices to accommodate handling stresses in individual members or segments of the structure during erection. Use wind loads and distribution of wind loads to girders according to AASHTO Guide Specifications for Wind Loads on Bridges During Construction.

1.d Maintaining Alignment and Camber. During erection, support segments of the structure in a manner that will produce the proper alignment and camber in the completed structure. Install cross frames and diagonal bracing, as necessary during the erection process, to provide stability and ensure correct geometry. Provide temporary bracing, if necessary, at any stage of erection.

2. Bearings. When elastomeric bearings are used under beams, temporarily remove or relocate waterproofing and other material as required to expose all sides of the pad. If a gap between the pad and bearing surfaces is present, proceed as follows unless the contract plans indicate that a lift-off condition is expected when the beam is initially set on the pad:

- **Gap Thickness > 3/8 inch.** If a gap along any edge of the pad exceeds 3/8 inch, grind the bearing surface of the substructure to eliminate the gap, except gaps along the front edge of the pad (edge toward the midspan of the beam) will be allowed as specified in Steps 1 and 2 below. Provide a rough textured bearing surface after grinding. Verify that the minimum required vertical clearance to the bottom of beams, as indicated, is maintained after grinding.

- **Gap Thickness ≤ 3/8 inch.** If gaps along any edge of the pad are less than or equal to 3/8 inch, proceed as follows:

  <u>Gap Along Rear Edge of Pad Only</u>. If a gap occurs anywhere along the rear edge of the pad (edge toward the end of the beam), eliminate the gap by placing a leveling bed of polymer-modified mortar beneath the pad as specified in Section 1080.3(c)2.a.

  <u>Gap Along Side Edges of Pad</u>. If a gap occurs along the side edges of the pad, and there is full contact at the front and rear edges, eliminate the gap by placing a leveling bed of polymer-modified mortar beneath the pad as specified in Section 1080.3(c)2.a.

  <u>Gap Along Front Edge of Pad</u>. If a gap occurs along the front edge (edge toward the midspan of the beam of the bearing pad), proceed as follows:

  Step 1: Determine the area of non-contact between the pad and beam. If the amount of non-contact is less than 20% of the pad area, proceed to Step 2; otherwise eliminate gap by grinding

of bearing surface. A leveling bed of polymer-modified mortar beneath the pad as specified in Section 1080.3(c)2.a may be used instead if approved by the Structural Control Engineer.

Step 2: Measure the maximum gap thickness along the front edge and proceed as follows:

Spans < 100 feet	
Gap Thickness ≤ 3/32 inch:	Leave gap in place.
3/32 inch < Gap Thickness ≤ 3/8 inch:	Eliminate the gap by placing a leveling bed of polymer-modified mortar beneath the pad as specified in Section 1080.3(c)2.a.
Spans ≥ 100 feet	
Gap Thickness ≤ 1/8 inch:	Leave gap in place.
1/8 inch < Gap Thickness ≤ 3/8 inch:	Eliminate the gap by placing a leveling bed of polymer-modified mortar beneath the pad as specified in Section 1080.3(c)2.a.

2.a Leveling Bed of Polymer-Modified Mortar, Placement Procedure.

1. Immediately before lifting beam, prepare mortar according to the manufacturer's recommendations. Do not extend mortar by adding coarse aggregate.
2. Lift beam as necessary.
3. Remove pad.
4. Apply a bed of mortar to the beam seat, covering an area approximately 2 inches beyond the perimeter of the bearing pad. Apply the mortar in a thickness approximately 1/8 inch greater than the maximum actual gap thickness.
5. Place the pad on the mortar.
6. Reset the beam on the pad while the mortar remains plastic.
7. Cure the mortar, as applicable, according to the manufacturer's recommendation.
8. Replace all previously removed preformed cellular polystyrene and closed cell neoprene sponge material around bearing area.

Place mortar according to temperature restrictions recommended by the manufacturer.
Do not place a leveling bed of mortar before the initial setting of beams.

(d) Shear Key Joints Between Adjacent Box Beams.

1. General. Check shear keys for widths. Maximum allowable gap between beams will be the tolerance for horizontal alignment plus 1/2 inch, as specified in Section 1107.03(e)1.b.

2. Preparation of the Joints. Before shipping, intentionally roughen and clean entire sides of beams where shear keys are present to provide a rough and bondable surface and to remove oil, grease, dirt, or material that would prevent bonding. Just before erection, clean the roughened surface with oil free compressed air, clean stiff-bristle fiber brushes, or vacuum. Seal joints at the bottom of beams below the shear keys with caulking, suitable backer rod, and/or closed cell neoprene sponge as shown on the Standard Drawings.

3. Filling Joints. Fill the longitudinal joints between adjacent beams with nonshrink epoxy grout as specified in Sections 910.2(b) and 1080.2(g). Place grout quickly and continuously into the joints. Follow the manufacturer's recommendations for filling in hot or cold weather.

Do not allow construction activity or other loadings on the bridge for at least 24 hours after the grout has been placed. For vehicular loading, Section 1080.3(d)5 applies.

4. Curing. Start curing immediately after the grout has been placed. Use a double thickness of water-saturated burlap. Keep the burlap wet during the curing period for at least 24 hours. During cold weather, prevent freezing of the grout. Provide curing temperatures of 50F or above.

5. Opening to Traffic. After grouting shear keys, do not allow any traffic on a span until grout compressive strength is 3,200 pounds per square inch minimum.

(e) Protective Coating for Prestressed Concrete Beams. Where indicated, apply an epoxy-resin protective coating, as specified in Section 1019.3(b). Apply coating as specified in Section 1019.3(b). Cure the coating according to the manufacturer's recommendations.

(f) Waterproofing at Abutments. As indicated, place closed cell neoprene sponge on top of abutments, then erect the beams.

Use a wire brush and clean vertical end notches in beams of adjacent box beam bridges, then seal by caulking with a suitable backer rod. Wet the backer rod 1 hour before grouting. Fill the notches with nonshrink grout. Cure with wet burlap for at least 24 hours.

(g) Resetting Expansion Bearings. Where indicated, reset expansion bearings as specified in Section 1050.3(c)4.c.2.

(h) Post-Tensioning Adjacent Box Beams. Post-tension adjacent box beams as indicated and as specified in Section 1108.03.

1080.4 MEASUREMENT AND PAYMENT—Lump Sum. The price includes the following component items.

- **Prestressed Concrete Bridge Beams.** Linear Foot
- **Preformed Neoprene Compression Joint Seal for Bridges.** Section 1008.4
- **Pedestrian Railing.** Section 1012.4
- **Aluminum Bridge Hand Railing.** Section 1023.4
- **Steel Bridge Hand Railing.** Section 1022.4
- **Protective Barrier.** Section 1015.4
- **Protective Fence.** Section 1016.4
- **Protective Coating for Reinforced Concrete Surfaces.** Section 1019.4
- **Tooth Expansion Dam with Drain Trough.** Section 1020.4
- **Armored Preformed Neoprene Compression Dam.** Section 1021.4
- **Reinforcement Bars.** Section 1002.4
- **Neoprene Strip Seal Dam.** Section 1026.4
- **Cement Concrete Structures.** Section 1001.4
- **Fabricated Structural Steel.** Section 1050.4
- **High Load Multi-Rotational Bearings.** Section 1050.4
- **Reset Expansion Bearings, Prestressed Concrete Superstructure.** Each

SECTION 1085—PRECAST REINFORCED CONCRETE BOX CULVERT

1085.1 DESCRIPTION—This work is the manufacture, storage, delivery, installation, and assembly of precast reinforced concrete box culvert segments into one continuous unit.

1085.2 MATERIAL—

(a) Cement Concrete. Section 704, Section 1085.2(e)

(b) Deformed Welded Wire Fabric. Section 709.4

(c) Galvanized Specialized Assembly and Tightening Hardware, Sleeves, Lug Plates, Bolts, Nuts, and Washers. Section 1105.02(d)

(d) Nonshrink Grout. Section 1080.2(c)

(e) Precast Reinforced Concrete Box Culvert Segments. From a manufacturer listed in Bulletin 15. Furnish, test, and place cement concrete as specified in Section 714.7; except, with a minimum 28-day compressive strength of 5,000 pounds per square inch or as shown on the approved shop drawings. Provide concrete as specified in Section 704 and meeting the specified compressive strength or other requirements shown on the approved shop drawings. AASHTO M 259/M 259M or M 273/M 273M; except, modify Section 11, Permissible Variations according to Form TR-28 and as follows:

- **11.1 Internal Dimensions**—Do not allow the internal dimensions to vary from design by more than 1% with a maximum variation of 1 inch. Do not allow the internal diagonal dimensions to vary by more than 1 inch. Do not allow the haunch dimensions to vary more than 1/4 inch from design dimensions.

- **11.2 Slab and Wall Thickness**—Do not allow slab and wall thickness to vary from design dimensions by more than plus 1/2 inch or minus 3/16 inch.

- **11.3 Length of Opposite Surface (square segments only)**—Do not allow laying length of any opposite or opposing surfaces of the box segment to vary more than 1/8 inch/foot of the internal span, with a maximum of 5/8 inch.

- **11.5 Position of Reinforcement**—Do not allow the position of the reinforcement to vary from the approved shop drawings by more than 1/2 inch in any direction. Place reinforcement so the indicated cover clearance does not deviate more than ± 1/4 inch. Provide 1 1/2 inch minimum cover at the mating surface, as measured to the end of the joint.

Certify as specified in Section 106.03(b)3.

(f) Reinforcement Bars. Section 1002.2

(g) Waterproofing. Section 680.2

(h) Selected Borrow Excavation - Structure Backfill. As shown on the Standard Drawings.

(i) Concrete Bonding Compound. Section 706

(j) Rock Protection. Section 850.2(a) and as indicated.

(k) Joint Sealing Compound. Section 705.4(e)

(m) Neoprene Joint Material. Identify neoprene material according to the type, class, and grade. Print, stencil, or otherwise affix this code to each pad at intervals of not more than 24 inches and in letters and numerals of not less than 1/4-inch height. Additional information such as lot or batch numbers, date, plant and place of manufacture, trademark, or name of manufacturer may also be added. Certify as specified in Section 106.03(b)3.

1. Closed-Cell Neoprene Sponge. Pads may be manufactured as sponge neoprene or expanded neoprene and may be composed of laminations. Use material conforming to the following:

- ASTM D1056, Type 2, Class C, Grades 2, 3, 4, and 5, including the requirements of suffixes B3 and F1
- ASTM D 1171, Quality Retention Rating of 100% after 6 weeks exposure

(n) Post Tensioning Strands. Section 1108.02(g)

1085.3 CONSTRUCTION—Construct as indicated and according to Article 12.11 of the AASHTO LRFD Specifications.

(a) Design. Design according to AASHTO specifications, as supplemented by PennDOT Design Manual, Part 4.

(b) Shop Drawings. Obtain approval of shop drawings before fabricating precast box culverts.

Show segment length on drawing. Provide segments of maximum length compatible with hauling equipment in order to minimize the number of joints.

Provide shop drawings as specified in Section 105.02(d).

Provide shop drawings clearly showing all items incorporated into the box culvert including all reinforcing. List items such as chairs and inserts by source, type, and supplier.

(c) Inspection. The Department will inspect precast segments during the entire fabrication process. The necessary facilities for inspection include a plant office as specified in Section 714.5(a).

(d) QC

1. General. Establish a level of QC based on uniform production practices. Submit the plant's QC Plan and mix design(s) to the Structural Materials Engineer, BDTD, for review and approval. Include with the QC Plan a company organizational chart indicating a separate chain of command from the QC Manager to the Owner/Plant Manager, independent of the Production Manager. Resubmit the QC Plan, mix design, and organizational chart if processes, materials, or personnel change.

2. QC Manager. Provide a QC Manager who has overall responsibility for the adequacy of production facilities, QC, sampling and testing, and fabrication of the product, and who will ensure that items are fabricated as designed and as specified. QC Managers are required to maintain an active ACI Grade I Field Technician Certification.

3. QC Personnel. Assign sufficient qualified personnel with precast concrete experience, to be responsible for QC and sampling and testing during the complete fabrication process, storage, and shipment. Technicians responsible for concrete sampling and testing are required to provide written evidence that they successfully completed the certification requirements for an ACI Grade I, Field Technician or have approval from the Structural Materials Engineer as a technician-in-training. Do not proceed with production until qualified personnel are present and approved.

4. Plant Acceptance. Section 714.4, except, register and certify the plant under either the National Precast Concrete Association (NPCA), American Concrete Pipe Association (ACPA) box culvert or Prestressed Concrete Institute (PCI), box culvert plant certification program. Submit an annual endorsed copy to the Chief Structural Materials Engineer for continued qualification.

(e) Handling and Storage. Handle and store precast reinforced concrete box culvert segments so that damage will not occur to the concrete or reinforcing steel. Provide suitable lifting devices for handling and installing precast reinforced concrete box culvert segments. Galvanize metal devices as specified in Section 1105.02(s). Before shipping, verify gasket material is sufficiently adhered to the joint. Verify gaps are not present between strips of adjacent gasket material. If gaps are present, a minimum of 6 inches must be replaced to assure material is tight.

(f) Delivery. Repair or replace precast reinforced concrete box culvert segments damaged by improper storing, handling, transporting, or erection. Minor damage may be repaired in the field according to Publication 145. Submit major repair procedures beyond the scope of Publication 145 to the Chief Structural Materials Engineer for evaluation and acceptance. Replace any segment that cannot be repaired to the satisfaction of the Representative.

The Representative will inspect the segments at the site for possible damage and cracking during shipment and for tolerances and other dimensions required for acceptance.

Do not ship segments until the 28-day minimum compressive strength is attained.

Provide 24-hour advance notice of loading and shipping schedule. Have the Representative verify Form CS-4171 and properly tag segments before shipping. Do not ship unapproved items.

Before shipping, patch lifting or handling devices that were temporarily used by the fabricator. Repair with Bulletin 15 approved patching material. If temporary lifting or handling devices are deemed necessary to be used during shipping and/or handling at the project site, provide details on the shop drawings for review and acceptance. Repair temporary lifting or handling devices with Bulletin 15 approved patching material.

(g) Architectural Treatment (When Indicated). As specified in Section 1086.3(d) and as indicated:

1. Prefabrication Meeting. Two weeks prior to fabrication, conduct a pre-fabrication meeting at the Fabricator's location to verify shop drawing, catalog cuts, staining materials, and fabrication information.

2. Test Sections (samples). Fabricate samples for acceptance before normal fabrication and after acceptance of the shop drawings and catalog cuts for the architectural treatment. Fabricate samples using the same process and materials that will be used for production. Erect samples at place of manufacture and store outdoors to allow for proper lighting for comparisons during manufacturing and inspection.

Apply penetrating stain, where specified, to one half of sample, to show the final finish after the sample wall is constructed.

Once test sections are fabricated, notify the Department, at least seven days before normal fabrication, so the appropriate Representatives may be present to determine acceptability of the test sections. Representatives may include the Environmental Manager, Project Manager, Design Staff, Construction Staff, Structural Materials Section representative and any other project team member designated by the Department.

Use test sections to determine the acceptability of the various surface treatments based on quality and overall appearance. Provide surfaces uniform in color and free of surface blemishes.

View architectural treatments for the sample and subsequent production pieces for acceptance at a distance of 30 feet, unless otherwise specified.

Produce additional samples until an acceptable product is produced if initial test sections are found to be unacceptable.

Accepted test samples will be used for comparative purposes for accepting production pieces. Additional test sections may be required if test sections are needed at the project site location.

Acceptable samples fabricated to the accepted shop drawings are allowed to be incorporated into the project in the final stage of construction, after all production has been completed and accepted.

(h) Installation Requirements. Submit erection plan for acceptance. Include crane locations, crane capacities, crane operator's license for the operator performing the crane work, setting devices, rigging, and communication

system to be employed during beam setting operations in the erection plan. Maintain an accepted copy of the erection plan onsite during erection operations. Erect culvert according to the accepted erection plan and accepted shop drawings. Have a Professional Engineer registered in the State sign and seal the erection plan. At the project site, the culvert will be inspected for tolerances, dimensions, and damage during shipment. Replace culvert segments damaged by improper storing, handling, transporting, or erecting at no additional cost to the Department. Before setting the culvert, conduct a pre-erection meeting a minimum of 14 calendar days before erection with the Professional Engineer of record for the erection plan, prime contractor, superintendent in charge of culvert setting operation, crane operators or crane company representative, signal personnel, Structure Control Engineer, and onsite Representative to discuss the accepted erection plan. Conduct safety talk with crane operator as specified in Section 108.05(c)6.

1. Foundation Material. Construct foundation as specified in Section 206, excluding Section 206.2(a)1.e. Provide uniform bedding material within 1/4 inch of the elevations shown on the plans. Use templates, screeds, and/or string lines to grade bedding within tolerance.

If unsuitable foundation material or rock is encountered, remove all unsuitable material at least 12 inches or rock at least 24 inches below bottom of box culvert and backfill with No. 2A or AASHTO No. 8 Coarse Aggregate, as shown on the Standard Drawings, graded in close conformity with the stream bed grade to provide proper bedding conditions. Accurately shape bedding material with a template to provide uniform contact (90% of bearing).

2. Grouting. Grout hand holes, pockets, bolt sleeves, tie rod holes, and lifting lugs after joints are sealed and hardware is installed.

3. Placement. Place box culverts as indicated. Do not disturb the bedding or damage the box culvert. Prevent aggregate from entering box culvert segment joints during placement. Place box culvert segments by matching the interior floor, haunches, and wall lines from segment to segment.

4. Backfill. Backfill reinforced concrete box culverts as shown on the Standard Drawings. Backfill trench as specified in Section 601.3(f).

5. Compaction of Cover. If cover or fill is indicated, do not traverse top of box culverts with construction equipment until after cover or fill has been placed, unless cover exceeds 5 feet. Do not use vibratory rollers to compact cover or fill over, or directly adjacent to, box culverts.

6. Waterproofing. Apply waterproofing as specified in Section 680.3 and as shown on the Standard Drawings. Submit a plan to the Department to correct exterior joints that exceed 1/2 inch difference across two adjacent box segments. Ensure waterproofing membrane will have full support and contact across the joint after correction and prior to membrane installation.

(i) Guide Rails. If indicated, install guide rail over box culverts as follows:

For fill heights greater than 24 inches at post locations, provide type 2 strong post guide rail as shown on the Standard Drawings.

For fill heights 24 inches or less at post locations, provide structure mounted guide rail as shown on the Standard Drawings and furnish a Class A cement concrete headwall.

(j) Cutoff Walls. If indicated, provide cast-in-place or precast cutoff walls of 12-inch thick by 42-inch deep Class A cement concrete, or less if directed, and install upstream and downstream. If indicated, install alternate cut off wall with grouted rock.

(k) Wingwalls. If indicated, provide cast-in-place Class A cement concrete wing walls.

(l) Aprons. If indicated, provide aprons of 6-inch thick Class A cement concrete, reinforced as shown on the Standard Drawings.

(m) Concrete Bonding Compound. If cutoff walls or wing walls are indicated, bond to box culvert by coating the contact surfaces with concrete bonding compound.

(n) Protective Coating. If indicated, apply two spray coats of coal tar epoxy, conforming to the requirements of SSPC-PS 16-82, to the top of the box and exposed end faces and to the entire height of the outside walls.

(o) Curing. Section 714.8; except, maintain box culvert segments, after stripping and during secondary curing, in a minimum 50F environment until they have reached a compressive strength of 70% of the required 28-day minimum concrete design strength shown on the approved shop drawings.

(p) Post-Tensioning. Install precast culvert segments as shown on the Standard Drawings, as indicated, and as specified in Section 1108 and as described below:

1. Post-Tensioning Sequence. Provide a post-tensioning sequence that will not cause misalignment of box culvert segments. Skewed segments may require tensioning of corners prior to internal post-tensioning locations. Determine post-tensioning sequence, staging, etc. based on the weight of segments being tensioned. Deviating from the established post-tensioning sequence, due to field adjustments, must be approved by the District Bridge Engineer, or their designee.

2. Gasket Material. Provide full contact of the gasket material around the perimeter of each joint. Remediate joints that are not sealed, to the satisfaction of the Representative.

3. Grouting Strand Ducts. If grouting is not going to be performed during the same day the tendons are stressed, then within 4 hours after stressing, protect the tendons and grout ducts against corrosion and debris by temporarily sealing all openings and vents, cleaning rust and other debris from all metal surfaces to be covered by the grout cap; and placing the grout cap, including a seal, over the anchor plate until the tendon is grouted.

Grout ducts within 3 calendar days after tensioning.

Failure to grout the ducts within 3 calendar days after tensioning will require the contractor to demonstrate the ducts are unobstructed to achieve complete grouting. If obstruction(s) are present, clean ducts to remove obstructions and re-inspect prior to grouting.

1085.4 MEASUREMENT AND PAYMENT—

(a) Precast Reinforced Concrete Box Culvert. Lump Sum
The price includes the following component items:

- **Cement Concrete.** Section 1001.4(a)

- **Deformed Welded Wire Fabric.** Pound
  Annealed iron wire, chairs, and ties are incidental to the deformed wire fabric.

- **Precast Reinforced Concrete Box Culvert Segments.** Linear Foot
  The unit price includes post-tensioning, if indicated.

- **Reinforcement Bars.** Section 1002.4

- **Membrane Waterproofing.** Section 680.4

- **Selected Borrow Excavation - Structure Backfill.** Section 1001.4(g)

- **Rock Protection.** Section 850.4(a)

- **Protective Coating (Coal Tar Epoxy).** Square Yard

(b) Guide Rail. Section 620.4

(c) Excavation for Unsuitable Material or Rock. Section 204.4

(d) Backfill for Unsuitable Material or Rock Excavation. Cubic Yard
The Department will pay as specified in Section 110.03.

SECTION 1086—SOUND BARRIERS

1086.1 DESCRIPTION—This work is the construction of either structure mounted, ground mounted, or offset sound barrier walls.

1086.2 MATERIAL—

(a) Wall Posts.

1. Structural Steel Posts.

- Structural Steel Shapes and Plates - Section 1105.02(a)2
- Structural Steel Tubing - ASTM A53/A53M, Grade B, Type E
- Anchor Bolts, Nuts, and Washers - Section 1105.02(c)3 galvanized as specified in Section 1105.02(s).
- Oversize Washers - Section 1105.02(a)2 galvanized and painted after fabrication as specified in Section 1105.02(s) and Section 1060.2(b).
- Welded Studs - Section 1105.02(e)
- Welding Material - Section 1105.02(t)
- Galvanizing- Section 1105.02(s)
- Paint - Section 1060.2(b)

2. Precast Reinforced Concrete Posts. Section 714

- Class AA Cement Concrete, Modified - Provide cement concrete as specified in Section 704; except, with a minimum 28-day compressive strength of 5,000 pounds per square inch.
- Structural Steel Base Plates - Section 1105.02(a)2 galvanized after fabrication as specified in Section 1105.02(s).
- Anchor Bolts, Nuts, and Washers - Section 1105.02(c)3 galvanized as specified in Section 1105.02(s).
- Oversize Washers - Section 1105.02(a)2 galvanized after fabrication as specified in Section 1105.02(s).
- Deformed Reinforcement Bars - Section 1002
- Deformed Welded Wire Fabric - Section 709.4

(b) Wall Panels.

1. Precast Reinforced Concrete Panels and Offset Wall Panels. Section 714

- Class AA Cement Concrete, Modified: Provide cement concrete as specified in Section 704; except, with a minimum 28-day compressive strength of 5,000 pounds per square inch.
    - Provide light weight concrete in the structure mounted sound barrier panels when specified to achieve a maximum oven dry density of 115 pounds per cubic foot. Verify the oven dry density of concrete in accordance with ASTM C567 during qualification of the mix design. Following mix design approval, perform oven dry unit weight testing in accordance with ASTM C567 for each lot. Proportion mix design in accordance with ACI 211 for structural lightweight concrete.
- Deformed Reinforcement Bars - Section 1002
- Steel Welded Wire Fabric - Section 709.3

(c) Finish. Provide texture (architectural surface treatments) and color of panels as specified in the proposal. Color and texture to be uniform from panel to panel and post to post.

(d) Penetrating Stain (Where Indicated). See Special Provisions in the proposal.

(e) Foundations.

1. Drilled Caissons. Section 1006.2

2. Spread Footings.

- Class A Cement Concrete - Section 704
- Deformed Reinforcement Bars - Section 1002

(f) Steel Cables (in precast concrete panels) and Accessories for Structure Mounted or Ground Mounted Sound Barrier Walls.

- Bolts - Section 1105.02(c)1
- Nuts - Section 1105.02(c)2.a
- Washers - Section 1105.02(c)2.b
- Galvanize and Paint all bolts, nuts, washers, and other hardware as specified in Section 1105.02(s) and Section 1060.2(b).
- Galvanized Steel Flexible Wire Rope - 3/8 inch 7 x 19 with a minimum breaking strength of 35.6 8 kips.
- Thimbles - Galvanized Heavy-Duty for 3/8 inch wire rope meeting the requirements of Federal Specification FF-T-267B, Type II.
- Galvanized Wire Rope Clips - 3/8 inch.
- Steel Pipe - ASTM A53/A53M, Grade B, Type E galvanized as specified in Section 1105.02(s).

(g) Steel Cables and Accessories for Offset Sound Barrier Walls.

- Stainless Steel (Type 302 or 304) Flexible Wire Rope (Aircraft Cable) - 3/8 inch 7 x 19 in accordance with MIL-W-83420 with a minimum breaking strength of 12 kips.
- Stainless Steel (Type 302 or 304) Internally Threaded Terminals - 5/8 inch outside diameter, swedged to cable, in accordance with MIL-T-6117. Provide compression fittings with a minimum breaking strength equal to or greater than the cable.
- Stainless Steel (Type 304) Hex Head Cap Screws - 1/2 inch - 13 UNC.
- Stainless Steel (Type 304) Washers.
- PVC Pipe (Schedule 40) - Section 1101.09(b)1.

(h) End Panel Connection for Offset Sound Barrier Walls.

- Structural Steel Angles - Section 1105.02(a)2 galvanized after fabrication as specified in Section 1105.02(s).
- Anchor Bolts, Nuts, and Washers - Section 1105.02(c)2 galvanized as specified in Section 1105.02(s).
- Thru Bolts - Section 1105.02(c)1 galvanized as specified in Section 1105.02(s).
- Nuts - Section 1105.02(c)2.a galvanized as specified in Section 1105.02(s).
- Washers - Section 1105.02(c)2.b galvanized as specified in Section 1105.02(s).
- PVC Pipe (Schedule 40) - Section 1101.09(b)1

(i) Access Door in Precast Concrete Panels (Where Indicated).

- Door and Frame - As manufactured by Windsor Republic Doors, Steelcraft, Pioneer Industries, or and approved equal. Refer to Standard Drawings for additional information.

(j) Other Material.

- Adhesive - as required and as specified by the manufacturer.
- Joint Sealing Material - Section 705.4(a)
- Caulking Compound - Section 705.8(b)
- Joint Backing Material (Backer Rod) - Section 705.9
- Epoxy Bonding Compound - Section 706.1

- Non-shrink Grout - Section 1080.2(c)
- Closed Cell Neoprene Sponge - Section 1085.2(m)
- Unreinforced, Plain Neoprene Bearing Pads - Sections 1113.02(a), 1113.03(a), 1113.03(d), and 1113.03(g). Mark each bearing pad in indelible ink or flexible paint with at least one of the following: order number, lot number, or any unique identifier marking traceable to a specific lot of bearing pad material. Markings may be on any surface of the bearing pad. Sample the completed bearing pads according to PTM No. 312, except reduce the sampling rate to three bearing pads per structure.
- Integral Color Pigmentation (Where Indicated) - See Special Provisions in the proposal.
- Lifting Inserts - Galvanized and as specified by Fabricator.
- Paint Color (Where Indicated) - See Special Provisions in the proposal.

(k) Certification. Section 106.03(b)3

1086.3 CONSTRUCTION—Before fabrication, obtain acceptance of shop drawings. Construct as indicated on the contract drawings, Standard Drawings, as shown on the accepted shop drawings, and as follows:

(a) Design.

1. General. Provide fire hydrant openings and other highway access (doors) as indicated. Provide adequate reinforcement around panel openings to prevent cracking. Show reinforcement details, in accordance with the Standard Drawing, on the shop drawings.

Submit design calculations, for acceptance, for the precast concrete panels in accordance with the requirements of the Standard Drawings.

Submit design calculations, for acceptance, for the panel and post lifting inserts for actual strength of concrete at time of stripping, transportation, and erection in accordance with the requirements of the Standard Drawings.

2. Ground Mounted and Offset Sound Barrier Walls. Refer to the contract drawings for the finished ground and acoustical profile elevations. Protect final ground elevations, established in the field, for the duration of the project and do not adjust without prior acceptance.

3. Structure Mounted Sound Barrier Walls. Refer to the contract drawings for the top of barrier/wall and acoustical profile elevations.

(b) Shop Drawings. Before beginning fabrication, submit, for acceptance, shop drawings showing fabrication details and handling and transportation procedures for all wall elements including connections. Submit shop drawings for the posts and panels concurrently.

(c) Erection and Construction Procedure. Submit erection and construction procedures for acceptance with the shop drawings.

(d) Catalog Cuts. Prepare and submit the following catalog cuts, for acceptance, with the shop drawings (if applicable):

1. Architectural Surface Treatments (When Indicated) indicating the following minimum information:

- Name of Manufacturer
- Pattern name and number
- Minimum, maximum, and average relief
- Joint Widths
- Liner material type
- Schematic drawing of Form Liner layout for each panel type

2. Lifting inserts indicating the following minimum information:

- Name of Manufacturer
- Specification
- Product Name, number and lifting capacity
- Minimum concrete strength for lifting insert
- Design information and calculations

3. Integral Color Pigmentation (When Indicated) indicating the following minimum information:

- Name of Manufacturer
- Product number and color number
- Specification

4. Caulking Compound/Joint Sealing Material indicating the following minimum information:

- Name of Manufacturer
- Product number and color number
- Specification

5. Provide any other catalog cuts required for other products used in the construction of the Sound Barrier Wall.

(e) Installation Requirements.

1. Foundations.

1.a. Drilled Caissons. Construct drilled caisson foundations as specified in Section 1006.3, and as follows:

Construct embankments and/or cut existing grade to the top of caisson elevations before construction of the caissons.

Provide vertical and tie reinforcement for the full height of the shaft. If the bottom of the caisson elevation is lower than required, then either provide additional vertical and tie reinforcement, at no additional cost to the Department, or suspend the reinforcement cage such that the reinforcement is in the proper position relative to the top of caisson elevation.

Provide test holes and probe holes only as indicated.

When permanent casing is used, drill, drive, or vibrate casing so soil is in full contact with the outside of the casing. Alternatively, place casing in an oversized hole and grout the annular space between the permanent casing and the surrounding soil to establish lateral support. Grout after the concrete has obtained its initial set but no later that 24 hours after placement of the concrete. Where excavation is stable and not subject to rapid degradation, the 24 hour period may be extended to 72 hours, as allowed. Use a pressurized grouting method capable of completely filling the open area. Provide grout as specified in Section 1108.03(f)1, except testing is not required.

When temporary casing is used, remove casing as specified in Section 1006.3(i). If unexpected construction conditions require the casing to remain in place, perform grouting as specified for permanent casing to fill cavities surrounding the casing.

Place caisson concrete within 24 hours of the completion of excavation and within 3 hours of final inspection of the drilled shaft. Where excavation is stable and not subject to rapid degradation, the 24 hour period may be extended to 72 hours, as allowed.

1.b. Spread Footings. Construct concrete spread footings as indicated, as specified in Section 1001.3, and as follows:

Construct embankments and/or cut existing grade to the top of footing elevations.

Excavate and backfill foundation areas as specified in Section 204.3; and compact using a mechanical tamper.

If unsuitable foundation material is encountered, remove all unsuitable material at least

12 inches or as specified or directed below the bottom of spread footing elevation and backfill with compacted No. 2A Coarse Aggregate or Class C Cement Concrete as specified or directed.

2. Fabrication.

2.a. Precast Concrete Posts and Panels. Fabricate precast concrete posts and panels as specified in Section 714, as indicated on the accepted shop drawings, and as follows:

Use only pre-approved Fabricators listed in Bulletin 15.

Obtain acceptance of the concrete mix design before fabrication.

Obtain initial acceptance of any architectural surface treatments before production of Test Posts and Panels.

Fill all holes in the precast concrete posts and panels, resulting from fabrication, with an accepted non-shrink grout (color to match panel/post).

Ensure that precast concrete posts and panels are cast in one continuous lift to eliminate cold joints.

Fabricate panels in a manner that will produce a secure and vibration free installation.

Provide a smooth finish on the portions of panels, being placed in post flanges or in contact with adjacent panels, as shown in the Standard Drawing.

Furnish full height panels or stacked panel sections with tongue and groove or interlocking joints that provide “light tight” conditions at the joints and prevent direct transmission of sound.

Furnish top panels with a smooth finish on the top side.

Furnish bottom panels with a smooth finish on the bottom side.

Repair defects in accordance with Publication 145.

Replace cracked or damaged posts and panels which cannot be repaired to the satisfaction of the Representative.

2.b. Steel Cables (in precast concrete panels) and Accessories. Assemble three sample connections and submit for testing and acceptance before panel fabrication. Samples must be assembled by the same process that is used for production panels.

Galvanized Wire Rope Clips: Tighten nuts evenly in accordance with the manufacturer’s recommendations. Confirm tension via torque verification.

2.c. Threaded Reinforcement Bars in Precast Concrete Posts with Base Plate Connections. Provide either epoxy coated or galvanized reinforcement bars. Thread end of bar or provide upset threads as specified. Fabricate in accordance with the following procedure:

Cut threads on one end of bar.

Clean any cutting lubricant from threads and bar and apply two coats of zinc oxide paint meeting the requirements of ASTM A780 to the threaded portion of the bar.

Assemble reinforcement and base plate assembly. Overtap nuts, if required, to accommodate the additional material on the bolt threads.

2.d. Structural Steel Posts. Fabricate steel posts as specified in Section 1105.03, as indicated on the accepted shop drawings, and as follows:

Use only pre-approved Fabricators listed in Bulletin 15.

Furnish posts which are galvanized and painted as specified in Section 1105.02(s) and Section 1060.2(b).

Furnish paint color as indicated or directed.

2.e. Steel Cables and Accessories for Offset Sound Barrier Walls. Assemble three sample connections and submit for testing and acceptance before panel fabrication. Samples must be assembled by the same process that is used for production panels.

2.f. Test Posts and Panels. Fabricate Test Posts and Panels (samples) for acceptance before normal fabrication and after acceptance of the shop drawings and catalog cuts for the panels and posts.

Ground Mounted Sound Barrier Walls and Structure Mounted Sound Barrier Walls: Fabricate and erect a sample wall consisting of a minimum of three posts and two panel sections. Provide post

heights that meet or exceed the average post height for the sound barriers on the project. Provide sufficient number of panels in order to match the height of the posts.

Offset Sound Barrier Walls: Fabricate and erect a sample wall consisting of a minimum of three panel sections (lengths). Provide sections that meet or exceed the average wall height for the sound barriers on the project.

Fabricate samples using the same process and materials that will be used for production. Erect sample walls at the place of manufacture and store outdoors to allow proper lighting for comparisons during manufacturing and inspection.

Apply penetrating stain, where specified, to one half of wall, per side, to show the final finish after the sample wall is constructed.

Use test sections to determine the acceptability of the various surface treatments, uniform color, free of surface blemishes, quality of construction, and overall appearance of both the roadway and residential sides of the sound barrier wall. Provide integrally colored posts and panels that are uniform in color consistency and free from discoloration and blemishes. Galvanize and paint structural steel posts as specified.

View architectural treatments for the sample wall and subsequent production for acceptance at a distance of 30 feet, unless otherwise specified.

Notify the Department, at least 14 days before the construction of the Test Panels and Posts, so the appropriate Department representatives may be present to determine acceptability. Department representatives may include the Environmental Manager, Project Manager, Design Staff, Construction Staff, and any other project team member designated by the Department.

Department representatives will determine whether the color and various surface treatments of the posts and panels are acceptable. Produce additional samples until an acceptable product is produced if initial test sections are found to be unacceptable.

Acceptable samples fabricated according to the accepted shop drawings are allowed to be incorporated into the project in the final stage of construction, after all production has been completed and accepted. Production panels and posts not conforming to the accepted test sections will be rejected.

3. Erection. Install sound barrier wall as indicated, as shown on the accepted shop drawings, and according to the manufacturer's recommendations.

Provide cranes that are sized to handle the posts and panels safely at the required height and reach.

Erect posts truly vertical.

Erect panels truly vertical in a manner that will provide a secure and vibration free system installation.

Pack or place non-shrink grout in locations as shown. Do not pour or inject grout.

Provide joints and connections with no visible openings or gaps to decrease sound attenuation.

Fill all lifting inserts, in all concrete panels and posts, with an accepted non-shrink grout (color to match panel/post).

Seal all open joints and holes with joint sealing material or caulking compound.

Apply penetrating stain when indicated. Stain to extend a minimum of 6 inch below finished ground line.

Construct finished ground as indicated or directed. Use only hand-operated compaction equipment within 4 feet of the sound barrier when backfilling.

Contractor is responsible for overall fit of wall.

4. Removal of Falsework and Bracing. Keep falsework and bracing that supports posts in place for at least 48 hours after placing the final portion of the foundation.

(f) Tolerances.

1. Fabrication Tolerances.

1. a. Reinforced Precast Concrete Posts and Panels. Section 714 and as indicated in Publication 145.

1. b. Structural Steel Posts – ASTM A6

1. c. All Others.

ENGLISH

Panels	(inch)
Height:	±1/4
Length:	±1/4
Thickness:	±1/4
Out of Flatness:	
• Lengths to 8 feet:	1/8
• Lengths over 8 feet:	1/4

Post	(inch)
Length:	±1/4
Width:	±1/4
Depth:	±1/4
Slot Depth:	±1/8
Slot Width:	±1/8
Out of Flatness:	
• Lengths to 8 feet:	1/8
• Lengths over 8 feet:	1/4

1.d. Steel Base Plate Flatness. Machine surfaces to within 0.01 inch of flatness. Determine flatness as specified in Section 1111.03(c).

1.e. Galvanized Lifting Inserts. Set inserts within ± 1 inch of the indicated location.

1.f. Steel Pipe in Precast Concrete Panels. Set steel pipe, for thru bolt, in precast concrete panels within ± 1/8 inch of the indicated location.

1.g. PVC Pipe in Offset Sound Barrier Panels. Set PVC pipe, for cable connection, in precast concrete panels ± 1/2 inch of the indicated location.

2. Architectural Surface Treatment Tolerances.

2.a. General. Provide architectural surface treatment patterns that are continuous and uninterrupted across horizontal joints in stacked panels.

2.b. Vertical Alignment for Stacked Panels (top-to-bottom). Provide a tolerance of ± 1/2 inch for the vertical alignment of the architectural surface treatment pattern between stacked panels.

2.c. Horizontal Alignment between Adjacent Panels (side-by-side panels). Provide a tolerance of ± 2 inch for the horizontal alignment of the architectural surface treatment pattern at adjacent panels.

2.d. Seam Lines between Form Liners. Assemble non-continuous form liner sections such that seams lines or match lines are not apparent when viewing the completed panels.

3. Erection Tolerances.

3.a. Vertical Alignment.

Height of Wall	Vertical Alignment of Walls and Posts
≤ 10 feet	1/4 inch
≤ 20 feet	1/2 inch
> 20 feet	3/4 inch

3.b. Horizontal Alignment. Horizontal alignment for walls and posts to be within ± 1/2 inch of the indicated location.

3.c. Posts. Set posts within ± 1/2 inch of the indicated location.

3.d. Post Rotation. Set orientation of post within ± 2 degrees of the indicated location.

3.e. Anchor Bolts. Set anchor bolts within ± 1/4 inch of the indicated location.

3.f. Top of Barrier, Wall, Caisson, Footings, Pedestals, and Raised Panel Seat Elevations. Set elevations within ± 1/2 inch of the indicated location.

3.g. Grout Depth under Base Plate. Set grout depth within ± 1/4 inch of the indicated thickness.

(g) Reject Individual Posts and Panels for any of the following:

- Production panels and posts not conforming to the accepted test sections.
- Fractures and cracks passing through the panel or post.
- Defects that indicate proportioning, mixing, and molding not in compliance with the specifications or as indicated.
- Honeycombed open texture.
- Damaged ends where such damage would prevent making a satisfactory joint.
- Twenty-eight day cylinder strength is less than design concrete strength.
- Defective welding.
- Dimensions not conforming to the allowable tolerances specified.

Panels and posts may be rejected either at the fabrication shop or at the construction site, even after installation, but before acceptance of project.

Mark the rejected post or panel "Rejected for the Department's Use" with waterproof paint.

1086.4 MEASUREMENT AND PAYMENT—

(a) Wall Posts. Each

The price includes excavation, foundation, post, base plate, bearing pads, and all associated hardware.

(b) Wall Panels. Square Foot

Measured to equal the total area of the panel including areas concealed by posts or finished ground. The unit price includes all joint sealing materials and all associated hardware.

(c) Offset Sound Barrier Wall. Square Meter (Square Foot)

Measured to equal the total area along the Sound Barrier Control line disregarding the offset. The barrier height will be measured from the top of wall to the bottom of wall (top of footing). The barrier length will be measured from begin to end of wall. The price includes excavation, foundation, bearing pads, joint sealing material, and all associated hardware.

(d) Sound Barrier Access Door. Each

The price includes installation of door in wall panel and all associated hardware.

(e) Excavation for Unsuitable Material. Section 204.4

Class 3 Excavation required for the over excavation of unsuitable material below the bottom of spread footing elevation as indicated or directed.

(f) Backfill for Unsuitable Material. Section 1001.4

Backfill over excavated area with compacted No. 2A Coarse Aggregate or Class C Cement Concrete as indicated or directed.

SECTION 1087—PA HT BRIDGE BARRIER

1087.1 DESCRIPTION— This work is the construction of a PA HT Bridge Barrier.

1087.2 MATERIAL— Unless otherwise specified, galvanize steel materials as specified in Section 1105.02(s). Before fabrication, submit shop drawings as specified in Section 105.02(d) for review and acceptance.

(a) Railing.

1. Steel Rails.

1.a. ASTM A 53/A 53M, Type E or S, Grade B, or A.P.I. 5LX52 PSL2, subsequently extruded or cold pressed into desired elliptical shape.

1.b. Pipe rail produced continuously off a pipe mill in an elliptical shape in accordance with the chemical, mechanical, and testing requirements of API 5L Grade X52 PSL 2 seamless or electric resistance welded, except, as modified below:

The inside flash for elliptical pipe used in a SLEEVE application is not required to be removed.

Eddy current testing of the weld line in accordance with ASTM E309, calibrated to 1/8 inch drilled hole is acceptable. Standard Operating procedure is as follows:

- Drill reference holes in the weld-line area on the mill for calibration. Pass this area through the inspection system at production speeds. Adjust signal levels to provide a suitable signal-to-noise ratio for the material being inspected.
- Adjust signal level to produce a minimum of 75% deflection on the strip chart recorder. Adjust the phase setting so signals are in between gate settings.
- Adjust marking system to spray any signal exceeding referenced hole calibration height of 75%.

Maintain documentation of Standard Operating Procedure to include daily verification checks.

Flattening test of the elliptical shape (cut a sample from the leading and trailing end of each coil) with the weld line located between the 10 o'clock and 2 o'clock position is acceptable. Conduct flattening test to 1/3 of the original outside diameter without the weld opening.

Hydrostatic testing is not required for the elliptical pipe.

Square cut pipe ends.

2. Steel Rail Sleeve Member.

2.a. ASTM A 53/A 53M, Type E or S, Grade B; ASTM A 36/A 36M or ASTM A 500, Grade B, or A.P.I - 5LX52 PSL2, subsequently extruded or cold pressed into desired shape.

2. b. Acceptable Alternate; Section 1087.2(a)1.b.

3. Sidewalk Rail Tubes. Section 1022.2(a).

4. Toggle Bolts for Sidewalk Rail Tube. Section 1022.2(b).

5. Sidewalk Rail Rod. ASTM A 36/A 36M.

6. Sidewalk Rail Rod Splice. ASTM A 513 As Welded Tubing, Grade 1020 or A 519 Hot Rolled Tubing, Grade 1020.

7. Railing Posts and Base Plates. Section 1105.02(a)2.

8. Test Requirements for Post Welds. Visually inspect all welds on all posts. In addition, inspect at least 10% of the posts in a lot, as defined in AWS D1/5/D1.5M-2008, Section 6.7.1.2(2)(c), as follows: perform magnetic particle testing over full length of the welds on all posts inspected. If unacceptable discontinuities are found in any of the welds tested, inspect an additional 10% of the posts in the same lot. If unacceptable discontinuities are found in any of the welds tested in the second group of posts, inspect all of the remaining posts in the lot.

9. Miscellaneous. Section 1105.02(a)2.

Certify as specified in Section 106.03(b)3.

(b) Anchor Bolts, Nuts, and Washers. Section 1105.02(c), galvanized as specified in Section 1105.02(s).

(c) Caulking Compound. Section 705.8.

1087.3 CONSTRUCTION—As shown on the Standard Drawings, the contract drawings, and as follows:

Before erection, use caulking compound and thoroughly coat surfaces of posts in contact with concrete. After erection and alignment, use caulking compound and seal openings between metal surfaces and concrete.

Remove blemishes and scratches from exposed surfaces. For areas that have been damaged, exposing base metal, repair galvanizing in accordance with ASTM A780.

Place joints, as indicated.

Do not open bridge to traffic until bridge railing is placed.

1087.4 MEASUREMENT AND PAYMENT—Linear Foot, measured from end to end of barrier.

SECTION 1088—PA TYPE 10M BRIDGE BARRIER

1088.1 DESCRIPTION—This work is the construction of a PA Type 10M Bridge Barrier.

1088.2 MATERIAL—Unless otherwise specified, galvanize steel materials as specified in Section 1105.02(s). Before fabrication, submit shop drawings as specified in Section 105.02(d) for review and acceptance.

(a) Railing.

- Steel Cold Formed Tubes. ASTM A500, Grade B
- Sidewalk Rail Tubes. Section 1022.2(a)
- Toggle Bolts for Sidewalk Rail Tube. Section 1022.2 (a)
- Railing Posts and Base Plates. Section 1105.02(a)3.b
- Test Requirements for Post Welds. At least 10% of the posts in a lot as defined in AWS D1.5-D1.5M-2008, Section 6.7.1(c), will be inspected. A visual inspection and magnetic particle testing will be performed over the full length of the welds on all posts inspected. Ultrasonic testing of the complete joint penetration welds will also be performed. If unacceptable discontinuities are found in more than 20% of the welds tested, an additional 10% of the posts in the same lot will be inspected. If unacceptable discontinuities are found in more than 20% of the welds tested in the second group of posts, all of the remaining posts in the lot will be inspected.
- Miscellaneous. Section 1105.02(a)2

Certify as specified in Section 106.03(b)3.

(b) Anchor Bolts, Nuts, and Washers. Section 1105.02(c), galvanized as specified in Section 1105.02(s).

(c) Barrier Mount Delineation Devices. Section 937.3(b)

(d) Caulking Compound. Section 705.8

1088.3 CONSTRUCTION—As shown on the Standard Drawings, the Contract Drawings, and as follows:

Before erection, use caulking compound and thoroughly coat surfaces of posts in contact with concrete. After erection and alignment, use caulking compound and seal openings between metal surfaces and concrete.

Remove blemishes and scratches from exposed surfaces. For areas that have been damaged, exposing base metal, paint with two coats, according to ASTM A780.

Place joints, as indicated.

At bend area, do not vary the diameter of rail tubes by more than 5% of the outside dimension when rail tubes are bent to the radii indicated.

Do not open bridge to traffic until bridge railing is placed.

1088.4 MEASUREMENT AND PAYMENT—Linear Foot, measured from end to end of barrier.

SECTION 1089—PA BRIDGE BARRIER

1089.1 DESCRIPTION— This work is the construction of a PA Bridge Barrier.

1089.2 MATERIAL— Unless otherwise specified, galvanize steel materials as specified in Section 1105.02(s). Before fabrication, submit shop drawings as specified in Section 105.02(d) for review and acceptance.

(a) Railing.

- Steel Cold Formed Tubes. ASTM A 500, Grade B
- Threaded Welded Anchor Studs for Barrier Rail Tube. ASTM A 108
- No Thread Welded Anchor Studs for Barrier Rail Splice. ASTM A 108
- Sidewalk Rail Tubes. Section 1022.2(a)
- Threaded Welded Anchor Studs for Sidewalk Rail Tube. ASTM A 108
- Sidewalk Rail Rod. Section 1105.02(a)2
- Sidewalk Rail Rod Splice. ASTM A513 or A519
- Railing Posts and Base Plates. Section 1105.02(a)3.d, Type 1, 2, or 3 only.
- Test Requirements for Post Welds. All welds on all posts will be visually inspected. In addition, at least 10% of the posts in a lot as defined in AWS D1.5/D1.5M-2008, Section 6.7.1.2(2)(c), will be inspected as follows: Magnetic particle testing will be performed over the full length of the welds on all posts inspected. Ultrasonic testing of the complete joint penetration welds will also be performed. If unacceptable discontinuities are found in more than 20% of the welds tested, an additional 10% of the posts in the same lot will be inspected. If unacceptable discontinuities are found in more than 20% of the welds tested in the second group of posts, all of the remaining posts in the lot will be inspected.
- Miscellaneous. Section 1105.02(a)2

Certify as specified in Section 106.03(b)3.

(b) Anchor Bolts, Nuts, and Washers. Section 1105.02(c)3, galvanized as specified in Section 1105.02(s).

(c) U-Shaped Washer. Section 1105.02(a), galvanized as specified in Section 1105.02(s).

(d) Barrier Mount Delineation Devices. Section 937.3(b)

(e) Caulking Compound. Section 705.8

1089.3 CONSTRUCTION—As shown on the Standard Drawings, the Contract Drawings, and as follows:

Before erection, use caulking compound and thoroughly coat surfaces of posts in contact with concrete. After

erection and alignment, use caulking compound and seal openings between metal surfaces and concrete.

Remove blemishes and scratches from exposed surfaces. For areas that have been damaged, exposing base metal, repair galvanizing in accordance with ASTM A 780.

Place joints, as indicated.

At bend area, do not vary the diameter of rail tubes by more than 5% of the outside dimension when rail tubes are bent to the radii indicated.

Do not open bridge to traffic until bridge railing is placed.

1089.4 MEASUREMENT AND PAYMENT—Linear Foot

Measure from end to end of barrier.

SECTION 1090 – BRIDGE PRESERVATION AND REHABILITATION

1090.1 DESCRIPTION – This work is bridge preservation and rehabilitation as follows:

(a) Preformed Neoprene Compression Seal Replacement. This work is the replacement of compression seals for unarmored and armored joints.

(b) Expansion Dam Replacement. This work is the furnishing and installation of neoprene strip seal expansion dams for bridge joints of the indicated movement classification, including the necessary fabricated structural steel. This work also includes the removal of existing expansion dams, cover plates, railing, barrier, sidewalk, and portions of bridge deck for the installation of new neoprene strip seal expansion dams.

(c) Neoprene Strip Seal Replacement. This work is the removal of existing neoprene strip seal gland and replacement with a new neoprene strip seal gland of the indicated movement.

(d) Prestressed Concrete Beam Repairs. This work is repairing unsound and spalled areas of prestressed concrete beams.

1090.2 MATERIAL –

(a) Preformed Neoprene Compression Seal Replacement. Section 1008.2.

(b) Expansion Dam Replacement. Section 1026.2 and as follows:

- Class AAAP Cement Concrete – Section 704, except use No. 8 coarse aggregate.
- Class AA Cement Concrete – Section 704, except use No. 8 coarse aggregate.
- Accelerated Structural Concrete (ASC) – Section 704, except use No. 8 coarse aggregate.
- Reinforcement Bars – Section 709.1
- Epoxy Bonding Compound – Type II, Grade 2, ASTM C 881 epoxy as specified in Section 706
- Forms – Section 1001.2(h)
- Mechanical Splice System – Section 1002.2(c)

(c) Neoprene Strip Seal Replacement. Section 1026.2(e)

(d) Prestressed Concrete Beam Repairs.

- Galvanized Spray – ASTM A780
- Concrete Bonding Compound – Section 706, ASTM C881, Type II, Grade 2 from a manufacturer listed in Bulletin 15 compatible with patching material
- Steel Expansion Anchor Pins – Section 1105.02(c), 3/8 inch diameter, galvanized according to ASTM B633
- Welded Wire Fabric (WWF) – Section 709.3(b), 4x4-W2.1xW2.1 min.
- Polymer Modified Rapid Hardening Concrete Patching Material – From a manufacturer listed in Bulletin 15
- Penetrating Sealer – Section 1019

1090.3 CONSTRUCTION – As shown on the Standard Drawings and as follows:

(a) Preformed Neoprene Compression Seal Replacement. Remove existing sidewalk cover plates, barrier cover plates, seal material, foam, and joint filler. Retain cover plates and re-install after joint has been re-sealed. During removal operations, do not damage portions of the structure to remain. Repair areas damaged beyond the removal limits at no additional cost to the Department.

(1) Unarmored Joint Seal Replacement. If minor spalling is present along the joint, sawcut a new seal groove as specified in Section 1008.3(c). If spalling cannot be removed by sawcutting a new seal groove, perform repairs as directed and as specified in Section 1040. Install seal as specified in Section 1008.3(d).

(2) Armored Joint Seal Replacement. Before installing the seal, clean metal surfaces according to SSPC-SP6 in direct contact with the seal. Install seal as specified in Section 1021.3.

(b) Expansion Dam Replacement.

(1) Standard Method. Follow standard method if indicated:

1.a Removal. Install falsework and shielding before removal. Remove barrier railings and posts as required to perform the indicated repairs. Do not damage or cut. Set aside for reuse. Remove existing barrier and sidewalk cover plates, dam and portions of existing deck, barrier, and median to the limits indicated or delineated by the Representative. Provide a 1 inch sawcut at all removal limits to create a neat removal line. Use pneumatic hammers not exceeding an impact rating of 30 foot-pounds or hand tools to remove concrete. Do not use excavators or large equipment with hammer attachments to remove concrete. During removal operations, do not damage portions of the structure to remain. Do not cut existing reinforcement that is to remain. Repair areas damaged beyond the removal limits at no additional cost to the Department.

1.b Preparation. Abrasive blast or wire brush exposed existing reinforcement that is to remain to near white metal and to remove loose concrete chips. Coat existing reinforcement to remain with an approved epoxy paint before placing new concrete.

1.c Repair. Install formwork and place reinforcement as indicated and specified in Section 1002.3. Apply epoxy bonding compound according to the manufacturer's specifications. Place Class AAAP Cement Concrete at blockout in bridge deck as indicated and against contact surface while epoxy bonding compound is still tacky to ensure bond between contact surface and fresh concrete. Place Class AA Cement Concrete in barrier as indicated. Cure concrete as specified in Section 1001.3(p)3.b.2. Clean extrusion and install neoprene seal as specified in Section 1026.3. Reset barrier rail once barrier concrete has hardened sufficiently to support the rail.

(2) Accelerated Method. Follow accelerated method if indicated:

2.a Removal. Install falsework and shielding before removal. Remove barrier railings and posts as required to perform the indicated repairs. Do not damage or cut. Set aside for reuse. Remove existing barrier and sidewalk cover plates, dam, and portions of existing deck, barrier, and median to the limits indicated or delineated by the Representative.

Provide two sawcuts. Provide first sawcut 6 inches from the removal limit (dam side) to a depth of 1 inch from existing beams. Remove concrete using an excavator with hammer attachment not exceeding an impact rating of 500 foot pounds. Provide second sawcut, 1 inch maximum depth at the removal limit and remove the remaining concrete with pneumatic hammers not exceeding an impact rating of 30 foot-pounds to expose 6 inches of the existing longitudinal reinforcement to accommodate a mechanical coupler. During removal operations, do not damage portions of the structure to remain. Repair areas damaged beyond the removal limits at no additional cost to the Department.

2.b Preparation. Section 1090.3(b)1.b.

2.c Repair. Install formwork and place reinforcement as indicated and specified in Section 1002.3. Using mechanical couplers, install longitudinal reinforcement. Install transverse reinforcement and all barrier reinforcement damaged during the removal operations. Apply epoxy bonding compound according to the manufacturer's specifications. Place ASC at blockout in bridge deck as indicated and against contact surface while epoxy bonding compound is still tacky to ensure bond between contact surface and fresh concrete. Place ASC in barrier as soon as bridge deck concrete in blockout can support the barrier concrete and as indicated. Cure as specified in Section 1001.3(p)3.d. Clean extrusion and install neoprene seal as specified in Section 1026.3. Reset barrier rail once barrier concrete has hardened sufficiently to support the rail.

(c) Neoprene Strip Seal Replacement. Field measure existing extrusion and upturn locations. Provide field measurements to seal manufacturer and provide replacement seals for the movement classification indicated and according to the manufacturer's recommendations. Remove existing barrier and sidewalk cover plates. Remove existing strip seal gland. Abrasive blast or wire brush areas of rust on the extrusion to clean white metal. Use galvanizing spray to coat blasted or brushed areas. Clean extrusion and install seal as specified in Section 1026.3. Reinstall barrier and sidewalk cover plates.

(d) Prestressed Concrete Beam Repairs. Perform repairs as shown on the Standard Drawings.

(1) Equipment.

1.a Hand Tools. Use hand tools for removal including hammers and chisels.

1.b Pneumatic Hammers. Use pneumatic hammers for removal not exceeding 15 foot-pounds.

- Do not operate pneumatic hammers at an angle in excess of 45 degrees relative to the surface of the beam.
- Do not place pneumatic tools in direct contact with reinforcement bars or strands.

1090.4 MEASUREMENT AND PAYMENT –

(a) Preformed Neoprene Compression Seal Replacement. Linear Foot.

For unarmored joints, the unit price includes sawcutting a new seal groove. Repairs as specified in Section 1040 will be paid separately.

(b) Expansion Dam Replacement. Linear Foot.

For the method and movement indicated. Measured out-to-out along the centerline of the exposed surfaces of the seal and the steel plates, including sidewalks if applicable, following the vertical and sloped faces of curbs and barriers, resulting in a true length, not a horizontally projected length.

(c) Neoprene Strip Seal Replacement. Linear Foot.

Length measured along centerline of seal including bends and upturns.

(d) Prestressed Concrete Beam Repairs. Square Foot.

Penetrating sealer is incidental to this item.

SECTION 1091—EPOXY INJECTION CRACK SEAL

1091.1 DESCRIPTION—This work is the preparation and sealing of cracks with epoxy resin mixture, excluding overhead sealing.

1091.2 MATERIAL—

(a) Epoxy Resin System. Provide a system conforming to the strength requirements of ASTM C 881, Type I, Grade 1, Section 706.1, for epoxy injection and from a manufacturer listed in Bulletin 15.

(b) Surface Seal. Provide a surface seal as recommended by the manufacturer and of adequate strength to hold injection fittings firmly in place and to resist injection pressures adequately to prevent leakage during injection.

(c) Injection Fittings. As recommended by the manufacturer.

(d) Certification. Section 106.03(b)3

1091.3 CONSTRUCTION—Construct as directed and as follows:

(a) Preliminary Work. The Representative will mark areas to be sealed.

(b) Preparation for Sealing. Thoroughly clean the surfaces of rust, scale, grease, loose and disintegrated particles, and material. Remove unsound concrete and mortar as directed. Glue injection ports in place at spacings as recommended by the manufacturer. Bevel cracks, as directed, to facilitate installation of injection ports. Seal the surface and areas surrounding the entry ports with surface seal. Apply seal so that the epoxy injection resin is sealed until initially cured.

(c) Mixing Epoxy Resin System. Mix the epoxy resin system according to the manufacturer's instructions with a minimum 180 second mixing time using a low speed (400 rpm to 600 rpm) electric drill with an approved mixing paddle. The mixing may also be accomplished by an injection machine capable of metering and mixing the specific proportions of components within a tolerance of ± 5%.

(d) Injection Procedure. Do not inject the cracked area until after the surface sealer has hardened. Inject the epoxy with a hand held gun, pressure pot, or injection machine or as recommended by the manufacturer. Start injection at the lowest point on the crack. When the material begins to flow from the next higher entry port, remove the nozzle, plug the port, and insert the nozzle in the next higher entry port. Continue the operation until the crack is completely filled. After the epoxy material has achieved an initial cure, remove the entry ports and, if necessary, patch the areas with the same material used to seal the rest of the crack surface.

(e) Application Limitations. Do not apply or inject epoxy materials if the ambient or concrete temperature is below 50F.

1091.4 MEASUREMENT AND PAYMENT—

(a) Linear Foot or

(b) Dollar

The proposal will include an item and a predetermined amount of money for Epoxy Injection Crack Seal. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Epoxy Injection Crack Seal item as follows:

1. Negotiated Price. At an agreed upon price. This price will be agreed upon with the Department, before performing the work. When applicable, agreement is also required with the FHWA.

2. Force Account Basis. Section 110.03(d)

SECTION 1092—EPOXY PROTECTION FOR STRUCTURAL STEEL

1092.1 DESCRIPTION—This work is the coating of surfaces of structural steel with an electrostatically applied, fusion-bonded epoxy.

1092.2 MATERIAL—

(a) Coating System. Use powdered epoxy coating material from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

Provide fusion-bonded epoxy coating that is a one-part, heat-curable, thermosetting, powdered coating conforming to ASTM A775, modified as follows:

- Wherever the terms “deformed steel reinforcing bar(s),” “plain steel reinforcing bar(s),” “reinforcing steel,” “bar(s),” or “reinforcing bar(s)” appear, substitute the terms “structural steel member(s),” “structural steel,” or “member(s)” as applicable.

- Unless otherwise indicated, coating color to match Federal Standard No. 595, Color No. 14223 (Foliage green).

- Section 4—Reinforcing Steel. Revise the title of the section and the section to read:

  4. Structural Steel.

  4.1 Furnish structural steel to be coated conforming to the requirements of applicable AASHTO standard specifications, as indicated or specified, and free of contaminants such as oil, grease, paint, and silvers. Structural steel exhibiting any silver-like defects after the heating and coating process will be rejected unless satisfactorily repaired. A single recorded coated steel member thickness measurement is defined as the average of three individual readings obtained from three immediately adjacent areas on the body of the member. Obtain a minimum of five recorded measurements approximately evenly spaced along each side of the test specimen (i.e., a minimum of ten recorded measurements per specimen). The film thickness limits do not apply to patched areas.

- Section 7.3—Adhesion. Delete this section.

- Section 8—Test Methods. Revise this section as follows:

  Revise the first sentence in Subsection 8.1 to read:

  Measure the thickness of the coating on the body of the member as specified in Section 4.1.

  Subsection 8.3—Adhesion of Coating. Delete this section.

- Section 12—Repairs Due to Handling. Revise Subsection 12.2 to read:

  Satisfactorily repair damage to the epoxy coating that occurs during fabrication, shipping, or installation either according to Section 11.1 or by mechanical wire brush cleaning and painting with an approved epoxy paint using the paint manufacturer's approved procedure. Repair any member with visible signs of rust according to Section 11.1. Do not cover more than 5% of the total surface area with patching material.

- Section 15—Fabrication of Steel Reinforcing Bars After Coating. Delete this section.

- Section A1.3—Specimens for Test. Revise this section as follows:

  Revise Subsection A1.3.1 to read:

  Submit the following type and number of test specimens for test:

  (1) Two steel plates 4 inches by 4 inches by 1/2 inch, cleaned, and uncoated.

  (2) Four steel plates 4 inches by 4 inches by 1/2 inch, and coated with a film thickness of 10 mils.

  (3) Three films of epoxy (of the minimum thickness proposed for use during production coating of structural steel) for the chloride permeability test.

  Revise the last sentence in the first paragraph in Subsection A1.3.3 to read:

  Measure the thickness of the film on the body of the member.

- Section A1.4.4—Flexibility of Coating. Delete this section.

- Section A1.4.5—Bond Strength to Concrete. Delete this section.

- Section A1.4.7—Impact Test. Revise the third sentence to read:

  Have impact occur on those areas that will be subject to impact when member is used for its intended purpose, if this can be determined. Otherwise, have impact occur on any areas.

- Section A1.4.8—Hardness Test. Revise the last sentence to read:

  Meet or exceed a Knoop Hardness Number of 16 when averaging four individual hardness measurements made on at least two specimens.

1092.3 CONSTRUCTION—

(a) General. Apply coating in an environmentally controlled plant that is fully enclosed. Provide a fully automatic coating system with the capability of preheating and post-baking. Use a fully automatic grit-blast cleaning machine, enclosed in an environmentally controlled plant.

(b) Surface Preparation. Free all surfaces of oil or any mill coating.

Gritblast the steel to white metal, as defined in SSPC-SP5, using a mixture of steel shot and grit. Protect clean surfaces from conditions of high humidity, rainfall, or surface moisture. Do not allow the steel to flash rust before coating. Provide a uniform, angular anchor blast profile from 2 mils to 5 mils deep. Determine anchor pattern depth by the Keane-Tator Surface Profile Comparator or Testex Replica Tape.

(c) Application of Coating. Apply the coating material according to the manufacturer's recommendation as to application procedure and curing schedule. In no case allow the over temperature, or temperature of the steel during any part of the curing process, to exceed 500F.

Provide a cured coating of uniform color, gloss, and thickness, and free of blisters, pinholes, fish eyes, sags, runs, and other irregularities.

Provide a finished coating thickness of 10 mils ± 2 mils tested according to ASTM G12.

(d) Inspection. The coater is responsible for all QC checks including visual inspection, thickness measurements,

and holiday testing, and for keeping records on the results of all such inspections in an approved form.

Provide access to each part of the process to the Inspector. Allow the Inspector to witness any QC tests, and perform such tests himself or herself on a random sampling basis, if requested by the Inspector.

After cure, check the coating for continuity using a 67.5 V wet sponge detector to check for holidays, pinholes, and voids. Allow no more than an average of 6 holidays per meter. Satisfactorily repair all defects.

(e) Touch-Up System. Provide a compatible two-part epoxy touch-up system designed and color-matched for patching the epoxy coating used on the structural steel. Satisfactorily patch all defects in the epoxy coating, areas damaged during erection, and all visible uncoated areas. Do not cover more than 5% of the total surface area with patching material.

1. Surface Preparation. Apply coating directly to the metal for maximum performance. Ensure that metal is clean, dry, and free of rust and scale. Blast clean to NACE near white where possible. Remove grease, oil, and other substances with suitable solvents. Coat cleaned surface before oxidation occurs.

2. Mixing. Mix Part A and Part B of the two-part system in the proportions recommended by the manufacturer. Mix the two parts thoroughly until a uniform color is obtained. If required, thin each part separately, with thinner recommended by the system manufacturer, to minimize loss of pot life. Furnish material having a pot life of at least 8 hours. Discard material that is not used within the pot life specified by the manufacturer.

3. Application. Apply material with ordinary brush or roller, according to the manufacturer's instructions, and as directed. Achieve a track free surface in 2 hours to 3 hours at 72F. Achieve full cure in 3 days to 5 days at 72F. Exercise care in handling pieces before they are fully cured.

1092.4 MEASUREMENT AND PAYMENT—Epoxy protection for structural steel is incidental to the items of work protected.

SECTION 1100
MANUFACTURED MATERIAL

SECTION 1101—HIGHWAY LIGHTING

1101.01 GENERAL REQUIREMENTS—Design, manufacture, and test lighting material and equipment according to the latest applicable standards of IEEE, ASTM, NEMA, ANSI, and the currently adopted AASHTO "LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" (AASHTO Specifications).

Fabricate highway lighting structural materials according to AWS, the AASHTO Specifications, and as specified in Section 1105 (steel members only); except, applying water to the base metal is permitted for the air plasma arc cutting process. Bulletin 15 listing, shop inspection, and AWS certified welding inspectors (CWI) are required for welded aluminum pole manufacturers and for welded steel pole manufacturers. Bulletin 15, shop inspection, and Section 1105 do not apply to cast aluminum poles, cast steel poles, cast iron poles, painting of aluminum poles, or poles without welds on any areas subject to tensile stress.

Design calculations are required for all poles. Submit design calculations and fatigue analysis within 60 days of contract award, or as directed. If the Bureau of Design has previously approved identical lighting material and equipment, submission of design calculations and fatigue analysis may not be required. Provide calculations signed and sealed by a Professional Engineer registered in Pennsylvania.

Provide steel poles that are fabricated from material according to the current AASHTO Specifications. The Charpy V-Notch toughness test is required for load carrying tension members 1/2 inch and greater in thickness, including base plates and arm connection plates, as required for Zone 2 in Table S1 according to AASHTO Specifications. The Charpy V-Notch toughness test is not required for high mast handhole frames. Bend testing is required for material less than 1/2 inch in thickness.

Provide steel poles that are either round or multisided with a minimum of eight sides.

Use radiographic test methods when inspecting complete penetration welds on steel poles with material less than 5/16 inch in thickness, and use radiographic or ultrasonic test methods when inspecting complete penetration welds on steel poles with material 5/16 inch in thickness and greater. Perform and evaluate all non-destructive testing according to cyclically loaded, non-tubular tension criteria. Use radiographic, ultrasonic, or magnetic particle test methods when inspecting other welds on steel poles.

Provide aluminum poles that are round. Provide aluminum welds and aluminum welding material according to ANSI/AWS D1.2, Structural Welding Code for Aluminum. Use radiographic test methods when inspecting complete-penetration welds on aluminum poles. Use radiographic or dye penetrant test methods when inspecting other welds on aluminum poles.

Provide testing and test methods according to ANSI/AWS D1.1 (Steel) D1.2 (Aluminum) and as determined by the LTS. Contact the LTS to arrange for proper pole manufacturing inspection. Inspection will include 100% of the length of each complete penetration weld and a minimum of 25% of the length of each other weld. The portion of the other welds to be tested will be selected by the Representative. Certify lighting poles, nuts, bolts, and associated hardware as specified in Section 106.03(b)3, including Charpy VNotch- test results, bend test results, and weld inspection reports. Provide catalog cuts or shop drawings for approval, instead of certification, for all other highway lighting items. The Department may select test samples at the source of supply before shipping or at the project site after delivery.

Submit for approval, before purchase and at no additional cost to the Department, catalog cuts, drawings, and manufacturer's specifications for all lighting material including; lighting poles, luminaires, junction boxes, conduits, cables, and power supply components proposed for the project.

Do not alter or modify any material unless authorized, in writing, by the manufacturer. Inform the Department of any alterations or modifications made outside of the manufacturer's facilities, and furnish proof of authorization from the manufacturer.

Provide poles, which are less than 70 feet in height in two sections or less.

Provide poles, which are between 70 feet and 100 feet in height in three sections or less.

Provide poles, which are over 100 feet in height in four sections or less.

Furnish minimum pole section lengths of 12 feet for high-mast poles and 15 feet for conventional poles. Obtain approval to furnish shorter section lengths.

Provide all units of any one item; such as luminaires, lamps, cable, and poles; that are of similar type and from the same manufacturer unless approved as a substitute.

1101.02 POLES AND BASES (CONVENTIONAL LIGHTING)—Furnish Type A poles with non-breakaway bases or Type S poles with breakaway bases, as indicated, as shown on the Standard Drawings, and as follows:

(a) General.

1. Poles.

- Manufacture shafts of steel or aluminum, with the shaft uniformly tapered approximately 0.14 inch per foot. Fabricate multi-piece shafts to allow field assembly by overlapping sections.

- Design for Service I, Strength I, and Extreme I Limit States and the wind load calculation shall be according to Section 3.8 of the AASHTO LRFD Specifications.

- Provide a handhole finished without rough edges and with a reinforcing frame and cover designed to maintain the required pole strength.

- Weld a 2 3/8-inch to 3-inch O.D. vertical tenon, fabricated from the same grade metal as the shaft, at the top of poles with post top luminaire mounting, and on the same axis as the pole.

- Compute the ice load on cobra head luminaires using a surface area equal to six times the Effective Projected Area (EPA). As specified in Section 1101.06(b) for cobra head luminaire EPA and weight.

- Design decorative light poles (with no significant arms) for Service I, Strength I, and Extreme I Limit States and the wind load calculation shall be according to Section 3.8 of the AASHTO LRFD Specifications. For square cross section poles only, include a design for fatigue according to AASHTO LRFD Specifications Section 11.5.1.

Furnish poles capable of sustaining loadings as follows:

- Horizontal load of 500 pounds applied 18 inches from the shaft top in any direction with no failure of any component part. Deflection of the shaft from vertical is limited to 7.5% of the shaft length.

- Horizontal load of 50 pounds applied at the luminaire attachment point and normal to the pole bracket member plane, with a vertical load of 30 pounds on the luminaire supporting arm. Rotation of individual sections of two-section poles is not allowed. The horizontal deflection is limited to 10% of the luminaire supporting arm's horizontal length.

- Vertical load of 100 pounds applied at the luminaire attachment point. The vertical deflection is limited to 5.5% of the pole arm's horizontal length.

- Vertical load of 250 pounds applied at the luminaire attachment point. Collapse or rupture of any portion of the structure is not allowed.

- Pole arm and luminaire dead load. The deflection from vertical at the top of the pole is limited to 1% of the total shaft length. The pole deflection from vertical is defined as the horizontal distance between the pole top centerline, when the pole alone is installed plumb, and the pole top centerline, after the arm and luminaire combination are installed on the previously plumb pole, measured without additional shaft adjustment.

2. Anchor Bases.

- Finish clean, smooth, and of the dimensions required for adequate pole mounting and structural support.

- Provide holes for anchor bolts.

- Telescope the base over the shaft and secure in place by electric arc welding at the pole bottom and at the top of the base plate.

3. Anchor Bolt Covers. Furnish a cover for each anchor bolt and use 1/4-inch, stainless steel, Phillips-head, or hex-head screws.

4. Frangible or Breakaway Bases. Provider transformer bases. Furnish bases according to the AASHTO Specifications. Perform non-destructive testing of all welds at the pole fabricator location. Submit a copy of the FHWA acceptance letter with the catalog cut or shop drawing information for approval. Other base types are not allowed unless specifically approved for the application.

5. Labels. Provide pole identification, date, and Lighting Management System (LMS) key tags with 1-inch high reflective aluminum characters and slide in aluminum holders, width as required to accommodate the characters. Provide 1/8-inch diameter holes for attachment with stainless steel rivets or screws. Provide black characters on white or gray background or white characters on black background. Do not use ID tags with decorative poles.

(b) Steel Poles.

1. Shaft.

- Fabricate from material according to ASTM A595 or ASTM A572 and not less than No. 11 gage, or from hot rolled, low carbon, high-strength steel according -to the following requirements:

  Minimum yield strength—50 kips per square inch
  Minimum ultimate tensile strength—65 kips per square inch
  Carbon content─0.15% min., 0.25% max.
  Maximum phosphorus content─0.04%
  Maximum sulfur content─0.05%
  Maximum silicon content─0.05%

Do not use equivalent steel types unless approved.

- Form into a continuously tapered shaft with one automatic electric arc welded, longitudinal joint per piece.

- Do not use transverse intermediate welds.

- It is permitted, after forming and welding, to use longitudinal cold rolling with sufficient pressure to tighten the weld, form a round shaft, and to increase the metal's minimum yield strength to 50 kips per square inch.

- Grind or bevel longitudinal weld beads and mating edges of two-piece shafts to avoid binding during section assembly.

- Provide complete-penetration longitudinal welds in the slip-joint area (1.5 times the inside diameter of the exposed end of the female section) plus 6 inches beyond, for the female section only.

- Provide a grounding nut for a 1/2-inch x 13 UNC threaded bolt or stud, when applicable, on the inside of the shaft, accessible from the handhole.

- Poles octagonal in shape, with flat or fluted faces, may be substituted for round steel poles. Furnish octagonal poles at least equal to round poles in thickness of metal and strength of pole, and meeting the requirements for round poles.

- Provide tapped holes for attaching anchor bolt covers.

2. Anchor Bases. Fabricate one-piece bases of cast steel according to ASTM A27, Grade 65-35, or steel plate according to AASHTO M 270 and according to ASTM A709, Grade 36.

3. Finish.

- Hot-dip galvanize the inside and outside surfaces of poles and bases as specified in Section 1105.02(s) and according to ASTM A123 after fabrication and before shipment.
- Clean the welds on poles by sandblasting or by an alternate, approved method before galvanizing.

(c) Aluminum Poles.

1. Shaft.

- Spin shafts to provide Alloy 6063-T6 according to the AASHTO Specifications.
- Provide a satin finish.
- Weld an aluminum grounding nut or lug for an 1/2-inch x 13 UNC threaded bolt or stud, when applicable, on the shaft inside, opposite the handhole.
- Furnish stainless steel hardware, unless otherwise directed.
- Provide poles with a J-Hook at the top of the shaft.

2. Anchor Bases. Fabricate one-piece bases of cast Aluminum Alloy SG70A-T6 (356-T6), ASTM B26 or ASTM B108. Provide tapped holes for attaching anchor bolt covers.

1101.03 POLE ARMS (CONVENTIONAL LIGHTING)—Furnish steel bracket arms and connections as shown on the Standard Drawings, and furnish clamp connections for aluminum truss arms and poles, and as follows:

(a) General.

- Manufacture arms of steel or aluminum.
- Install the arm with a weather-resistant connection to the shaft, with a smooth raceway for wiring.
- Furnish arms of the same material as the pole.
- Provide ASTM F3125 Grade A325 connecting bolts as specified in Section 1105.02(d) for steel poles.

(b) Bracket Type.

- Furnish arm assemblies, consisting of an upper member and a lower member, rigidly secured by vertical struts (truss), or consisting of a cantilever-type arm (single member).
- Provide a fitting on the pole end of each type arm to allow the bracket-arm assembly to be secured to the pole.
- Do not use gusset plates for truss arm connections to the clamp plate for arms less than or equal to 15 feet.

1. Truss Arms.

1.a Steel. Fabricate arms to have a minimum nominal diameter of 2 inches. Finish as specified in Section

1101.02(b)3.

1.b Aluminum. Fabricate upper and lower members using 2-inch or larger nominal diameter aluminum pipe, or using a combination of pipe and elliptical sections. Provide Alloy 6063-T6 according to the AASHTO Specifications.

2. Single-Member Arms.

2.a Steel. Fabricate arms to have the same taper and a minimum nominal diameter of 2 inches. Finish as specified in Section 1101.02(b)3.

2.b Aluminum. Fabricate using 2-inch or larger nominal diameter tapered aluminum tube or using tapered aluminum section, oval in shape, at the pole end and tapering to the luminaire end. Provide Alloy 6063-T6 according to AASHTO Specifications.

1101.04 ANCHOR BOLTS, NUTS, AND WASHERS (CONVENTIONAL AND HIGH MAST LIGHTING)—
Provide a preassembled high mast anchor bolt arrangement. Mark the anchor bolt assembly for matching with the corresponding high mast pole base plate. Use an identification mark that will be visible after embedment in concrete.
Furnish structural steel anchor bolts, hex-head bolts, nuts, and washers for conventional and high mast lighting as specified in Section 1105.02(c)3, the following requirements, and as shown on the Standard Drawings:

(a) Hex Head Bolts. Provide hot–dipped galvanized bolts according to ASTM F3125 Grade A325 for anchor bolts with yield strength of 55 kips per square inch and ASTM A354, Grade BC, for anchor bolts with yield strength of 105 kips per square inch.

(b) Galvanizing. As specified in Section 1105.02(s) and as follows:
Galvanize the top 12 inches minimum of anchor bolts and all associated hardware according to ASTM A153, or another acceptable method according to ASTM A153. Brushing of the threaded area to remove excess zinc is allowed, according to the American Hot-Dip Galvanizers Association's recommended procedures for galvanizing of threaded parts.

1101.05 POLES (HIGH MAST LIGHTING)—Furnish poles as shown on the Standard Drawings, as specified in Section 1101.01, and the following:

(a) General.

- According to the AASHTO LRFD Specifications. Design for Service I, Strength I, and Extreme I Limit States. Design for fatigue to resist the combined wind effect according to AASHTO LRFD Specifications 11.7.2. Consider Fatigue Design Case according to Table 11.7.2-1 for Fatigue Category I.

- Design poles to provide a maximum deflection equal to 10% of the shaft length.

- Design based on ten luminaires per pole with each luminaire exerting a downward force equal to 75 pounds and having an EPA of 2.0 square feet. Include EPA and downward force for the head frame assembly being used. Compute the ice load on the luminaire using a surface area equal to six times the APA.

- Fabricate pole shafts and base plates from high-strength, low-alloy structural steel according to AASHTO M 270 -and according to ASTM A709 Grade 50. Do not use equivalent steel types unless approved.

- Galvanize poles and base plates as specified in Section 1101.02(b)3.

- Grind or bevel mating edges of multi-section poles to avoid binding during section assembly.

- Do not use transverse welds.

- Provide base plates with a minimum thickness of 3-inch unless otherwise approved.
- Provide bottom shaft sections with an 0.625 inch minimum thickness.
- Provide a complete joint penetration weld for the connection of the shaft to the base plate according to the AASHTO LRFD Specifications Table 11.9.3.1-1 Section 4.4.
- Provide complete-penetration longitudinal welds in the slip-joint area (1.5 times the inside diameter of the exposed end of the female section) plus 6 inches beyond, for the female section only. Provide 6-inch complete penetration longitudinal welds at the base plate connection.
- Join each pole section by telescoping the individual sections. Overlap a minimum of 6 inches and maximum of 12 inches. Do not field weld.
- Mark corresponding pole sections for field mating and assembly.
- Mark the inner telescoping section to show the minimum required telescoping length.
- Clearly mark and identify each pole base plate for matching to the corresponding anchor bolt assembly, to ensure proper fit in the erection of each pole.
- Permanently inscribe each pole with manufacturing identification and reordering information, or show on a nameplate attached to the pole.
- Provide four-conductor copper No. 10 AWG minimum, 600 V, electrical cable, of the type and length required, with a watertight electrical plug and receptacle suitable for use.
- Provide a matching watertight power receptacle having sufficient cord length to be brought outside for energizing the lowered luminaire mounting ring and the electrical power drive.
- Provide a low resistance grounding lug at the top of the pole for grounding the lightning rod to the pole shaft.
- Provide stainless steel hardware; such as nuts, bolts, screws, and washers.

(b) Head Frame Assembly. Provide a head frame assembly with each high-mast pole, to support the luminaire ring with its required number of luminaires, and as follows:

- Mount pulleys and mechanisms on the head-frame assembly; cover with a protective non-corrosive housing.
- Make necessary cable openings as small as practical to prevent the entry of birds.
- Provide a housing that can be easily removed from the head-frame assembly for servicing of pulleys and other mechanisms.
- Provide a 24-inch, nickel-tip copper lightning rod on each pole, extending not less than 20 inches above the head-frame cover and located on or near the pole centerline.
- Ground the lightning rod to a grounding lug at the pole top, using No. 1/0 AWG braided copper wire, adapters, and cable connectors. Provide a grounding lug furnished by the lightning rod manufacturer.
- Mount the lightning rod with brass or bronze hardware.
- Provide pulleys large enough to contain the various required cables, without exceeding the recommended

bending radii.

- Fabricate pulleys of either cast steel with a nylon bushing or aluminum with a bronze bushing, both with a stainless-steel shaft Type 304, and both equipped with guards to prevent the cable from jumping off the pulley.

- Furnish a head frame that provides three-point suspension and positive centering and engagement between the mating parts of the head frame and the luminaire ring assembly.

- Hot-dip galvanize the head frame, after fabrication, as specified in Section 1105.02(s) and according to ASTM A123, or completely zinc-electroplate with an additional 5-mil minimum thickness of approved zinc-rich paint or an epoxy powder coating.

(c) Latching. Furnish each high mast pole assembly with either a latching device or two safety cables to secure the luminaire ring in the fully raised position after tension is removed from the winch hoist cable.

- If a latching device is furnished, the mechanism is required to release either automatically or by manual pull of a cable after the luminaire ring has been raised from the latching pins or fingers. Provide a mechanically operated indicator for each of the three luminaire ring latches to indicate positive latching at each point on the luminaire ring.

- If two safety cables are furnished, anchor the cables to the winch-mounting frame or to eyebolts embedded in the foundation. Attach the safety cables to the cable terminator securing the luminaire ring in the fully raised position removing tension from the winch hoist cable. Provide a mechanically operated indicator for each of the three cables to indicate a fully seated ring.

(d) Luminaire Ring Assembly.

- Equally space 2-inch luminaire tenons around the ring for the indicated number of luminaires.

- Hot-dip galvanize the entire luminaire ring assembly after fabrication as specified in Section 1105.02(s) and according to ASTM A123.

- Provide a weatherproof male plug wired to the terminal box, for energizing the luminaires in the servicing position.

- Provide a 30 A, four-wire type watertight plug to mate with the power receptacle.

- Provide a ring-mounted enclosure as specified in Section 1101.11(c) to house a terminal block, fuse block, and lightning arrester.

- Provide guide rollers or pads to cushion excess swing during raising and lowering operations.

(e) Winch Assembly. Provide a self-locking, permanently lubricated, worm gear winch assembly, enclosed within the pole mast, capable of raising and lowering the entire luminaire ring at a rate of approximately 15 feet per minute when driven by a portable winch drive. Provide a drive unit of a size and speed determined by the lifting and lowering force required, and the required raising and lowering speed, without exceeding 50% of the capacity of the worm gear assembly or the drive unit. Provide a winch that remains locked in any position to prevent the luminaire ring assembly from falling under its own gravitational force if the operator interrupts the raising or lowering operations. Provide a winch designed to ensure proper spooling of the cable upon the drum at all times.

(f) Electrical Winch Drive. Furnish, for each project, one portable, heavy-duty, industrial-rated, reversible, electrical winch drive as follows:

- Provide the drive with a torque limiter that causes drive slipping at a predetermined torque to prevent damage to the system.

- Provide sufficient length of cable and mating plug to directly utilize the power supply.
- Equip the drive to attach to the winch drive shaft and the pole so the drive is completely self-supporting.
- Furnish a drive that operates from a remote switch, with sufficient cable length so the operator can stand a safe distance outside the radius of the luminaire ring assembly.
- A 120 V drill motor and transformer may be provided instead of a 240 V drill motor. The maximum transformer weight allowed is 50 pounds. Provide a transformer enclosure, carrying handle, and connectors.

(g) Hoist Cables. Furnish hoist cables made from stainless steel aircraft cable, according -to Military Specification MIL-W-83420J.

- Attach the support cables to a self-leveling yoke, to which is attached the winch cable from the winch drum.
- Provide guide cables or other acceptable means to prevent cable entanglements in the pole shaft.

(h) Miscellaneous Hardware. Furnish miscellaneous hardware of stainless steel, Type 304.

1101.06 LUMINAIRES (CONVENTIONAL LIGHTING)—Furnish luminaires complete including lamps, ballasts, decals, associated hardware, and necessary wiring.

(a) General.

- Furnish materials incorporating the latest available ratings and design improvements.
- Provide NEMA 5- or 7- pin photocell receptacle and shorting cap. Omit shorting cap if individual photocell control is indicated.
- Provide individual NEMA 5- or 7- pin remote monitoring and control module as specified in Section 1101.11(b), when indicated.
- Furnish warranty and luminaire certification of UL approval, as applicable.
- Furnish a sample luminaire for review and acceptance, if directed, when data is submitted for a product that has not previously been accepted by the Department.
- Furnish luminaire photometric data and ballast or driver data with catalog cut information.
- Install glare shields, where indicated.
- Furnish clear high pressure sodium lamps for HPS luminaires. Provide lamps with a date marking code on the base. The nominal lamp voltage for less than 150 W is 55 V, and for 150 W and greater is 100 V.
- Provide HPS luminaires with internal pre-wired ballasts, regulator or auto-regulator, capable of operating within ±10% of the specified supply voltage. Furnish ballasts that provide dependable starting of the lamp at a temperature of -20F, with a power factor of not less than 90%, and according to the latest ANSI specifications.
- For LED luminaires, provide documentation that demonstrates that the proposed model of LED luminaire has been tested for electromagnetic compliance following the measurement protocols according to ANSI standard C63.4-2003 and 47 CFR 15.31.

(b) Arm Mount Luminaires – HPS (Cobra Head).

1. Housings.

- Provide a precision cast or formed housing of aluminum, with a refractor holder and an integral 2-inch slip-fitter, capable of adapting to the mounting tenons.

- Provide a gasketed, thermal, shock-resistant glass prismatic refractor accurately molded to give the specified light distribution pattern, held in position in the lower housing with retaining clips.

- Provide a detachable reflector of processed aluminum, with a sealed anodic coating over an electrolytically or chemically brightened surface.

- Install the reflector with a gasket between it and the refractor, designed for easy removal from the housing. Silicone rubber gaskets are acceptable for luminaires up to and including 1000 W, and ethylene propylene (EPT or EPDM) gaskets are acceptable for luminaires up to and including 400 W. For cobra head and other luminaires where the housing provides a drip-proof protection, refractor gaskets of high density, filtering type, non-wicking PET not less than 1/4 inch thick are also permitted. Die cut gaskets and overlay at joints.

- Include an adjustable mogul lamp socket.

- Furnish a luminaire capable of accommodating the appropriate lamps, properly positioned relative to the optical system. Provide a slip-fitter designed to prevent linear creep or rotation of the luminaire on the tenon.

- Provide a frame size for conventional High-Pressure Sodium Luminaires as follows, or equal:

Watts	American Electric	Cooper Lighting	General Electric	Hubbell
Less than 200	115	OVZ	M-250	RM 150
200, 250 & 400	125	OVF	M-400R	RL 400

- Provide luminaires with a maximum EPA of 1.5 square feet, and a maximum weight of 55 pounds.

(c) Arm Mount Luminaires – LED – (Cobra Head).

1. Housings.

- Provide a precision cast or formed housing of minimum 96% copper-free aluminum, minimum shell thickness of 0.050-inch, with stainless steel or zinc plated steel fastening hardware and an integral 2-inch slip-fitter capable of adapting to the mounting tenons and adjustable for 1-1/4-inch or 2-inch mounting pipe. Provide integral die cast mounting pipe stop feature and integral levelling means..

- Provide ANSI/NEMA C136.31 Vibration Test Level 3G.

- Provide factory installed LED array thermally sealed to heat sink. Chip on board LEDs will not be accepted.

- Driver to be accessible and removable without the use of tools. Enclosure to be sealed to prevent entry of animals and insects.

- Provide luminaire assembled in the USA, according to US Steel Certifications, and as specified in Section 106.10.

- Provide luminaires with an EPA between 0.6 square feet and 1.5 square feet, and a weight between 20 pounds and 55 pounds.

2. Optical.

- Provide UV stabilized refractor for each individual diode.
- Provide IP66 optical chamber and IP65 driver.
- Provide minimum 70 CRI, verified according to LM-79.
- Provide nominal correlated color temperature (CCT) of 4,000 K, according to LM-79.

3. Electrical.

- Provide luminaire with a minimum L85 of 60,000 hours tested according to TM-21. Testing data must indicate minimum testing period of 8,400 hours.
- Provide 0-10 V dimmable electronic driver with minimum rated life of 60,000 hours at 77F.

4. Warranty.

- Luminaire to be free from defects and operate as indicated for a period of 10 years from the date of delivery

(d) Post Top Mount Luminaires – HPS (Offset). Furnish as specified in Section 1101.06(b) and as follows:

- Furnish a precision cast aluminum housing, with a refractor holder.
- Provide a gasketed, thermal, shock-resistant glass prismatic refractor accurately molded to give the specified light distribution pattern, held in position in the lower housing with retaining clips.
- Join the upper and lower housings by stainless steel hinges and provide with twin trigger latches for access to internal components.
- Install gaskets at critical points to prevent entry of moisture and contaminants.
- Provide a detachable reflector, of processed aluminum, with a sealed anodic coating over an electrolytically or chemically brightened surface.
- Permanently attach the lamp socket to the reflector, to ensure correct lamp positioning. Provide the socket with a quick disconnect for easy removal of the reflector/socket assembly.
- Provide the luminaire with a slip-fitter designed to accept a 2 3/8-inch to 3-inch O.D. vertical tenon for lateral orientation.
- Provide external adjustments for horizontal luminaire leveling.
- Provide infinite angular fixture adjustment in the vertical plane for proper luminaire aiming.

(e) Wall Mount Luminaires (Underpass). Furnish as specified in Sections 1101.06(b) and (c) and as follows.

Furnish luminaires that provide total available downward street side lumens, between one mounting height and three mounting heights transverse distance, of not less than 20% of the bare lamp lumen output.

(f) Overhead Mount Luminaires (Underpass). Furnish as specified in Sections 1101.06(b) and (c).

1101.07 LUMINAIRES (HIGH-MAST LIGHTING)—Furnish open-type, cutoff luminaires complete with lamps, ballasts, associated hardware, and necessary wiring as specified in Sections 1101.06(a), (b), and (c), and as follows:

(a) Luminaires – HPS – (High-Mast Lighting).

- Provide with adjustable slip-fitters designed for a 2-inch tenon to allow a positioning adjustment of ±3 degrees about the tenon axis.
- Provide with a heavy-duty, porcelain-enclosed, lamp socket, with the brass shell impregnated to prevent thermal freezing with the lamp base.
- Provide a lamp-stabilizing clamp that is non asbestos-lined, heat-resistant, and stainless steel.
- Equip luminaires with ballasts, as specified in Section 1101.06(a).
- Furnish 400 W, high-pressure sodium lamps with a minimum initial output rating of 50,000 lumen and a minimum rated life of 24,000 hours based on 10 hours of operation per start.
- Furnish lamps that burn in a vertical (base-up) position.
- Provide luminaires with a maximum luminous intensity angle nominally 60 to 65 degrees from nadir.
- Furnish luminaires having a projected area not exceeding 3.5 square feet, an EPA not exceeding 2.0 square feet, and exerting a gravitational force not more than 75 pounds.
- Provide glare shields, when indicated.
- Furnish luminaires that provide the following nominal initial luminous intensity at the angles specified below:

Vertical Angle (degrees)	Luminous Intensity (candelas)
20	2,850
30	4,170
40	4,760
50	7,500
55	9,550
60	12,900
65	13,800
70	9,250*
72 1/2	7,350*
75	4,350*

* These are minimum values at the respective angles. Other candelas are nominal values.

Furnish vertical luminous intensity trace data to ascertain compliance with luminous intensity distribution requirements.

(b) Luminaires – LED – (High-Mast Lighting).

1. Housings.

- Provide a precision cast or formed housing of minimum 96% copper-free aluminum, minimum shell thickness of 0.050-inch, with stainless steel or zinc plated steel fastening hardware and an integral 2-inch slip-fitter, capable of adapting to the mounting tenons and adjustable for 1-1/4-inch or 2-inch mounting pipe. Provide integral die cast mounting pipe stop feature and integral levelling means.
- Provide ANSI/NEMA C136.31 Vibration Test Level 3G.
- Provide factory installed LED array thermally sealed to heat sink.
- Driver to be accessible and removable without the use of tools. Enclosure to be sealed to prevent entry of animals and insects.
- Provide luminaire that is assembled in the USA, according to US Steel Certifications, and as specified in Section 106.10(a).
- Furnish luminaires having a projected area not exceeding 3.5 square feet, an EPA not exceeding 2.0 square feet, and exerting a gravitational force not more than 75 pounds.

2. Optical.

- Provide UV stabilized refractor for each individual diode.
- Provide IP66 optical chamber and IP65 driver.
- Provide minimum 70 CRI, verified according to LM-79.
- Provide nominal CCT of 4,000 K, verified according to LM-79.
- Provide luminaires with a maximum luminous intensity angle nominally 60 to 65 degrees from nadir.

- Provide glare shields, when indicated.

- Furnish luminaires that provide the following nominal initial luminous intensity at the angles specified below:

Vertical Angle (degrees)	Luminous Intensity (candelas)
20	2,850
30	4,170
40	4,760
50	7,500
55	9,550
60	12,900
65	13,800
70	9,250*
72 1/2	7,350*
75	4,350*

* These are minimum values at the respective angles. Other candelas are nominal values.

Furnish vertical luminous intensity trace data to ascertain compliance with luminous intensity distribution requirements.

3. Electrical.

- Provide luminaire with a minimum L85 of 60,000 hours tested according to TM-21. Testing data must indicate minimum testing period of 8,400 hours.

- Provide 0-10v dimmable electronic driver with minimum rated life of 60,000 hours at 77F.

4. Warranty.

- Luminaire to be free from defects and operate as expected for a period of 10 years from the date of delivery

1101.08 CABLE—Furnish cable as follows:

(a) General.

- Provide 600 V conductors with insulation, and jacket as applicable, according to ICEA S-95-658/NEMA WC-70. Provide insulated equipment grounding conductors. Provide bare grounding electrode conductors.

- Provide color-coded cables. Color code by surface markings, pigmented insulation, or tape. If surface markings are used, place marks at intervals not exceeding 24 inches, located so as not to conflict with the required NEC markings. Provide cable with surface markings, except as specified in Section 1101.01. If taping is provided, overlap the tape for a minimum of 6 inches on the cable, at all access locations, and for each conductor.

- Conductors for all types of cables, including ground wire, as follows:

	Copper
Conductor	Soft Drawn

	ASTM B3
Stranding	ASTM B8 5.26 to 33.6 mm^2 (10-2): 7 Strand 42.4 to 107.2 mm^2 (1-4/0): 19 Strand

(b) Underground Cable. Furnish with insulation and jacket, as required, according to the following:

	Rubber-Neoprene	XLP
Insulation	****SBR Rubber** ***Ethylene Propylene **(EP) Rubber** Thickness (in.) 12-10: 3/64 or 0.045 8-2: 4/64 or 0.060 1-4/0: 5/64 or 0.080	**Cross-Linked** Thickness (in.) 12-10: 3/64 or 0.045 8-2: 4/64 or 0.060 1-4/0: 5/64 or 0.080
Jacket	**Neoprene** ASTM D4247 Thickness (in.) 12-2: 2/64 or 0.030 1-4/0: 3/64 or 0.045	None
Max. Normal Operating Temperature	**167F ***194F	Wet: 167F Dry: 194F
Code	****RHW** *****RHW, RHH, USE**	**RHW, RHH, USE**

(c) Aboveground Cable. The cables specified for Underground applications may be used for above ground applications.

Furnish with PVC insulation without nylon jacket or thinner XLP-insulated, as applicable, and as follows:

	PVC (Without Jacket)	XLP
Insulation	Thickness (in.) 12-10: 3/64 or 0.045 8-2: 4/64 or 0.060 1-4/0: 5/64 or 0.080	**Cross-Linked Polyethylene** Thickness (in.) 12-10: 0.030 8-2: 0.045 1-4/0: 0.055
Jacket	None	None
Max. Normal Operating Temperature	Wet: 167F Dry: 194F	Wet: 167F Dry: 194F
Code	THW	XHHW

(d) Cable Duct. When indicated, furnish cable, preinstalled in a polyethylene Schedule 40 plastic conduit according to NEMA TC-7. Provide cable conductors and stranding according to Underground Cable, with cable insulation RHW/RHH/USE, and with insulation thickness as specified above.

(e) Application, Testing, and Shipping.

- Utilize acceptable cable as follows:

With luminaires	194F
Other uses	167F

- Show the name of the manufacturer, conductor size in AWG or MCM, and cable voltage rating on the outer cable covering with the code clearly printed or molded on the sheath.
- Manufacture, inspect, and test cable, according to the latest issues of ICEA Publications.
- Submit certification of these tests identifying each cable reel with the test data supplied.
- Ship cable on reels, plainly and indelibly marked with the name of the manufacturer, gross, net and tare masses, size, type, voltage rating, and length of cable per reel.
- Ship on a reel having a minimum drum diameter not less than 14 times the nominal cable diameter.
- Seal cable ends against entrance of moisture.
- Provide a covering of heavy cardboard, burlap, or lagging to protect the cable during handling or shipping.

1101.09 CONDUIT—Furnish conduit and protective coating for conduit.

(a) General. Furnish PVC and fiberglass conduit, conduit fittings, and conduit elbows and expansion fittings from the same manufacturer. Provide expansion/deflection fittings required for structures as shown on Standard Drawing BC-721M. Clean PVC conduit in join area according to manufacturer's recommendation. Use PVC cement labeled by or recommended by the conduit manufacturer.

If metal conduit bodies and fittings are specified and hot dipped galvanized parts are not available, apply two coats of zinc paint as specified in Section 910.3(r).

Provide manufactured sweep bends or as specified in Section 910.3(g).

(b) Direct Burial.

1. Polyvinyl Chloride (PVC) Conduit. Provide Schedule 40; 194F, UL-listed conduit according -to NEMA Standard TC-2 (EPC-40PVC), with fittings according -to NEMA Standard TC-3 (EPC-40-PVC).

2. Fiberglass Reinforced Epoxy Conduit. Provide UL-rated conduit according -to NEMA Standard TC-14, Part B; and as follows:

- Filament wound
- Minimum glass content of 68%
- Minimum tensile strength of 11,000 pounds per square inch
- Containing carbon black for ultra-violet protection.

(c) Concrete Encased or Exposed. Provide one of the following:

1. Rigid Steel Conduit. Hot-dipped galvanized, inside and outside; and according -to ANSI C80.1, UL Standard 6, and UL Standard 1242. Provide hot-dipped- galvanized conduit bodies and fittings.

2. Polyvinyl Chloride (PVC) Conduit. Section 1101.09(b) for Direct Burial Conduit.

3. **Fiberglass Reinforced Epoxy Conduit.** Section 1101.09(b) for Direct Burial Conduit.

(d) Conduit Sleeve – Jacked, Augered, or Bored Conduit. Rigid steel conduit, as specified in Section 1101.09(c).

1101.10 JUNCTION BOXES AND BURIED CABLE AND CONDUIT MARKERS—

(a) Junction Boxes. Furnish as shown on the Standard Drawings for the type indicated, and as follows:

- **Concrete Junction Boxes.** Provide cast-in-place boxes made from Class A cement concrete as specified in Section 704; or provide precast boxes as specified in Section 714. Provide frames as specified in Section 605. Refer to Standard Drawings RC-81M and RC-82M for details of junction boxes JB-1, 2, 11, and 12.

- **Cast iron or Welded Steel Plate Junction Boxes.** Provide boxes as specified in Section 605. Provide boxes hot-dipped galvanized as specified in Section 1105.02(s) and according to ASTM A123 after fabrication. Provide a cover with a closed cell neoprene gasket with screws to secure cover. Provide a factory installed grounding stud and hex nut in rear of the box, as applicable. Refer to Standard Drawing BC-721M for junction box JB-25 details.

(b) Buried Cable and Conduit Markers. Furnish cast-in-place or precast, Class A cement concrete markers as shown on the Standard Drawings. Form letters and arrows by making depressions in the plastic concrete. Refer to Standard Drawing RC-84M for marker details.

1101.11 POWER SUPPLY—Furnish the power supply, consisting of:

(a) Service Poles.

- According to ANSI specifications.

- Of Western Red Cedar, Southern Yellow Pine, or equal.

- Minimum size, as listed under Class 4.

- Minimum length of 30 feet.

- Impregnate with nonleaching, waterborne preservative Chromated Copper Arsenate (CCA), Type C, according -to AWPA-P5, preservative applied in closed cylinder by pressure process according to AWPA-C4. Provide retention of CCA dry salts of 0.60 pounds per cubic foot (Oxide basis). Approved trade names: -Chrom-Ar-Cu-; Osmose K33C; Wolman CCA, and Wolmanac- CCA. Include treatment certification with each shipment.

(b) Photoelectric Control Device.

- Photo cell of the cadmium-sulphide type with fail-safe in the “On” position.

- Weatherproof pheonolic, cycolac, or acrylic plastic housing, not susceptible to distortion, discoloration, cracking, or crazing.

- Adaptable for pole-top- or cross-arm mounting in a plugin, locking-type receptacle, according -to UL Specification 773.

- Provide solid brass plug blades.

- Relay rated 1,800 VA and 15 amps for all HID lamps.
- Control unit, with a built-in surge protective device for protection from induced high voltage and follow-through currents, and having a turn-off time delay to prevent false turn-off, due to lightning, stray lighting, or flashing lights.
- Designed to operate at the required voltage, and to operate satisfactorily at -20F ambient temperature, with performance characteristics according to EEI and NEMA standards.
- Load switching capability of 5,000 operations minimum at rated load.

A separate photoelectric cell conforming to the above requirements may be installed as an integral part of each luminaire assembly, as a substitute for the above, when indicated.

(c) Control Cabinet (Enclosure). As shown on the Standard Drawings and as follows:

1. Cabinet Construction. According to one of the following:

- Code gage stainless steel, ASTM A240/A240M-15a, Type 304.
- Code gage aluminum sheet alloy, No. 5052H32, having mechanical properties according- to ASTM B209.

2. Other Requirements.

- NEMA 3R or 4.
- Having closed cell neoprene gasket, welded seams, continuous hinge with stainless steel pin, and stainless steel external hardware.
- Having a backboard for mounting apparatus.
- Having two weep holes in the bottom.
- Equipped for padlocking. Provide acceptable outdoor, tumbler-type padlocks, keyed as directed. Furnish two keys with each lock.
- Having manufacturer's nameplate.

(d) Main Disconnect. Provide a main disconnect in a separate NEMA 3R or a 4 enclosure that is labeled ‘suitable for use as service equipment’. Provide with a lockable cover and no external handle. The disconnect may be provided integral to the control cabinet if the cabinet is dead front. Provide a 2pole, 10000 A.I.C. minimum, -moldedcase- circuit breaker, with line and load lugs and capacity to accommodate the specified conductors and current, and according to Federal Specification W-C-375b. If greater interrupting capacity is required by the local utility, the main disconnect may be a fused device.

(e) Lightning Arrester.

- According to IEEE C62.45-2002 Category B.
- UL 1449, 3rd Edition listing.
- Minimum MCOV: 120/240 VAC service rating: 150/300V. 240/480 VAC service rating: 300/600V.
- Minimum Short Circuit Current Rating (SCCR): 200,000A.

- With bracket for mounting on the control cabinet backboard.

(f) Lighting Contactor. Magnetic, 600 V, twopole lighting contactor with coil and contacts rated as indicated on Plans-.

(g) Selector Switch (for the Photoelectric Control Contactor). Provide a 600 V, three position (automatic-off-manual), maintained-contact control station.

(h) Distribution Circuit Breakers.

- Minimum rating of 10,000 A.I.C line and load lugs..
- No fuse, quick-make, quick-break type; having tumbler mechanism, full contact, and positive pressure until opening, whether operated automatically or manually.
- Stationary contacts as an integral breaker part and non-welding contacts when operating.
- Trip free from handle so the contacts cannot be held closed against short circuit or abnormal overload.
- Mounted individually on DIN rail or similar.
- Handle position, indicating the breaker contact position.
- Size and capacity, as indicated

(i) Circuit Breaker Panels. Enclosure mounted panel with solid neutral; and with bus bars and solderless lugs of large enough rating and size to accommodate the required voltage, current, and conductors.

(j) Ground Rod. Copper-clad steel, UL listed. Provide with bronze clamp or exothermic weld for connection to the grounding electrode conductor.

(k) Transformers (Less Than or Equal to 25 KVA).

- Secondary windings for three-wire unbalanced circuits.
- Step-up or step-down as indicated.
- Copper or aluminum windings.
- Totally enclosed non-ventilated outdoor type.
- Enclosure degreased, primed, and finished with a coat of outdoor enamel.
- Core and coil assembly encapsulated with an epoxy compound for transformers rated 25 KVA and less.
- Insulation of Class F material that does not exceed 239F raise above a 104F ambient, when tested according to ANSI and NEMA Standards.
- Terminal compartment located in the transformer bottom, with provisions for side or bottom, conduit entrance.
- Certified copy of results required for transformer temperature, performance, and sound tests, according to ANSI and NEMA Standards.

(m) Guy Anchor Assembly. Single down guy consisting of:

- A cone-type anchor having a diameter of not less than 12 inches.
- A 3/4-inch thimble-eye, anchor rod.
- A 1/2-inch, seven-strand, galvanized steel, guy wire.
- Three bolt, heavy-duty, guy clamps.
- A strain insulator.
- Strain and load plates on the pole.
- An angle thimble-eye through bolt of the required length.
- Curved washer and nuts.
- Hardware, galvanized as specified in Section 1105.02(s) and according to ASTM A123 or other acceptable method according to ASTM A153.

1101.12 REMOTE MONITORING AND CONTROL SYSTEM—Furnish a complete outdoor lighting network for remotely monitoring and controlling highway lighting luminaires, consisting of:

(a) Central Management System (CMS).

- Provide graphical user interface for operation of the remote monitoring and control system, to be compatible with the individual control nodes as specified in Section 1101.12(b) and segment controller as specified in Section 1101.12(c).
- Capable of multiple user access with assignable restrictions to user functionality.
- Capable of exporting records to .xls or .csv spreadsheets with a predetermined format.
- Capable of running custom reports for feedback of system status and operation.
- Capable of selecting on or a group of fixtures in a graphical site map format and modifying on/off status or dimming level.

(b) Individual luminaire control nodes.

- Provide one control node per arm mounted luminaire.
- Capable of normal operation over an ambient temperature range of -40F to 122F.
- Operation from 120-277 V (nominal ±10%) universal AC input (RMS volts).
- Mechanical and electrically connected to luminaire using NEMA C136.41 standard 5- or 7- terminal polarized twist-lock receptacle for both electrical and dimming control signal connectivity.
- Capable of:
    - Actuating the on/off status of a luminaire.
    - Actuating a luminaire OFF state that results in a ZERO watt power requirement for the luminaire. It is understood that the controller will require power to remain online.

- Actuating a luminaire DIMMED state by creating a 0-10 V control signal.
- Measuring and monitoring, over time, for the luminaire:
  - RMS input voltage (volts).
  - RMS input current (amps).
  - Apparent power (VA).
  - True input power (watts).
  - Power factor.
- Measuring energy consumption with an accuracy and precision of ±2% over the ambient temperature range and a load range of 0.1% to 100% relative power, and according to ANSI C136.50.
- Integrally sensing GPS location.

(c) Segment Controller.

- Provide one or more Segment Controllers as necessary to ensure communication with all luminaire controllers. Separate segment controllers are not required if the conditions in this section are met by the luminaire controller.
- Provide a segment controller capable of logging cumulative hours in the luminaire ON state for each luminaire controller.
- During online operation, provide a segment controller capable of reporting the following online luminaire controller parameters:
  - Controller Status (Online time, Offline time, Warning or Error codes)
  - Luminaire Status(Online time, Offline time, Warning or Error codes)
  - Average RMS input voltage (volts) in the ON state
  - Average RMS input current (amps) in the ON state
  - Average true input power (watts) in the ON state
  - Average input power factor in the ON state
  - Cumulative ON state time (hours)
  - Cumulative energy consumption (kWh)
  - LED Driver status (Warning or Error codes)
- During online operation, provide a segment controller capable of reporting all control point parameters for all luminaire controllers at a maximum reporting frequency of once every 60 minutes.

1101.13 MISCELLANEOUS MATERIAL—Furnish as follows:

(a) Hardware Stainless-steel or hot-dipped galvanized, as directed.

(b) Shims. Stainless steel, nonmagnetic, 300 Series, or acceptable aluminum.

(c) Pulling Lubricant. According to cable manufacturer.

(d) Cable Tags. Acceptable, non-conducting.

(e) Plastic Marking Tape. Provide one of the following or approved equal:

- "Allen Marking Tape" (Allen Systems Inc.)
- "Brady Identoline Tape" (W.H. Brady Co.)
- "Terra Tape" (Reef Industries Inc.)

(f) Ground Rod. As specified in Section 1101.11(j).

SECTION 1102—SIGN LIGHTING

1102.01 GENERAL REQUIREMENTS—Section 1101.01

1102.02 LUMINAIRES—

(a) Light Fixture. Furnish a light fixture as follows:

- LED or metal halide
- LED – As specified in Section 1101.06 and 7,500 lumens minimum
- Aluminum mounting bracket, when specified.
- Positive door closure by use of stainless steel latches and hinges.
- Cast aluminum housing and door assembly.
- Refractor and door assembly with nonpermanent-set gasket material.
- Thermal and shock resistant borosilicate glass refractor.
- Weep holes in the lowest area of the luminaire housing bottom when mounted.
- Polished aluminum reflector.
- Conduit entries in the luminaire assembly.
- Constant-wattage ballast, either integral or remote mounted.
- Aluminum, cast aluminum, or stainless steel enclosures for remote ballasts.

(b) Metal Halide Lamps. Furnish lamps as follows:

- 100 watt coated ceramic.
- 20,000 hours minimum rated life.
- Universal operating position.
- Rated 7,500 initial lumens minimum.

(c) Ballasts. Furnish electronic ballasts as follows:

- Fully enclosed aluminum housing.
- Power factor greater than 90%
- Lamp starting down to -22F ambient temperature and an operating case temperature up to 176 F.
- Thermally protected.
- End-of-life and output short-circuit protection.

- Output frequency less than 200 Hz.
- Lamp wattage regulation less than ± 5% for a ± 10% change in rated line voltage.

(d) Fittings. Furnish:

- Washers to level and adjust the luminaires on the supports, and made of the same material as the supports.
- Fittings at the entry into the luminaires made of a standard, factory-made, watertight design.

1102.03 CIRCUIT BREAKERS, PANELS, AND ENCLOSURES—Furnish the following:

(a) Circuit Breakers. Section 1101.11(h)

(b) Circuit Breaker Panels. Section 1101.11(i)

(c) Enclosures. Section 1101.11(c), (d), and as follows:
Provide enclosures with dimensions that provide code clearance and wiring space for the specified control apparatus.

1102.04 CONTROLS—Furnish the following controls:

(a) Photoelectric Control Device. Section 1101.11(b)

(b) Control Contactor. Magnetic control contactor, 600 V, two-pole, 60 A, with a 120 V or 240 V operating coil.

(c) Selector Switch. Section 1101.11(g)

1102.05 LIGHTNING ARRESTER—Section 1101.11(e)

1102.06 JUNCTION BOXES—Section 1101.10:

1102.07 CABLE—Section 1101.08 and as follows:
Provide Type TC, Tray Cable, with XHHW insulation and a PVC jacket, for cable from the sign enclosure to the luminaire.

1102.08 CONDUIT—Section 1101.09

1102.09 MISCELLANEOUS MATERIAL—Section 1101.13 and as follows:

(a) Service Poles. Section 1101.11(a)

(b) Ground Rod. Section 1101.11(j)

(c) Guy Anchor Assembly. Section 1101.11(m)

(d) Fittings. Provide standard, factory-made, watertight fittings at enclosures, junction boxes, conduits, and service heads.

SECTION 1103—TRAFFIC SIGNING AND MARKING

1103.01 GENERAL REQUIREMENTS—Certify material, as specified in Section 106.03(b)3.

1103.02 EXTRUDED ALUMINUM CHANNEL SIGNS (FOR POST MOUNTED SIGNS, TYPES A AND E AND STRUCTURE MOUNTED)—

(a) Extruded Aluminum Channels. As shown on the Standard Drawings.

Use channels according to ASTM B 221, Alloy 6063-T6, from a manufacturer listed in Bulletin 15.

Use continuous-channel sections equal to the sign width. The channel section is nominal. The Contractor may use an alternate extruded channel section of equal or greater section moduli with dimensions suitable to utilize the mounting hardware with written permission.

(b) Coating Treatment. Use a chemical conversion coating, such as Alodine No. 1200, Alodine No. 1200S, or Bonderite No. 781.

Apply the coating to the channel surfaces to ensure a good bond between the reflective sheeting material and the surface. Coat according to Military Specification, MIL-C-5541E, "Chemical Conversion Coatings on Aluminum and Aluminum Alloys." Do not handle with bare hands between the chemical conversion coating process and the application of the reflective sheeting. Handle by special devices or by hand wearing clean PVC gloves.

(c) Reflective Sheeting. Use precolored Type III, IV, VIII, IX, or XI sheeting, according to the Department's specification for Retroreflective Sheeting Materials and Process Inks for Traffic Control, from a manufacturer listed in Bulletin 15.

Apply the sheeting to the face and a 3/8-inch width along both edges of the channel sections, using a procedure specified by the sheeting material manufacturer. Apply free of bubbles or wrinkles greater than 3 inches in length and with total sheeting shrinkage of not more than 1/8 inch. A maximum of one splice may be made in the sheeting for any channel section. Make the splice perpendicular to the longitudinal centerline of the channel, with the edges of adjacent pieces butted together throughout the entire seam length, without any overlap or separation. If covered sections are stacked before sign fabrication, then use microfoam between sign faces and store sections in a vertical position.

(d) Legend and Border. Use direct-applied cutout Type VIII, IX, or XI reflective sheeting material for letters, numerals, accessories, borders, and symbols.

(e) Sign Fabrication. Apply the reflective sheeting, then firmly bolt channels together with the webs in the same plane, to form a smooth and uniform surface. Adjust channel ends for correct position so the edges are free from projections.

Securely fasten assembled sign panels to a rigid framework, before application of legend and before shipment. Lay out the legend and border on the sign face as indicated on the sign fabrication drawings.

Apply cutout Type VIII, IX, or XI legend and border to sign face according to manufacturer's instructions.

Fabricate signs in a single unit. If necessary, ship large signs sectionalized in panels. When shipping sectionalized signs, slit any legend and border, which overlaps the panels.

(f) Sign Identification. Fabricate the plaques of aluminum, plastic, or fiberglass of sufficient thickness to provide the necessary stiffness and to resist vandalism, or stencil directly on the sign panel with weather-resistant paint. Indicate sign number and the month and year of erection in 1-inch high characters of a contrasting color to the background, and affix to the rear of the sign in the lower righthand corner when viewed from the back. If rivets are used to attach plaques, use 1/8-inch aluminum rivets inserted from the sign face.

1103.03 FLAT SHEET ALUMINUM SIGNS WITH STIFFENERS (FOR POST MOUNTED SIGNS, TYPES A, D, AND E; AND STRUCTURE MOUNTED SIGNS)—

(a) Flat Sheet Aluminum. Use aluminum as specified in Section 1103.04(a) with a minimum thickness of 0.080 inch.

Fabricate panels from a single aluminum sheet or from a number of pieces, making every effort to minimize the total length of joints. Locate joints so the legend does not straddle two or more aluminum sheets, whenever possible. Use sheets with a minimum width of 48 inches, wherever possible. Use continuous sheets for the full width of signs less than 12 feet wide or for the full height of signs less than 12 feet high. Use sheets free of buckles, warps, or dents. Remove burrs.

(b) Coating Treatment and Reflective Sheeting. Sections 1103.02(b) and (c), except as follows:

Apply the sheeting only to the face of the sign. A maximum of one splice in the reflective sheeting will be allowed on an aluminum sheet.

(c) Legend and Border. Section 1103.02(d)

(d) Extruded Aluminum Stiffeners, and Splice Bars. As shown on the Standard Drawings and as follows:

Manufacture channels from aluminum, according to ASTM B 209, Alloy 6061-T6.

Use large stiffener sections in 16-foot lengths and medium stiffener sections in 12-foot lengths. An alternate cross section of equal or greater section modulus than that indicated may be used with written permission.

(e) Sign Fabrication. Stiffener sections may end at a maximum of 3 inches from each sign edge. If the sign is more than 6 inches wider than the length of a full-length stiffener section, then splice two sections together, using 3/16-inch rivets, as shown on the Standard Drawings, to form a longer composite section. Position the splice so it is not on or within 15 inches of a sign post or within the center half of the span between sign posts. Stagger splices on adjacent sign stiffeners as much as possible. The aluminum sheeting may extend above the top stiffener or below the bottom stiffener for a maximum distance equal to one-third of the spacing between the stiffeners. If using an exit panel, use a stiffener on both the primary sign top and on the exit panel bottom.

Use 3/16-inch aluminum rivets at a maximum spacing of 6 inches and end rivets within 1 inch of the end of the stiffener. Hold the aluminum sheet firmly against the stiffener section while holes are drilled and rivets are expanded.

If the aluminum sheets are placed with the long dimension vertical or if a single large section stiffener or a single flanged medium section stiffener is used to join two panels together, then it may be necessary to have the flat sheet aluminum clamped to the stiffener section while the holes are drilled. Then, disassemble the sign for shipping. If disassembled, then remove burrs around the drilled holes to facilitate handling and to ensure a tight connection.

If exit panels cannot be supported by two sign posts, brace the panel with one or more auxiliary supports. Bolt the supports to a minimum of three stiffeners on the primary sign by use of clips.

If a single stiffener section is not used to join two adjacent panels together use butting plates, as shown on the Standard Drawings. Place butting plates at the left and right edges of the sign and at intervals not greater than 36 inches throughout the length of horizontal joints between the posts. Use either twist-in bolts or standard-connection bolts and plastic inserts to fasten the butting plates.

For joints between aluminum sheets, without a stiffener on the joint, fasten lightweight aluminum sheets with 1/8-inch aluminum rivets to the sign back.

Use twist-in toggle and buckle straps, or post clips, on stiffener sections at each post.

Lay out the legend and border on the sign face according to the sign fabrication drawings.

Apply cutout Type VIII, IX, or XI legend and border to sign face according to manufacturer's instructions.

Fabricate signs in a single unit. If necessary, ship large signs sectionalized in panels. Slit any legend and border, which overlaps the panel, when shipping sectionalized signs.

(f) Sign Identification. Section 1103.02(f)

(g) Internally Illuminated Signs. Provide from a Bulletin 15 manufacturer, as indicated, and as follows:

Mount to traffic signal support using a minimum of two bracket connections. Secure each bracket to the mast arm using double stainless steel banding. Connect wiring from Internally Illuminated Sign to a circuit breaker in the electrical service disconnect box. Provide maintenance demonstration to municipal official responsible for maintaining the sign.

Construct sign using a weatherproof housing with drain holes in the bottom of the sign and corrosion resistant stainless steel for all fasteners and hardware.

Sign must be UL listed and approved.

Use Bulletin 15 approved transparent reflective sheeting capable of being internally illuminated and retroreflective when not energized. Use Clearview W2 font or as specified on the plan. Display the designated message clearly and legibly during both daylight and during hours of darkness. Internally illuminate with Light Emitting Diodes (LEDs).

For Street Name Signs show approved street name on both faces (double-sided), unless otherwise approved by the Representative in writing.

Supply a weather-tight wire entrance junction box with the sign assembly. Mount the box on the exterior or interior of the sign. Use an appropriately sized 3-conductor (minimum 14 AWG) cable between the sign and the controller assembly.

For Street Name Signs provide brackets that allow the sign to swing freely. Use a two-point support assembly to mount the Internally Illuminated Street Name Sign to a mast arm that is perpendicular to the street, or use a single-point support assembly if the Internally Illuminated Sign is attached to a mast arm that is diagonal to the street.

Mount a photocell on the top of each sign.

Provide all warranty documentation to the Representative at final acceptance.

(h) School Zone Speed Limit Flashing Warning Sign. Provide a School Zone Speed Limit Sign Assembly as specified in Section 1104, as indicated, and as follows:

Utilize approved yellow Light Emitting Diode (LED) indications as specified in Section 955.

For Type II and Type III sign, use LED-illuminated “15” speed limit message.

Include all hardware to provide a functional assembly. Assembly includes specified structural support with foundation, mounting hardware, an approved solid state flasher - dual circuit controller assembly, an approved solid state time clock and wiring for the indications.

Provide and label an on/off switch in the controller assembly to operate the flashing yellow LED lenses and the steady red "15" speed limit message while retaining power to the time clock.

Provide sign assembly capable of obtaining power from solar or electric source.

Provide all warranty documentation to the Representative at final acceptance.

(i) Flashing Warning Sign. Provide a Flashing Warning Sign as specified in Section 1104, as indicated, and as follows:

Utilize approved yellow Light Emitting Diodes (LED) indications as specified in Section 955.

Include all hardware to provide a functional assembly. Assembly includes specified structural support with foundation, mounting hardware, an approved solid state flasher - dual circuit controller assembly, an approved solid state time clock and wiring for the indications.

Provide and label an on/off switch in the controller assembly to operate the flashing yellow LED lenses while retaining power to the time clock.

Provide sign assembly capable of obtaining power from solar or electric source.

(j) Light Emitting Diode (LED) Blank-Out Signs. Provide LED Blank-Out sign from a manufacturer listed in Bulletin 15, as specified in Section 936, conforming to all regulations, and as indicated.

Provide verification from independent laboratory test results.

Provide all warranty documentation to the Representative at final acceptance.

1103.04 FLAT SHEET SIGNS (FOR POST MOUNTED SIGNS, TYPES B, C, AND F; AND DISTANCE MARKER(S)—

(a) Blanks. Use aluminum blanks. For signs furnished under Section 901, use plywood, aluminum, acryonitrite butadiene styrene (ABS), aluminum/plastic laminate, corrugated polypropylene, or polyethylene blanks.

Physical and chemical properties of plywood and aluminum blanks according to Publication 306.

(b) Coating Treatment. Prepare sign faces with appropriate coating according to Publication 306.

(c) Reflective Sheeting. Use sheeting from a manufacturer listed in Bulletin 15.

1. General. Apply the sheeting to the sign face using a procedure according to the sheeting manufacturer, free of bubbles or wrinkles greater than 3 inches in length, and with total sheeting shrinkage of not more than 1/8 inch.

On signs larger than 48 inches on the shorter side, sheeting may be spliced with the edges of adjacent pieces butted together throughout the entire seam length without any overlap or separation.

Use Type III, IV, VIII, IX, or XI sheeting for all signs.

(d) Ink. As recommended by the manufacturer of the reflective sheeting.

(e) Electronic Cuttable (EC) Film. Use film from a sheeting manufacturer listed in Bulletin 15. Apply the sheeting to the sign face using a procedure according to the sheeting manufacturer, free of bubbles or wrinkles greater than 1 inch in length.

(f) Legend and Border. Apply legend and border of the color, size, and dimensions according to Publication 212, Publication 213, and the MUTCD or as indicated. Use silk screens with a mesh of 12XX or finer for reverse screening. Use stencils with sharp clear-cut edges, uniform curvature, and straight lines. Silk screen in a manner resulting in uniform color and tone, with -sharply-defined edges and without blemishes on the sign background. Air dry or bake signs after silk screening to achieve a smooth hard finish. Blisters appearing during the drying process will be cause for rejection. If -direct-applied- legend is indicated for any directional or destination sign, use Type III, IV, VIII, IX, or XI reflective sheeting. Slip-sheet- and pack signs to ensure delivery in an undamaged condition.

1103.05 DELINEATION DEVICES—Not used.

1103.07 STEEL S OR W BEAM POSTS AND BREAKAWAY SYSTEM (FOR POST MOUNTED SIGNS, TYPE A)—

(a) Steel S or W Beam Posts. As shown on the Standard Drawings.

(b) Breakaway System. As shown on the Standard Drawings and as follows:

1. Couplings. Alloy steel AMS 6378D with:

- Minimum tensile yield stress of 130,000 psi.
- Ultimate tensile strength of 150,000 psi.
- Minimum Rockwell C hardness of 32.
- Capable of withstanding a tensile breaking load of 41,000 pounds.

2. Hinge Plates. Alloy steel AISI 4130, 4340, or an equivalent material with a minimum tensile yield stress of 70,000 pounds per square inch, an ultimate tensile stress range of 90,000 pounds per square inch to 108,000 pounds per square inch, and a tensile breaking load, in pounds, as follows:

Model SBHB1B	51 min. (11,450 min.)
Model SBHB2B	73 min. (16,400 min.)

3. Brackets. Aluminum alloy ASTM B 221, Alloy 6061T6 or equal, with a -loadconcentrating- boss of stainless steel, ASTM A 582, Type 416, or equal.

4. Bolts, Nuts, and Washers.

4.a Hinge Plates. AISI 4130 Steel. Galvanized as specified in Section 1105.02(s) and according to ASTM A 153.

4.b Brackets. ASTM B 209; Alloy 6061-T6.

5. Anchor. Type 304 stainless steel ferrule with 1053 steel rod and coil.

6. Coupling Bolts. AMS 6378D, galvanized as specified in Section 1105.02(s) and according to ASTM A 153.

(c) Fabrication. Cut, drill or punch holes in parts or members, before galvanizing. Furnish a statement, before the beginning of galvanizing, showing the carbon content of the steel to be galvanized. Hot-dip- galvanize posts and

hardware after fabrication, as specified in Section 1105.02(s). Bolts, nuts, and washers to be galvanized according to ASTM B 695 and B 696 and according to the coating thickness, adherence, and quality requirements of ASTM A 153 (AASHTO M 232).

1103.08 BREAKAWAY STEEL POSTS (FOR POST MOUNTED SIGNS, TYPE B AND DISTANCE MARKERS)—

(a) Steel Channel Bar Posts. As shown on the Standard Drawings. Use steel channel bar post, according to the Department's specification for Breakaway Channel Bar Posts, from a manufacturer listed in Bulletin 15.

(b) Steel Square Posts. As shown on the Standard Drawings. Use steel square post, according to the Department's specification for Breakaway Steel Square Posts, from a manufacturer listed in Bulletin 15.

1103.09 TREATED WOOD AND COMPOSITE POSTS (FOR POST MOUNTED SIGNS, TYPES C AND E)—

(a) Treated Wood Posts (for Post Mounted Signs, Types C and E).

1. Posts. S4S No. 1 Dense or No. 1 Dense SR Southern Yellow Pine or No. 1 Douglas Fir-Larch, seasoned to a maximum of 19% moisture.

Grade and grade mark each post, before treatment, with an official grade stamp or inspection agency mark, certified by the Board of Review, American Lumber Standards Committee. Cut and drill before preservative treatment.

2. Treatment. Treat with Ammoniacal Copper Arsenite (ACA) or Chromated Copper Arsenate (CCA) Type A, B, or C meeting AWPA Standard P5. Use a minimum preservative retention of 0.40 pound per cubic foot by assay (oxide basis). Treat and quality mark according to AWPA C2. Inspect according to AWPA Standards M1 and M2.

Include a treatment certificate with each shipment.

(b) Composite Posts (for Post Mounted Signs, Type E).

1. Posts. Unsaturated polyester resin reinforced with E-glass and lightweight aggregate concrete not greater than 110 pounds per cubic foot to form a rigid structural support member. Tensile modulus of tube to be not less than 2,500 kips per square inch. Posts to be equal to or greater in strength to Schedule 40 steel of the same diameter according to ASTM A 53.

2. Weathering. Post shall have less than 10% loss of strength after 3,600 hours of accelerated weathering exposure to moisture and lamps according to ASTM G 152, G 155, and G 154.

3. Color. Specified post color will be permanent throughout the FRP tube with not less than 1.5 mil dry film thickness. After 3,600 hours exposure according to ASTM G 152, G 155, and G 154, posts will exhibit 90% adhesion, ASTM D 4541 and a maximum color change of 25, Delta -E.

1103.10 DELINEATOR POSTS—Not used.

1103.11 MISCELLANEOUS MATERIALS—

(a) Hex Head Bolts, Nuts, and Washers for Extruded Panel Sign Post-Clips. Galvanized steel as specified in Section 1105.02(s):

1. Hex Head Bolts. ASTM A 307, Grade A or B.

2. Nut. ASTM A 563 DH or ASTM A 194 Grade 1 or 2.

3. Washer. Carbon steel helical coil or ASTM F 436 or ASTM F 844 (Note 1)

Note 1: If either ASTM F 436 or ASTM F 844 flat washers are used, bolt must be fastened either using two nuts or a single nut with the threads galled adjacent to the nut to prevent loosening.

(b) Post-Clips-. For extruded panel signs, aluminum, according to ASTM B 108, Alloy 356-T6. For flat sheet aluminum signs with stiffeners, stainless steel, Type 304, 14 gage.

(c) Auxiliary Supports for Exit Panels. Aluminum according to ASTM B 211, Alloy 6061-T6. 3 inches by 3 inches by 3/16-inch angle, 6 1/2 feet long or long enough to attach to three stiffeners on the main sign.

(d) Lag Screws. 5/16-inch round head, galvanized steel as specified in Section 1105.02(s), and according to ASTM A 307.

(e) Rivets. Aluminum, self-plugging or hollow-core, as follows:

- 3/16-inch for mounting reflective units and distance plaques—Alloy 5056 with 7178 mandrels.
- 3/16-inch for mounting flat aluminum sheets to stiffeners sections— Alloy 5056 with carbon steel mandrels.

Rivet size specified is the minimum shank diameter. Use rivets with sufficient grip range to attach to background sign material, stiffeners, or posts. Use a No. 10 drill for 3/16-inch rivets for attachment of stiffeners and splice bars.

(f) Bolts, Nuts, and Washers for Flat Sheet Aluminum Signs with Stiffeners. Stainless steel, Type 304 bolts. Use 5/16-inch by 1 inch long for butting plates and 5/16-inch by 2 inches long for post-clips. Use standard connection bolts or twist-in bolts.

(g) Twist-in Toggle and Buckle Straps. Stainless steel, Type 201, and 0.75 inch wide and 0.03 inch thick, with rounded edges. Spot welded, twist-in type toggle on end of strap. Spot welded, antirotational buckle on other end of strap. Toggles and buckles shall be stainless steel, Type 304, and 1/16 inch thick.

(h) Butting Plates. Fabricate from stainless steel, Type 304.

(i) Anchors. Section 1105.02(c)2. From a manufacturer listed in Bulletin 15.

(j) Anti-Theft Sign Hardware.

1. System A.

- **Bolts.** Section 1105.02(c)1 and as follows:
  Provide 5/16-inch by 2 1/2-inch or 5/16-inch by 3-inch steel carriage bolts with minimum 11/16-inch diameter round head, square neck, and threads to within 1 inch of head.
  Furnish bolts having a mechanically deposited cadmium coating, ASTM B 696, or zinc, Type I coating as specified in Section 1105.02(s).

- **Nuts.** Square, pyramidal-shaped nuts with all four sides sloping at an angle of 41 degrees; 5/16-18 UNC threads; C-1010 cold-rolled steel, case hardened to Rockwell hardness of 55 to 60.
  Furnish nuts having a 0.002 inch to 0.005 inch thick, mechanically deposited, zinc, Type II yellow chromate coating as specified in Section 1105.02(s) according to ASTM B 695, tested according to ASTM B 201.

2. System B.

- **Bolts.** Section 1103.11(m) and as follows:
  Provide 5/16-inch by 2 1/2-inch and 5/16-inch by 3-inch bolts with minimum 9/16-inch diameter one-way heads and threads to within 1 inch of head.

- **Nuts.** Section 1103.11(n) and as follows:
  Provide nuts, Aluminum Alloy 2011-T3 according to ASTM B 211, double-chamfered hexagon with self-locking conical shape 9/16-inch - 3/8-inch by 3/16-inch unit under the nut with 5/16-18 UNC threads. Hexagon portion should break away from self-locking unit with 5/16-18 UNC to 40 inch-pounds to 80 inch-pounds of torque.

- **Washers.** Nylon 1/8 inch thick by 1-inch minimum outside diameter with 480 inch-pounds maximum allowable applied torque.

(k) Banding. Stainless steel, Type 201, 0.750 inch wide by 0.030 inch thick, with rounded edges for handling ease and safety. Buckles and other necessary hardware shall be of stainless steel, Type 304.

(m) Aluminum Bolts. ASTM B 211. Alloy 2024-T4, thread fit, ANSI Class 6g, and threads shall be within two threads of the head or a minimum of 1 3/4 inches.

(n) Aluminum Nuts. ASTM B 211. Alloy 2024-T6, thread fit, ANSI Class 6H (ANSI Class 2B, 18 UNC threads).

1103.12 SIGN AND DISTANCE MARKER SUPPORTS—

(a) General. Hot-dip galvanize steel, except stainless steel, after fabrication, as specified in Section 1105.02(s). Drill or punch holes and cut before galvanizing.

(b) Brackets for Post Mounted Signs, Types C, D, and F. ASTM A 283.

(c) Bars for Post Mounted Signs, Types C, D, and E. AASHTO M 270 (ASTM A 709) Grade 250 (Grade 36).

(d) Shims for Post Mounted Sign, Types C and E. AASHTO M 270 (ASTM A 709) Grade 250 (Grade 36).

(e) Steel Pipe Supports for Post Mounted Signs, Types D and E. ASTM A 53.

(f) Shapes and Plates for Post Mounted Signs, Type D. AASHTO M 270 (ASTM A 709) Grade 250 (Grade 36).

(g) Angles (Aluminum) for Post Mounted Signs, Type E, and Structure Mounted Signs. ASTM B 308, Alloy 6061-T6.

(h) Shim Bars and Plates for Post Mounted Signs, Type E. AASHTO M 270/M 270M (ASTM A 709) Grade 250 (Grade 36).

(i) Brackets, Bars, Clamps, Strips, and Gussett Plates (for Erecting Distance Markers on Bridge Railing). Stainless Steel, ASTM A 240.

1103.13 DELINEATOR BRACKETS—Not used.

1103.14 REFLECTIVE GLASS BEADS—

(a) General. Furnish reflective glass beads according to AASHTO M 247, except as follows:

1. Gradation. Satisfies the following gradation for type indicated:

Sieve Size	Percent Beads Passing				
	Type A	**Type B**	**Type C**	**Type D**	**Type E**
2.0 mm (10)	-	100	-	-	-

1.7 mm (12)	-	95 to 100	100	-	-
1.4 mm (14)	-	80 to 95	95 to 100	-	100
1.18 mm (16)	100	10 to 40	80 to 95	100	-
1.0 mm (18)	-	0 to 5	10 to 40	-	65 to 80
850 µm (20)	-	0 to 2	0 to 5	95 to 100	-
710 µm (25)	-	-	0 to 2	65 to 90	-
600 µm (30)	75 to 95	-	-	-	30 to 50
500 µm (35)	-	-	-	10 to 45	-
300 µm (50)	15 to 35	-	-	0 to 10	0 to 5
150 µm (100)	0 to 2	-	-	0 to 5	-

2. Rounds. Provide glass beads with a minimum of 75% true spheres overall, a minimum of 70% true spheres per sieve, and not more than 3% angulars overall. Type E beads must meet a minimum of 80% true spheres for all sieve fractions when measured according to AASHTO T 346.

3. Coating. Supply Type A, B, D, and E glass beads with coatings to enhance moisture resistance, embedment, and adherence with the binder. Supply Type C with coatings to enhance embedment and adherence. Evaluate coatings to referee methods according to AASHTO T 346.

4. Color-Clarity. Provide glass beads that are colorless/clear and visually free of carbon residue and/or inclusions containing no greater than 0.004% carbon by weight when measured according to ASTM D 4239 combustion infrared.

5. Refractive Index. Minimum 1.51 by oil immersion or equivalent method premeasured according to AASHTO T 346.

6. **Air Inclusions.** <5% by visual inspection.

7. Hardness. Beads above the No. 30 sieve are to exhibit an average hardness of C70.5 when measured using the Rockwell C scale method with a minimum sample of 100 glass beads.

8. Crushing Strength. Beads above the No. 30 sieve are to exhibit an average crushing strength of not less than 60,000 pounds per square inch when measured with L/D^2 method with a minimum sample of 100 glass beads.

9. Chemical Resistance. Chemical resistance to hydrochloric acid, water, calcium and other chlorides and sodium sulfides tested according to sections 4.3.6 to 4.3.9 of TT-B Federal Specification 1325D.

10. Performance Properties. The Department will benchmark bead performance properties according to NCHRP 743 to ensure continued quality and retroreflectivity in markings.

11. Recycled Postconsumer Glass. Incorporate recycled postconsumer glass into glass used for beads at a minimum of 2% for direct melt processes up to a maximum of 100% by weight for non-direct melt production. Type E beads will contain a minimum of 50% of direct melt glass.

SECTION 1104—TRAFFIC SIGNALS

1104.01 GENERAL REQUIREMENTS—Comply with the requirements of associations, societies, codes, and regulations, as applicable, pertaining to the work of furnishing and installing operational traffic signals; including traffic signal supports, controller assemblies, traffic signal systems and communications, electrical distribution, traffic signal indications, and detectors.

Words and phrases specific to traffic signals that are not defined in these specifications or in the regulations, are to be defined as in NEMA TS 1, NEMA TS 2, Type 170-ATC, or Type 2070-ATC industry standards.

(a) Traffic Signals Materials Acceptance. Before the submission of a bid proposal, verify that Bulletin 15 approved products issued by the Department, for traffic signal equipment, as provided in 67 PA Code, Chapter 212.

At least 3 weeks before their installation, submit to the Representative, for review and acceptance, a tabulation of all project traffic signal materials. Include the type of material, manufacturer's name, model number, and the Department's Certificate of Approval number for each item to be supplied. Refer to Publication 46 to obtain the listing of traffic signal items that require Bulletin 15 approval. Provide catalog cuts for further clarification of the material, when requested.

(b) Structural Material. Fabricate traffic signal structural material according to Section 1105 (steel members only), AWS, and the AASHTO Specifications; except, applying water to the base metal during plasma arc cutting is permitted. Bulletin 15 listing and shop inspection is required. Fabricators provide an AWS certified welding inspector (CWI) for welded steel or aluminum pole products as specified in Section 1105.01(g)3. Bulletin 15, shop inspection, and Section 1105 do not apply to painting of aluminum poles and for the following non-welded items: cast aluminum poles, cast steel poles, and cast iron poles.

The Charpy V-Notch toughness test is required for load carrying tension members greater than 1/2-inch in thickness, as required for Zone 2, non-fracture critical criteria, of the applicable AASHTO specifications.

Provide steel poles that either round or multi-sided with a minimum of eight sides.

Provide testing and test methods according to AWS D1.1 (Steel) or AWS D1.2 (Aluminum) and as determined by the LTS.

Provide non-destructive testing on 100% of full penetration groove welds and a random 25% of partial penetration groove welds of longitudinal seams on steel poles and arms. When inspecting full penetration seam welds, use radiographic test methods on material less than 5/16-inch in thickness, and use radiographic or ultrasonic test methods on material 5/16-inch and greater in thickness. Use magnetic particle inspection on partial penetration seam welds.

Provide non-destructive testing by ultrasonic test methods on random 25% of all pole to base plate and arm to arm plate full penetration groove welds. For tube material less than 5/16-inch in thickness, have the fabricator submit a detailed ultrasonic testing procedure, including acceptance criteria, to the LTS for review and approval before testing.

For all other welds on steel traffic poles, perform magnetic particle inspection on a minimum of 25% of the length of each weld. Provide inspection for the full length of the weld when less than 6 inches in length.

For aluminum traffic pole structures, perform fabrication and non-destructive testing in accordance with Section 1101.01.

Where less than 100% of the weld is non-destructively tested, and a rejectable defect is found, test 100% of the length of the weld.

Where applicable, the Department’s plant inspector will select portions of welds to be tested.

Perform and evaluate all non-destructive testing according to cyclically loaded non-tubular tension criteria.

(c) Certification. As specified in Section 106.03(b)3. Certify from the manufacturer, that all signal supports satisfy the Department's criteria and are adequate to support the loads indicated on the approved plans. Include on the certification the signature and seal of a Professional Engineer registered in the State. Certify the structural adequacy of all sign and signal brackets as well as all other mounting hardware.

(d) Traffic Signal Controllers. Provide switches, controls, and indicators that are operable without the use of tools. Clearly and permanently identify the switches, controls, and indicators.

Furnish three copies of warranties, guarantees, instruction manuals, wiring diagrams, and parts’ lists with each different type material. Also, provide in the controller assembly cabinet one instruction manual for each controller unit, time clock, and coordination unit.

Upon completion of a controller assembly, conduct a physical and functional shop test of the assembly's continuous, satisfactory operation, for not less than 7 calendar days, in accordance with industry standards. Provide 300 W loads

for signal circuit and simulated inputs for detectors, and interconnection. Certify that the equipment operates as indicated. Demonstrate and provide written documentation that the conflict monitor or malfunction management unit will cause transfer of the signals to flashing operation upon sensing all possible conflicting signal indications.

Label the load switch sockets and cable connectors for detector amplifiers, in the controller assembly, according to function.

All equipment which requires a separate device to set, adjust, or read the timing intervals, furnish plans or programs with one of these devices for each ten units or fraction thereof.

(e) Wiring Diagrams and Timing Plans. Provide three copies of the cabinet wiring diagram, traffic signal equipment wiring diagram, approved plans, and manufacturer's timing plan for each controller assembly, in accordance with the approved signal construction drawings. Place a clear protective envelope in the controller assembly cabinet that contains one copy of the manufacturer's instruction manual for each controller unit, time clock, coordination unit, software programming manuals, time setting charts, wiring diagrams, and parts list. Upon completion of the 30-day test, if there were any changes that would affect a change to these documents, then provide three new copies of each.

(f) Shop Testing. Submit results from shop tests to the Representative as specified in Section 952 and most recent publication for the applicable controller type as follows:

- NEMA TS1 Standard "Traffic Control Systems" (for existing traffic control equipment)
- NEMA TS2 Standard "Traffic Controller Assemblies With NTCIP Requirements"
- Type 170 Industry Standard
- Type 2070 Industry Standard

(g) Standard Construction Practices. As shown in Sections 910.3(a) and 1105, the Standard Drawings, and as follows:

Existing traffic signals are to remain in operation, as is, until the new traffic signal equipment and devices are in place and operable unless an approved plans indicates otherwise. If it becomes necessary to turn off the existing system of signalization, obtain the District Traffic Engineer's approval, municipal concurrence, and provide flaggers or other approved means to direct traffic within the intersection during periods when the traffic signals are not operating. Place temporary poles to adequately support existing traffic signals, as indicated or directed. Provide certification to the Department that such poles have sufficient strength to support the traffic signals.

Make revisions to the existing system of signalization, as indicated or directed.

Before any excavation for placement of traffic signal or sign support poles, mark proposed locations in the field. Field review pole locations with the Representative and adjust pole locations as necessary.

Remove all existing traffic signal supports, including those with traffic signals, flashing warning devices, and lane control signs and signal equipment, unless otherwise indicated.

Maintain existing controller assemblies, as a unit. Store material on the project site. Provide a listing of the equipment for the municipal owner and make arrangements to deliver equipment to the municipal storage area. Do not damage items during removal and storage.

Abandon underground conduit, conductors, and detectors not interfering with new construction. Remove foundations and junction boxes that are designated to be abandoned and are located in an "off traveled roadway" area, to 1 foot below final grade and dispose of removed materials. Fill, compact, and landscape the resulting hole, including topsoil if necessary by the particular planting.

Repair damage to galvanized finishes.

Restore areas damaged by construction.

If any vegetation is blocking the visibility of signs or traffic signals, in the opinion of the Representative, generate and submit a list of items to the Representative. Obtain approval to remove or relocate any of the items.

If not notified by the Representative, notify the Representative as soon as it is recognized that a utility facility is causing, or will cause, an obstruction to visibility.

Before the initial turn-on, verify for the Representative that all traffic signals are working properly. Make the initial turn-on to flashing mode and full operation in the presence of the Representative between the hours of 9 AM and 2 PM, Tuesday through Thursday except holidays. Under special circumstances involving safety of motoring public, the Representative may grant exceptions to this rule. Give the Representative a minimum 7 calendar day notice before the initial turn-on. For locations presently unsignalized, flash signals for a period of 3 to 7 days.

1. 30-Day Testing. After the traffic signal installation becomes operational, conduct a continuous, 24 hour

operating test for not less than 30 consecutive calendar days. Correct failures during the test period by repairing or replacing malfunctioning parts or equipment or faulty work regardless of the cause in less than 24 hours as directed. After correcting failures caused by defective equipment, material, or faulty work, re-conduct the 30-day test.

During the 30-day test period, change, adjust, or reinstall controller and/or master controller settings as directed at any time. Adjust or revise initial signal timing parameters, as directed, to optimize signal operation due to actual traffic flows and field conditions. During this time period, power and communication costs associated with maintaining the operation of the traffic signal will be the responsibility of municipality or other party that currently (or will ultimately) assume ownership or maintenance of the installation.

In addition to the provisions of Sections 105.10 and 107.10, those Department, Federal, and municipal personnel and agencies, as well as public and private interests, that are involved with the signal installation, have jurisdictional control over the installation or adjacent facilities, or will ultimately assume ownership or maintenance of the installation, will at the discretion of the Department, be allowed to observe signal turn-on, installation of initial timing parameters and any subsequent adjustment, and inspection before completion of 30-day test.

2. Equipment Guarantee. Guarantee the in service operation of mechanical and electrical equipment, related components, and the controller assembly for a period of 180 days from the date of completion of the specified 30 day field test. During this period:

- Maintain equipment in the controller cabinet. Use additional locks, as necessary, to prevent entry by others.
- Repair faulty work, repair or replace defective materials or equipment and correct malfunctions in the controller cabinet within 48 hours after starting repairs.
- Start repairs no later than the working day following notification of failures or malfunctions.
- Guarantee repairs or replacements for the balance of the 180-day guarantee period, or 30 days, whichever is the longer period.
- Repair or replacement work not performed within the guarantee period, or any extension period, will be considered latent defects as specified in Section 107.16(b).

Provide the Representative with the name and telephone number of the person to be notified in the event of failures or malfunctions during the guarantee period.

Issuance of an acceptance certificate or final settlement of the Contract does not in any respect relieve the Contractor of responsibility for the in-service guarantee period described in these Specifications.

(h) Warranties, Instruction Manuals, and Guarantees. Furnish, as specified in Sections 952, 953, 955, and 956.

1104.02 TRAFFIC SIGNAL SUPPORTS—

(a) General.

1. Design and Acceptance. Design in accordance with Publication 149. Submit shop drawings in accordance with Publication 149, including calculations for all special structures, for review and acceptance.

2. Supports. Fabricate shafts and arms in any of the following shapes and styles:

Round Tapered.

- One longitudinal seam, continuously welded, and ground or rolled flush.
- Transverse butt welds are not acceptable.
- Uniform wall thickness.
- Uniform taper, 0.14 inch maximum and 0.07 inch minimum per foot of length.

Round Stepped.

- Round pipe sections, each with not more than one longitudinal seam continuously welded and ground

or rolled flush. Join sections by a hot-swaged shrink fit continuously seal-welded to prevent entrance of water.
- Uniform wall thickness for each section.
- Maximum change in diameter between stepped sections not to exceed 2 1/8 inches.

Multi-Sided Tapered.

- Maximum of two longitudinal seams, continuously welded, and ground or rolled to a maximum bead height of 1/8 inch.
- Transverse butt welds are not acceptable.
- Uniform wall thickness.
- Uniform taper, 0.14 inch maximum and 0.07 inch minimum per foot of length.
- Minimum of eight sides.

Round Untapered.

- Maximum of one longitudinal seam, continuously welded, and ground or rolled flush.
- Uniform wall thickness and diameter.
- Transverse butt welds are not acceptable

3. Cable Support. Weld a cable support to the inside top of the shaft.

4. Grounding. Weld a UL-Listed grounding lug, capable of accommodating a No. 6 AWG stranded copper cable, to the inside of the shaft adjacent to the handhole.

5. Handholes. Provide a handhole in the shaft of the poles, as shown on the Standard Drawings. Reinforce the area to develop the minimum guaranteed yield strength of the shaft. Furnish a cover and keeper chain.

6. Wire Inlets. Provide a wire inlet at each signal head or at each electrically operated sign location. Weatherproof each inlet with an insulated grommet.

Provide a deburred hole, 2 1/2-inch minimum diameter, in the flange plate and shaft, which serves as a wire entrance into the arm from inside the shaft.

Provide Type LB access fittings from Type II mounted controller cabinet into pole shaft and in pole shafts for pedestrian pushbuttons.

7. Anchor Bases.

- Fabricate the base clean, smooth, and of the dimensions necessary for adequate pole mounting and structural support.
- Provide holes for anchor bolts.
- Fabricate the base to telescope over the shaft and be secured in place by welding.

8. Galvanizing. Section 1105.02(s) and as follows:

Galvanize steel shafts and arms, including those manufactured of high strength and corrosion resistant steels, according to ASTM A123 (AASHTO M 111). Galvanize accessories and hardware according to ASTM A153 (AASHTO M 232).

(b) Overhead Supports. As shown on the Standard Drawings and as follows:

- Shaft and Arms—AASHTO M 270/ASTM A709, Grade 36 or Grade 50, ASTM A36, ASTM A53, ASTM A572 Grade 50, ASTM A501 and A595.
- Luminaire Mounting Arms—Section 1101.03
- Anchor (Base) Plates, Flange (Arm and Column Connection) Plates, and Gusset Plates—AASHTO M 270 (ASTM A709), Grade 36. ASTM A36, ASTM A572 Grade 50.
- Miscellaneous Shapes, plates and bars—AASHTO M 270 (ASTM A709), Grade 36. ASTM A36, ASTM, ASTM A572 Grade 50 and ASTM A992.

- Flange Plate Assembly Bolts, Nuts and Washers— ASTM A325, ASTM 563 and ASTM F436. Mechanically galvanize in accordance with ASTM B695. Furnish bolts, nuts and washers for testing purposes and test as specified in Section 1050.3(c) 7.b.
- Shaft and Arm Caps—Galvanized steel (C-coat) cast iron or cast aluminum.
- Handhole CH and hole Cover Plates – AASHTO M 270 (ASTM A709), Grade 36. ASTM A36, ASTM, ASTM A572 Grade 50 and ASTM A1011
- Pipe Caps – AASHTO M 270 (ASTM A709), Grade 36. ASTM A36, ASTM, ASTM A572, ASTM A1011 or ASTM B26
- Arm dampening – Harmonic mitigation device, as shown on the Standard Drawings.

(c) Pedestal Supports. As shown on the Standard Drawings and as follows:

1. Aluminum.

- Support—One length, 4 1/2-inch minimum outside diameter aluminum pipe, Schedule 40, ASTM B210, or B221, Alloy 6063-T6.
- Bases—Cast aluminum, ASTM B26, or B 108, Alloy 356-T6; aluminum plate, ASTM B209, Alloy 6061-T6.
- Pole Tops—Aluminum

2. Steel.

- Support—One length, 4 1/2-inch minimum outside diameter steel pipe, Schedule 40, ASTM A53, Type F.
- Base—Steel casting, ASTM A27, Grade 65-35; gray iron casting, ASTM A126, Class 26; steel plate, AASHTO M 270 (ASTM A709), Grade 36.

(d) Pedestrian Stub Poles. As specified in Section 1104.02(c) except having a fixed length of 60 inches and a rounded top cap to minimize injuries.

(e) Anchor Bolts. As shown on the Standard Drawings and as follows:

- Anchor Bolts—ASTM A449 or F1554.
- Hex Nuts—ASTM A563M/A 63
- Washers—ASTM F436

Galvanize the top 8 inches of bolts and all associated hardware as specified in Section 1105.02(s) (ASTM A153), or by another acceptable method conforming to the coating thickness, adherence, and quality requirements of ASTM A153. Furnish template prints for setting anchor bolts with each support.

(f) Wood Support Poles. When used for temporary signal installations, certify sawn material, both rough and dressed by the mill as to grade and mark in accordance with the grading rules and basic provisions of the American Lumber Standards (PS-20-70) by a lumber grading or inspection bureau or agency. If dressed, the grade mark shall be applied after dressing.

(g) Span Wire. ASTM A475, Class A, Siemens-Martin, or ASTM B416.

(h) Tether Wire. ASTM A475, Class A, Siemens-Martin, or ASTM B416.

(i) Lashing. As shown on the Standard Drawings for attaching cable to span wire.

1104.03 CONTROLLER ASSEMBLY—

(a) Type of Operation.

1. Solid-State Pretimed.

- TS 1, Section 2, Environmental Standards and Test Procedures.
- LI-1, Type FR-4, Circuit Boards.

1.a Operational Requirements.

- Cycles—Three minimum or indicated otherwise on the approved plans.
- Splits—One per cycle minimum or indicated otherwise on the approved plans.
- Settable Offsets—Three per cycle or indicated otherwise on the approved plans.
- Cycle Duration—30 seconds to 120 seconds, in 1-second increments or indicated otherwise on the approved plans.
- Signal Circuits—12 minimum, wired for 18, including terminal blocks.

1.b Interconnect.

- Offsets—1, 2, 3, or indicated otherwise on the approved plans.
- Cycle—Call Cycle 2; Call Cycle 3.
- Flashing—Remote flashing.
- Voltage—95 V to 135 V (ac), 57 Hz to 63 Hz.
- Input—Positive true.
- Fuse—Ampacity per manufacturer's recommendations.
- Isolation—Remote common from local ground.

2. Solid-State Actuated.

- TS 1, Section 2, Environmental Standards and Test Procedures.
- TS 1, Section 13, Interface Standards.
- TS 1, Section 14, Solid-State Traffic Signal Controller Units.

3. Solid-State Actuated with Volume Density. Section 1104.03(a)1.a and with the following operational requirements:

- Variable Initial Timing—Maximum variable initial timing programmable from 0 to 60 seconds.
- Gap Reduction Timings—As indicated.
- Time Before Reduction (TBR) —As indicated.

4. Solid-State Flasher.

- Flasher—Section 1104.03(b)1.d
- Circuit Breaker—Section 1104.03(c)3
- Surge Protector—Section 1104.03(c)3
- Cabinet—Section 1104.03(b)1.f

(b) Type of Controller.

1. NEMA Controller Unit.

1.a Standards.

- TS 1, Section 2, Environmental Standards and Test Procedures
- TS 1, Section 13, Interface Standards
- TS 1, Section 14, Solid-State Traffic Signal Controller Units
- L1-1, Type FR-4, Circuit Boards (pre-timed operation)
- TS-2, Section 2, Environmental Standards and Test Procedures

- TS-2, Section 3, Controller Standards and Coordination
- TS-2, Section 5, Interface and Electrical Standards
- TS-2, Section 8, Bus Interface Unit Requirements

1.b Controller Requirements. All hardware and software must be in compliance with NEMA TS-1, TS-2 standards, and as directed by the Representative. All products must be Bulletin 15 approved products.

An approved plug-in Hand Control with cord is required in all cabinets, and a method to switch the signal controller from automatic to manual control.

Include ability to accept a contact closure (or open controller output) to reset clock on controller at a predetermined hour each day (typically 2:00 AM).

Provide Fiber Modem (as specified per the system) for the communication between local controller and master controller. Clean and connect fiber-optic cable to the new controller using procedures described in current Department and industry guidelines – Fiber Optic Association Inc. (FOA).

1.c Conflict Monitor.

- TS 1, Section 6, Conflict Monitor.
- TS 2, Section 2.3, Malfunction Management Unit Test.
- TS 2, Section 4, Malfunction Management Unit.

A minimum of one input channel for each load switch socket as specified in Section 1104.03(b)1e.

1.d Flasher Unit.

- TS 1, Section 8, Solid State Flasher.
- TS 2, Section 2.6, Flasher Tests.
- TS 2, Section 6.3, Solid-State Flasher.

1.e Load Switches.

- TS 1, Section 5, Solid-State Load Switches.
- TS 2, Section 2.5, Load Switch Tests.
- TS 2, Section 6.2, Three-Circuit Solid State Load Switch
- Operational Features: Provide Light Emitting Diode (LED) indicators to display operation. Isolate signal load from load switch input using optic couplers. Furnish a minimum of one load switch for each of the following active controller unit functions:
  - Vehicle Phase.
  - Overlapping Vehicle Phase.
  - Pedestrian Phase.

1.f Cabinet. Furnish a weatherproof controller cabinet, large enough to suitably house the traffic signal controller unit and auxiliary equipment, and conforming to the following requirements:

1.f.1 Enclosure.

- Material—Sheet or cast aluminum.

- Wall Thickness—1/8 inch minimum, reinforced where required.

- Minimum Size—As shown on the Standard Drawings and as follows:
  Position equipment in the cabinet to provide access to all terminal strips and equipment from the front without removing other equipment. Provide an unobstructed view of all equipment having visual indicators. Place all equipment in an upright position and not on top of other equipment.

  Provide Department approved controller cabinet with adequate room for all necessary

equipment and cable. Provide removable 5/8-inch handle designed for the door(s) and a full height, continuously welded, piano hinge. Continuously weld all joints of the cabinet. Mount a fluorescent light (suitable for freezing temperatures) inside the front and back of the cabinet automatically turning on when the cabinet door is open. Provide a pull-out shelf to double as a storage container for wiring diagrams, plans, and timing sheets.

Provide a twist lock receptacle and transfer switch for power provided by an emergency generator during power outages. Access to the twist lock receptacle and the transfer switch thorough the use of a locked police door using a No. 2 key or standard police key.

Provide door with continuous stainless steel door hinge on right side, door stop at 90 degrees and 180 degrees, ± 10 degrees, for all doors over 22 inches wide, auxiliary door for access to police panel, pocket for prints.

- Hardware—Vandal and corrosion resistant.
- Finish—Natural with external welds free of irregularities and a maximum bead height of 1/8 inch.
- Gaskets—Neoprene, attached with an oil resistant adhesive.
- Mountings—As indicated, pole or foundation.
- Locks—Brass, tumbler type for main door and standard police lock for auxiliary door; two keys for each lock.
- Latching Mechanism—One point-through mechanism for doors less than 22 inches in width; three point-through mechanism for doors 22 inches or wider.
- Interior—Shelf-mounted equipment, unless rack or panel-mounted.
- Test Pushbutton Panel—One pushbutton to each input for simulated detector operation of vehicles and pedestrians with type and phase permanently labeled on panel. Mount panel on inside of door.

Back panels, wiring and terminals for maximum phase capability of solid-state controller unit, load switch sockets as required and as follows:

Controller Unit	**Load Switch Sockets**	
	Minimum Number	**Maximum Number**
Pretimed	6	As required
2 Phase Actuated	4	As required
2-4 Phase Actuated	8*	12
2-8 Phase Actuated	12*	20

* Provide a minimum of two unused sockets per unit.

1.f.2 Environmental Controls.

- Ventilation—Weatherproof vents of minimum 4 square inches area in the lower part of the door or cabinet.
- Filter—Cover vents with full perimeter frame with a disposable filter securely held in place.

1.f.3 Solid-State Equipment.

- Fan—Capacity; 100 cubic feet/minute minimum.
- Fan Thermostat—Line-voltage type, adjustable from 91F to 149F, with fan set to turn on at

43F.

2. Type 170 Controller Unit.

2.a Standards. The manufacturers of all component parts and hardware are to be from a Bulletin 15 manufacturer.

Comply with current Type 170 controller industry standards.

2.b Controller Requirements.

- Provide controller chip as directed by the Representative.
- Provide a 170 microcomputer having a vertical board design with separate input and output boards.
- Include ability to accept a contact closure (or open controller output) to reset clock on controller at a predetermined hour each day (typically 2:00 AM).
- Equip the controller with four serial communication ports, each capable of communicating at speeds up to 9600 bits/sec. The port assignments to be as follows:
  Port 1: Internal Modem
  Port 2: PC Laptop Connection
  Port 3: Conflict Monitor Communication
  Port 4: Future Use
- Provide 412C prom module.
  - Data retention in the absence of Controller Voltage (Vcc).
  - Data is automatically protected during power loss.
  - Directly replaces 8K x 8 volatile static RAM or EEPROM.
  - Unlimited write cycles.
  - Low-power CMOS.
  - Over 50 years of data retention.
  - Standard 28-pin JEDEC pinout.
  - 200 ns read access time.
  - Read cycle time equals write cycle time.
  - Lithium energy source is electrically disconnected to retain freshness until power is applied for the first time.
  - Industrial temperature range of -40F to 185F.
- Furnish all controller assemblies so that the controller returns to normal operation from cabinet flash automatically.
- An approved plug-in hand control with cord is required in all cabinets, and a method to switch the signal controller from automatic to manual control.
- Provide for automatic return to flashing operation when lost electrical service has been restored.
- The "Flash Sense", "Stop Time", and "Cabinet Door Open" functions to be optically isolated but capable of operating without a Model 242 DC isolator.
- Provide pre-wired input file with a minimum of eight inputs, and equipped with Model 242 Two-Channel DC isolators. Supply the required number of Model 242 DC isolators, plus one spare, for each intersection. Also provide slots and internal wiring for two future model 224 four-channel loop sensing units.
- Provide Fiber Modem (as specified per the system) for the communication between local controller and master controller. Clean and connect fiber-optic cable to the new controller using procedures described in current Department and industry guidelines – FOA.
- Provide software as directed by special provision unless provided by the municipality.

2.c Conflict Monitor. Provide Model 170 card-mounted conflict monitor capable of communicating with the 170 Microcomputer. The conflict monitor, when polled by a system compatible 170 Microcomputer, will return information including, but not limited to, the status of all monitored inputs and events stored in non-volatile memory. It will also monitor the absence of a red indication along with normal conflicts, and perform all the functions required by a Model 210 conflict monitor, including the following features:

- Monitoring the absence of signal on any channel.
- Include three preemption inputs to disable red monitoring.
- Include red signal monitoring interface through front panel connector.
- Detect simultaneous display of GREEN and YELLOW on a channel.
- Detect simultaneous display of GREEN and RED on a channel.
- Detect minimum YELLOW display following a GREEN on a channel.
- Store of up to 64 events.
- Inform 170 controller of a resetting via a communication port.
- Monitor incoming line voltage.

A minimum of one input channel for each load switch socket as specified in Section 1104.03(b)2.e.

2.d Flasher Unit.

- TS 1, Section 8, Solid State Flasher.
- TS 2, Section 2.6, Flasher Tests.
- TS 2, Section 6.3, Solid-State Flasher.

2.e Load Switches.

- TS 1, Section 5, Solid-State Load Switches.
- TS 2, Section 2.5, Load Switch Tests.
- TS 2, Section 6.2, Three-Circuit Solid State Load Switch.
- Provide Type 170 load switch.
- Provide a minimum of twenty pre-wired load switch positions as shown on the approved plans.
- Provide a load switch of a repairable, modular type construction.
- Provide a minimum of four flash transfer relays.
- Operational Features: Provide LED indicators to display operation. Isolate signal load from load switch input using optic couplers. Furnish a minimum of one load switch for each of the following active controller unit functions:
  - Vehicle Phase.
  - Overlapping Vehicle Phase.
  - Pedestrian Phase.

2.f Cabinet. Minimum size as shown on the approved plans and as follows:

Position equipment in the cabinet to provide access to all terminal strips and equipment from the front without removing other equipment. Provide an unobstructed view of all equipment having visual indicators. Place all equipment in an upright position and not on top of other equipment.

Provide Department approved Type 170 controller cabinet with adequate room for all necessary equipment and cable. Provide removable 5/8-inch handle designed for the door(s) and a full height, continuously welded, piano hinge. Continuously weld all joints of the cabinet. Mount a fluorescent light (suitable for freezing temperatures) inside the front and back of the cabinet automatically turning on when the cabinet door is open. Provide a pull-out shelf to double as a storage container for wiring diagrams, approved plans, and timing sheets.

The latching mechanism will be a three point draw roller. Equip the large cabinet door with a spring lock, which can be opened only by a key. Equip the smaller compartment door with a similar spring lock, which can be opened only by a standard police box key.

An approved plug-in hand control is required in all cabinets and a method to switch the signal controller from automatic to manual control.

Provide a twist lock receptacle and transfer switch for power provided by an emergency generator during power outages. Access to the twist lock receptacle and the transfer switch thorough the use of a locked police door using a No. 2 key or standard police key.

3. Type 2070 Controller Unit.

3.a Standards. The manufacturers of all component parts and hardware are to be Bulletin 15 approved.

Comply with current Type 2070 controller industry standards.

3.b Controller Requirements.

- Program module as approved by Representative
- Communications module as approved by Representative
- Processor module as approved by Representative
- Power supply module as approved by Representative
- The 2070 microcomputer is to have a vertical board design with separate input and output boards.
- Include ability to accept a contact closure (or open controller output) to reset clock on controller at a predetermined hour each day (typically 2:00 AM).
- Equip the controller with four serial communication ports and one Ethernet port, each capable of communicating at speeds up to 9600 bits/sec. The port assignments are to be as follows:
  Port 1: Internal Modem
  Port 2: PC Laptop Connection
  Port 3: Conflict Monitor Communication
  Port 4: Future Use
  Port 5: Ethernet
- Provide 412C prom module.
  - Data retention in the absence of Controller Voltage (Vcc).
  - Data is automatically protected during power loss.
  - Directly replaces 8K x 8 volatile static RAM or EEPROM.
  - Unlimited write cycles.
  - Low-power CMOS.
  - Over 50 years of data retention.
  - Standard 28-pin JEDEC pin out.
  - 200 ns read access time.
  - Read cycle time equals write cycle time.
  - Lithium energy source is electrically disconnected to retain freshness until power is applied for the first time.
  - Industrial temperature range of -40F to 185F.
- Furnish all controller assemblies so that the controller returns to normal operation from time clock flash automatically.
- An approved plug-in hand control with cord is required in all cabinets, and a method to switch the signal controller from automatic to manual control.
- Provide for automatic return to flashing operation when lost electrical service has been restored.
- The "Flash Sense", "Stop Time", and "Cabinet Door Open" functions to be optically isolated but capable of operating without a Model 242 DC isolator.
- Provide pre-wired input file with a minimum of eight inputs, and equipped with Model 242 Two-Channel DC isolators. Supply the required number of Model 242 DC isolators, plus one spare, for each intersection. Also, provide slots and internal wiring for two future model 224 four-channel loop sensing units.
- Provide Fiber Modem (as specified per the system) for the communication between local controller and master controller. Clean and connect fiber-optic cable to the new controller using procedures described in current Department and industry guidelines –FOA.
- Provide software as directed by special provision unless provided by the municipality.

3.c Conflict Monitor. Provide Model 2070 Malfunction Management Unit. Exception: When mounted in a 336 cabinet provide conflict monitor using cabinet bus interface.

Equip the conflict monitor with a programmable serial interface capable of communicating at a speed of up to 1200 bits/sec with the 2070 Microcomputer. The conflict monitor, when polled by a system compatible 2070 Microcomputer, is to return information including, but not limited to, the status of all monitored inputs and events stored in non-volatile memory. Also monitor the absence of a red indication along with normal conflicts, and perform all the functions required by a Model 210 conflict monitor, including the following features:

- Monitoring the absence of signal on any channel.

- Include three preemption inputs to disable red monitoring.
- Include red signal monitoring interface through front panel connector.
- Detect simultaneous display of GREEN and YELLOW on a channel.
- Detect simultaneous display of GREEN and RED on a channel.
- Detect minimum YELLOW display following a GREEN on a channel.
- Store of up to 64 events.
- Inform 2070 controller of a resetting via a communication port.
- Monitor incoming line voltage.

A minimum of one input channel for each load switch socket as specified in Section 1104.03(b)3.e.

3.d Flasher Unit.

- TS 1, Section 8, Solid State Flasher.
- TS 2, Section 2.6, Flasher Tests.
- TS 2, Section 6.3, Solid-State Flasher.

3.e Load Switches.

- TS 1, Section 5, Solid-State Load Switches.
- TS 2, Section 2.5, Load Switch Tests.
- TS 2, Section 6.2, Three-Circuit Solid State Load Switch
- Provide Type 2070 Switch Packs
- Provide a minimum of eight, maximum of twenty pre-wired switch positions as shown on the approved plans.
- Provide a switch pack is to be of a repairable, modular type construction.
- Provide a minimum of four flash transfer relays.
- Operational Features: Provide LED indicators to display operation. Isolate signal load from switch pack input using optic couplers. Furnish a minimum of one switch pack for each of the following active controller unit functions:
  - Vehicle Phase.
  - Overlapping Vehicle Phase.
  - Pedestrian Phase.

3.f Cabinet. Section 1104.03(b)2.f

(c) Controller Hardware.

1. Relays.

1.a Light Duty Relay. Mounted in a clear, plastic cover, permanently marked to indicate coil voltage rating, and as follows:

- Usage—Logic, Preemption or Interconnection.
- Voltage—115 V (ac) or 24 V (dc).
- Switch Type—TPDT or DPDT.
- Contact Rating—2 A.
- Contact Material—Fine Silver or Silver Alloy.

1.b Heavy Duty Relay. Mounted in a clear, plastic cover, permanently marked to indicate coil voltage rating, and as follows:

- Usage—Continuous Duty-Transfer of signal indications from normal operation to flashing and the reverse.
- Voltage—95V to 135 V (ac), 57Hz to 63 Hz.

- Switch Type—DPDT.
- Contact Reading—20 A.
- Contact Material—Fine Silver or Silver Alloy.
- Standard Socket—8 Pin, Jones Type.

1.c Dial Transfer. Mounted in a clear plastic cover, permanently marked to indicate coil voltage rating, and as follows:

- Usage—Dial Transfer.
- Voltage—95-135 V (ac), 57 to 63 Hz, 9 W.
- Switch Type—TPDT Electric Latching (two external poles), DPDT Mechanical Latching.
- Contact Rating—1 A.
- Contact Material—Fine Silver or Silver Alloy.
- Standard Socket—Plug, interchangeable with furnished base.

2. Cable Terminal/Harness Assembly. For wiring the cabinet, including connections to the electrical load center, police panel switches, signal load switches, signal cable terminals, controller unit, conflict monitor, detectors, and relays, and as follows:

- Wiring—Arrange and lace or enclose in a raceway or in plastic tubing.
- Terminal Blocks—Barrier-type, with marker strips and nickel-plated brass screws, 8-5/16-inch minimum for detector leads, 10-5/16-inch minimum for signal leads, rated for 20 A at 1000 V (rms).

3. Electrical Load Center.

3.a Breakers and Receptacles.

- Circuit Breakers—15 A minimum, flashing circuit and duplex receptacle. 15 A minimum, traffic control equipment.
- Duplex Receptacle—NEC-Type, Ground Fault Interruptor, with test buttons. 15 A minimum.

3.b Radio Frequency Interference (RFI). UL-Listed, RFI filter, according to NEMA standard testing procedures, TS-2 chapter 5, and as follows:

- Line Voltage—95 V to 135 V (ac).
- Line Frequency—200kHz to 75MHz with minimum attenuation of 50dB.
- Line Current—125% of the total connected load, 30 A minimum.
- Operating Temperature— -29F to 165F.
- Insulation Resistance—6,000 megaohms.
- Line to Ground Rating—1500 V (ac), one minute.
- Line to Line Rating—1450 V (dc), one minute.
- Humidity Range—5 % to 95 %, relative.
- Overload—360 A, for 8 minutes.

3.c Surge Protection. Provide surge protection that has multi-strike capability, UL listed, and line to neutral clamping voltage to be no more than 340 V at 20,000 amps. Filtering surge protector is not to exceed 3.5 inches x 6.0 inches x 2.5 inches, not including studs or mounting flange. Spark gap arrestors are not allowed. All surge protection devices must be approved. The cabinet and content must, as an assembly, pass all NEMA TS-2 voltage spikes test for the AC line.

• Peak Current (8 x 20 ms)	20,000 Amps
• Life Test	5% change
• (Voltage clamp before and after 25 surges of 20 kA waveshape)	
• Clamp voltage	280 V type @ 20 kA

• Response time	voltage never excess 280 V during surge
• Continuous Service Current (120 VAC, 60Hz)	20 Amps maximum
• Operating Temperature	-40F to 185F

Provide surge suppressor that is UL listed and has dual pair (four wire) module implementing three stage hybrid technology or equivalent type as approved by the Representative, for communications cable to 10 kA (2500 A per line).

• Peak Surge Current (10 times):	
o 8 x 20 ms	10 kA
o 10 x 700 ms	500 A per line
• Life Expectancy:	
o 8 x 20 ms	>100 occurrences
o 10 x 700 ms	
• Response time	< 1 nanosecond
• Technology	SAD Hybrid
• Operating Temperature	-40F to 185F

3.d Grounding Requirements. Provide each controller with its own grounding rod in addition to the other grounding requirements for signal supports. Grounding and Grounding Rods will be installed in accordance with the Standard Drawings and as follows:

Place two grounding rods at the base of the controller. Test all grounding rods used for controllers, mast arms, and supports for their resistance to ground in accordance with the NEC; with resistance less than 25 ohms. For grounding rods failing the above-mentioned test, relocate the grounding rod to a suitable location approved by the Representative. When suitable, place a grounding grid utilizing shielded copper wire and grounding rods at each corner, around the intersection. Documentation regarding grounding resistance and as-built plans of grounding grid must be verified by the Representative.

4. Police Panel. Furnish with the following switches:

- Auto—Flash
- Lights (ON—OFF)
- Auto—Manual

Provide hand control cable in panel.

5. Time Clock.

5.a Solid-State. Enclosed in an electrical-shockproof housing, conforming to the following requirements:

- Input Voltage—95 V to 135 V (ac), 57 Hz to 63 Hz.
- Output Voltage—95 V to 135 V (ac), 57Hz to 63 Hz.
- Output Current—5 A.
- Output Circuits—As required.
- Output Setting Limit—10 minutes.
- Skip-Feature—7 day.
- Carryover—24 hours minimum.
- Clock Setting Limit—1 second.
- Time Sets—One on-off/day/circuit.
- Temperature— -29F to 165F.
- Transient Immunity—Varistor.
- Humidity—5% to 95% relative.
- Daylight Savings Time—Automatic transfer.

5.b Time-of-Day Clock, Global Positioning System (GPS).

- A system consisting of a GPS receiver and base unit for mounting in traffic controller enclosure.
- This system must have a contact closure (or open controller output) to reset clock on controller at a predetermined hour each day (typically 2:00 AM).
- They will require Daylight Savings Time (DST) adjustment and zone adjustment entries as well as time setting.
- Once programmed, the base unit will send signals or messages to the traffic light host controller over the contact closure.
- The base is to be equipped with a LED to indicate the unit's status during operation.

1104.04 SYSTEMS AND COMMUNICATIONS—

(a) Time-Based Coordinator Unit.

1. Type. Internal to controller unit or as required to interface with controller unit not having internal time-based coordination capability. If being placed in an existing traffic signal system, make compatible with the existing time-based coordinators in that system.

2. NEMA Standards.

- TS 1-2.1.1, Operating Voltage, Frequency, and Power Interrupt.
- TS 1-2.1.2, Voltage.
- TS 1-2.1.3, Frequency Range.
- TS 1-2.1.5, Temperature and Humidity.
- TS 1-2.1.6, Transients, Power Service.
- TS 1-2.1.12, Vibration.
- TS 1-2.1.13, Shock.
- TS 1-13.2, Electrical Limits of Input/Output.

3. Provisions for Timing Plans.

- Storage Capability (minimum)—Nine, settable, timing programs; one dedicated free-operation program; and three control programs.
- Settable Program Positions (minimum)—One Offset; One Cycle; One Split
- On/Off Output Switch—One per control program.
- Program Assertion—Turn-off previous settable or free programs at the assertion of any of the settable or free, operational programs.

4. Cycle.

- Number—Three, minimum.
- Duration—Settable range of at least 30 seconds to 250 seconds.
- Increments—5 second maximum.

5. Clock/Calendar.

- Resolution—1 second.
- Selectable Programs—Day of week/hour/minute/second
- Number of Changes—50 minimum per day.
- Daylight Savings Time—Automatic transfer.
- Accuracy—±0.005 (50 ppm)% of clock calendar time, with respect to real time.

6. Display. A type providing the functionality of programming and obtaining the following: day of week, hour,

minute, second, program in effect, and setting stored or entered for storage.

7. Uninterruptible Power Supply (UPS). Sections 1104.05(i) and 954.4(m)

8. Inputs.

- Power Requirements—95 V to 135 V (ac), 57 Hz to 63 Hz.
- Minimum Number and Type—Eight green-signal inputs at 24 V (dc), negative true.
- Keyboard—Front panel mount.
- Transfer Function—Input program from other unit.

9. Outputs. Section 1104.04(b)

10. Program Transition. Pretimed Controller Units

- Dwell in coordinated phase walk.
- Dwell not to exceed 25% of operating cycle.
- Dwell in called-cycle when cycle transfer occurs due to program change.
- Program transfer, not to exceed four cycles.

(b) Master Controller Assembly. In accordance with Section 952 and as follows:

1. Master Controller Unit (Solid-State, Pretimed). Capable of functioning as an intersection controller or as a master controller to supervise other intersection controllers and as follows:

- Output Circuits—Ground true.
- Time Switch—For functions.
- Manual Pushbutton—For sync function with master removed.

2. Conflict Monitor. Section 1104.03(c)

3. Flasher. Section 1104.03(c)

4. Relays. Section 1104.03(c)

5. Load Switches. Section 1104.03(c)

6. Cable Terminal/Harness Assembly. Section 1104.03(c)

7. Electrical Load Center. Section 1104.03(c)

8. Police Panel. Section 1104.03(c)

9. NEMA Cabinet. Section 1104.03(c)

(c) Coordination Unit. In accordance with Section 952 and as follows:

1. Solid-State. Capable of coordination up to an eight-phase, dual-ring, solid-state, actuated controller unit and as follows:

1.a Cycle.

- Length—As indicated, in 1-second increments.
- Force-Off—Ensure the force-off command is directed to correct phase.
- Cycle and Split Transfer—At 0% point in local cycle.
- Offset Transfer—With pedestrian control, transfer in “green/walk” interval. With nonpedestrian

control, transfer in "green." Transfer to occur in a maximum of three cycles with no more than 17% change in any one cycle.

1.b Interface. NEMA TS 1, Section 13.

1.c System Interconnection.

- Type—Standard, seven-wire, positive subsystem.
- Function Requirements—95 V to 135 V (ac), 57 Hz to 63 Hz with isolated ground.

1.d Environment. NEMA TS 1, Section 2

(d) Closed Loop Signal System.

1. Master Controller. As directed by the Representative, provide a master controller or field-hardened CPU compatible with the closed loop signal system software.

2. Computer System. Provide a computer system to host a central system software and user interface.

3. Software. Furnish two versions of closed loop system software along with appropriate manuals. Provide software capable of operating in latest Windows operating system or updated version.

(e) Radio Communications System. Radio communication system consisting of a transmit/receive radio unit, coaxial cable, coaxial cable surge protection, antennas, mounting hardware, and antenna grounding kit. Use unlicensed frequency bands for radio units unless a licensed band has been preapproved by the Representative. Provide all necessary antennas, cables, jumpers and lightning protection, but not be limited to the following requirements:

- Provide omni antennas having a minimum gain of 8dbi and directional antennas 12dbi unless stated higher in the approved drawings. Provide antennas having 50 ohms impedance and voltage standing wave ratio (VSWR) less than 1.5:1.
- Provide coaxial cable having 50 ohms impedance. Provide a minimum 1/2 inch coaxial cable with N-type connections. Smaller 1/4 inch flexible jumpers are allowed inside enclosures. Provide external antenna connectors that are weatherproofed with an approved rubber mastic tape.
- Provide serial radio units with a minimum data throughput of 115kbps and for Ethernet radio units 1Mbps. Use radio units having built-in setup and diagnostic capabilities. Have a minimum receiver sensitivity -106dbm for serial radio units and -92dbm for Ethernet. Output impedance of 50 ohms on all radio units. Provide radio units meeting the following approval agencies (FCC, IEC, ANSI, and UL).

(f) Cable.

1. Control Cable. Furnish control cable, for field devices not requiring shielded conductors, conforming to IMSA Specification 19-1 or 20-1 for cable in conduit and IMSA Specification 20-3 for aerial cable. Provide stranded conductors, 14 AWG, minimum.

2. Communication Cable. Furnish communication cable, for signal controller telecommunications, conforming to IMSA Specification 19-2 or 20-2 for cable in conduit and IMSA Specification 20-4 for aerial cable. Provide as indicated, stranded conductors, 19 AWG, minimum.

3. Instrument Cable. Provide IMSA certified shielded cable, for filed devices requiring immunity to frequency interference, with three solid 20 AWG conductors and one drain wire and as follows:

- Insulation—Moisture and heat resistant (167F) polyethylene conforming to ASTM D1248, Type I, Class B, Category 5, Grade E4, 600 V rating applied concentrically about the conductor.
- Color Code—(1) yellow, (1) blue, (1) orange.
  - Shield—Mylar/aluminum tape shielding, applied with a nominal overlap of 20%, with the aluminum side in contact with the drain wire.

- Jacket—Polyvinyl chloride, having an average wall thickness of 0.045 inch, conforming to IMSA Specification 19-l, and rated at 176F.
- Electrical—dc resistance of each conductor, less characteristics than 11 ohms per 1,000 feet. Capacitance between each insulated wire and all other less than 48 pF per foot.
- Finished outside diameter—Less than 0.300 inch.

(g) Data Level Protocols for Serial or Ethernet Communications. In accordance with TIA/EIA-568-b, ANSI/TIA/EIA-232, ANSI/TIA/EIA-485 or compatible standards-based protocol for, but not limited to, the following:

- Data Capacity ("Bandwidth").
- Required Turnaround Time.
- Allowable Latency.
- Allowable Bit Error Rates.
- Data-Level Protocols.
- Testing, including requirements and test plans.

1104.05 ELECTRICAL DISTRIBUTION—

(a) Conduit.

1. Rigid Steel Conduit. Section 1101.09, except may be used for direct burial, and UL-6 Listing for rigid metallic conduit, galvanized inside and outside.

2. Rigid Polyvinyl Chloride Conduit. Section 1101.09 with UL-651 Listing for rigid nonmetallic conduit, and UL-514 Listing for fittings.

3. Cable Pulling Lubricant. Section 1101.13(c)

4. Conduit Sealant. An acceptable duct seal.

(b) Wire and Cable.

1. Signal Cable. 14 AWG minimum, stranded conductors; conforming to IMSA Specification 19-1 or 20-1.

2. Service Wire. 8 AWG minimum wire, Type USE conforming to UL-854 Listing and ASTM B3 and B8 for soft, annealed copper.

3. Ground Wire. Bare or insulated (green) copper wire, 8 AWG, conforming to ASTM B3.

4. Cable Tags. An acceptable type.

5. Cable Ties. An acceptable type.

6. High-Density Polyethylene (HDPE) Conduit. NEMA TC7 Standards and Schedule 40.

7. Polyester Pull Tape. Rated 900 pounds

8. Cable Supports. For span wire installations utilize insulated cable rings and saddles, or other acceptable type support, to secure cable to span wire.

(c) Junction Box. Furnish the type indicated and as follows:

- Precast Junction Box—Section 714
- Steel or Cast-Iron Junction Box—steel or cast iron conforming to the requirements for cast-iron junction

box, Section 1101.10.

- Reinforced Plastic Mortar Junction Box—Provide heavy duty junction box with nonskid surface and a watertight connection to the housing. Provide a minimum design load 15,000 pounds with a test load of 22,500 pounds. Place a logo "Traffic Signal" on cover.

(d) Electrical Service.

1. Service Pole. Section 1101.11(a)

2. Service Head. UL-Listed weatherproof service head, for applicable conduit type.

3. Meter Socket. As specified by the utility company.

4. Service Disconnect.

4.a Enclosure. Galvanized steel, aluminum, or stainless steel, with a hinged door having provisions for a padlock and no external handles or switches; conforming to the NEMA Standard for Type 3R, Type 3S, or Type 4. Provide a brass padlock for outdoor use, with two keys. All padlocks shall be keyed alike.

4.b Main Disconnect. Provide a means for disconnecting the service conforming to NEC.

4.c Fuses. UL-Listed Type K-1, 30 A minimum.

4.d Fuse Block. UL-Listed for K-1 fuses.

4.e Power Line Surge Protector. UL-Listed, rated for a maximum permissible line to ground voltage of 175 V (rms). Clamping voltage not to exceed 250 volts. Provide model with LED to indicate proper functioning of protection for each line.

(e) Wire Connectors.

1. Wire Nuts. Insulated, UL-Listed, with spring insert for applicable wire size and rating of wire insulation.

2. Waterproof Resin Sealer. Insulated, UL-Listed for wire nuts.

3. Terminal Blocks. UL-Listed with twelve-sets minimum to two terminals each, screw-type, rated at a minimum of 600 V, and suitable for the applicable wire size. Connect each set of terminals by means of a removable link. Separate each set of terminals by a molded barrier. Provide a marker strip for terminal identification.

4. Insulated Locking Spade Terminals. An acceptable type.

(f) Grounding Bushings and Lugs.

1. Bushings. UL-Listed for applicable conduit type and size.

2. Lugs. UL-Listed for applicable materials.

(g) Ground Rods With Clamp. Section 1101.11(j)

(h) Generator Adaptor Kit. Facilitate connection to an external power source, a 110 V AC generator.

1. Disconnect Enclosure. Section 1104.05(d)4.a

2. Transfer Switch. Capable of disconnecting the permanent power source and connecting to the emergency power source.

3. Connector Cable Assembly. Sufficient length to allow the attachment of an external power source in

accordance with the latest NEC.

4. Surge Protection. Protect the signal controller assembly with line to neutral clamping voltage of no more than 250 V at 20,000 A.

(i) Uninterrupted Power Supply (UPS). Furnish a Battery Backup System (BBS) and full-time double conversion power conditioner UPS compatible with the controller assembly and the following:

- Provide a UL-listed BBS for use with traffic signal equipment.
- Connect to the BBS a standard, readily available RS232 cable.
- Provide batteries that are deep-cycle, scaled prismatic lead-calcium based AGM/VRLA (Absorbed Glass Mat/Valve Regulated Lead Acid).
- Provide a system with minimum 4-hour backup operation.
- Provide all warranty information to the Representative at final acceptance.

(j) Service Receptacle. Provide one duplex Ground Fault Circuit Interrupter (GFCI) receptacle that is only used by service technicians working on the signal controller system. No other internal equipment is to be connected to the service receptacle. Minimum rating 20A.

1104.06 SIGNAL HEADS—

(a) Vehicular Signal Heads.

1. Housings. Bulletin 15 manufacturer.

- Plastic—Opaque polycarbonate resin molding, conforming to ASTM D3935. Federal yellow in color, except the inside of the visor, will have a non-reflective black finish.

- Aluminum—Finish exterior of aluminum housings as follows:

  Clean and coat surfaces of the signal housing, door, and visor, with an infrared, oven-baked, iron-oxide backing primer, conforming to Federal Specification TT-P-1757B and Federal Specification SSPC-Paint 25.

  Coat finished surfaces, except the inside of the visor, with infrared, ovenbaked, highway yellow exterior enamel, conforming to, according to Federal Standard No. 595B. Finish the inside of the visor with phathalic anhydride, black, synthetic baking enamel, with zero gloss reflectance and conforming to the performance requirements of MIL-E-5557 Enamel Heating Resisting Glyceryl Phathalate, Type 4, Instrument Black.

  Requests for black traffic signal housing require the Bureau of Maintenance and Operations approval.

2. Reflectors. Polycarbonate or aluminum. When the reflector is attached to the door, provide a means by which opening the door disables the indication.

3. Backplates. Furnish backplates that conform to the following:

- One-piece aluminum with a minimum thickness of 0.06-inch (thickness does not include retroreflective border).
- Powder coated dull black (Federal Standard 595-37038) on both the front and back sides.
- Top, bottom, and sides that measure from 5 to 8 inches in width.
- Rounded outside corners.
- Include louvers with no louvers closer than 0.5 inch from the inner or 2.5 inches from the outer edge. Orient the louver so it is vertical on sides and horizontal on top and bottom.
- Provide a minimum of four corner mounting attachment points per section head and must not interfere

with the operation of the section head doors.

- Include passivated stainless steel type 316 or 304 screws, washers, and other installation hardware required to mount securely.
- Permanently mark the manufacturer name, part/model number and date of manufacture on the back side.
- Universal backplates that fit all applicable PennDOT approved products.
- A minimum 2-inch fluorescent yellow, Type IX retroreflective border, placed flush with the outer edge of the backplate and placed no closer than 0.5 inch from all louvers. No sheeting is allowed over any louvered area.

4. Miscellaneous. Furnish cut-away visors unless otherwise indicated. Furnish louvers and backplates as indicated, with a non-reflective black finish.

5. Warranty. Provide all warranty documentation to the Representative at final acceptance.

(b) LED Vehicular Signal Head Modules. Bulletin 15 manufacturer and conforming to the following:

- ITE Standard for "Vehicle Traffic Control Signal Heads, Light Emitting Diode (LED) Circular Signal Supplement"
- ITE "Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement"
- MUTCD

Also, conforming to the regulations, and as follows:

1. Housings. Section 1104.06(a)1

2. Miscellaneous. Section 1104.06(a)4

3. Warranties. Provide all warranty documentation to the Representative at final acceptance.

(c) Optically Programmed Signal Heads. Bulletin 15 manufacturer and conforming to the following:

1. Optical. Incorporate an optical system, using LED modules for the green, yellow, and red signal indications, that limits the visibility zone internally and optically, without the use of hoods or louvers. The projected signal may be visible or selectively veiled anywhere within 15 degrees of the optical axis.

2. Sections. Provide an integral means for the incremental tilting of each section, from 0 degrees to 10 degrees above and below the horizontal. Unless directed otherwise, assemble vertically-mounted signals with a 4-degree tilt below the horizontal. Provide couplers, serrated locking rings, flanges, gaskets, and other hardware necessary to mate optically programmed signal sections together or to mate with nonoptically programmed sections, all in a secure and weathertight manner. Shop-join the sections. Use corrosion resistant internal hardware.

3. Painting. Section 1104.06(a)1

4. Electrical. Use copper, brass, nickel-plated brass, or phosphor-bronze, electrical-conducting hardware. Furnish lamps that provide luminous intensity of 950 beam candlepower, conforming to the traffic signal manufacturer's specification, rated at a minimum of 6000 hours. Color code the internal wiring. Provide a breaker that disables the indication when the lamp door is opened.

Provide an integral means within each signal face for regulating its luminous intensity between limits, in proportion to the individual background illumination, but not less than 97% of uncontrolled intensity at 1,000 footcandles; and reduce to 15% ± 2% of maximum intensity at less than 1 footcandle, proportionally and instantaneously.

5. Miscellaneous. Furnish cut-away visors. Furnish optical programming material and instructions. Within each section, affix a permanent, conspicuous warning label, advising of possible eye damage and fire hazard from the sun.

6. Warranty. Provide all warranty documentation to the Representative at final acceptance.

(d) Pedestrian Signal Housing. Bulletin 15 manufacturer and conforming to the ITE Standard for "Adjustable Face Pedestrian Signal Heads," the regulations, and as follows:

1. Housings. Section 1104.06(a)1

2. Reflectors. Section 1104.06(a)2

3. Miscellaneous. Furnish cut-away visors, unless otherwise indicated.

(e) Pedestrian Signal Heads-LED Pedestrian Signal Modules. Bulletin 15 manufacturer and conforming to ITE Standard for "Pedestrian Traffic Control Signal Indications –Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules" and the MUTCD. Provide verification from independent laboratory test results.

Also, conforming to the regulations, and as follows:

1. Housing. Section 1104.06(a)1

2. Electrical. Section 1104.06(c)4

3. Luminous Intensity. Meet or exceed the illumination values for the maintained minimum luminous intensity listed in the ITE Standard for "Pedestrian Traffic Control Signal Indications – Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules," Section 3 "Photometric Requirement," Subsection 4.1.1.

4. Warranties. Provide all warranty documentation to the Representative at final acceptance.

(f) Pedestrian Signal Heads—LED Countdown Pedestrian Signal Modules. Bulletin 15 manufacturer and conforming to the ITE Standard for "Pedestrian Traffic Control Signal Indications -Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules" and the MUTCD. Provide verification from independent laboratory test results.

Also, conforming to the regulations, and as follows:

1. Housings. Section 1104.06(a)1

2. Electrical. Section 1104.06(c)4

3. Design and Operation. Furnish double overlay or side-by-side message capable of displaying the symbols of a filled UPRAISED HAND (symbolizing DON'T WALK) and a filled WALKING PERSON (symbolizing WALK), and a countdown timer consisting of 2, 7-segment digits constructed of LEDs.

Provide numeric display either integral to, or separate from, the LED countdown pedestrian signal. If the numeric display is a separate component, the message display unit and the LED countdown numeric display unit must be approved as one system.

Provide UPRAISED HAND and WALKING PERSON symbols as solid figures.

4. Countdown Timer Module. Discontinue and make the LED countdown pedestrian signal display go dark immediately if the pedestrian change interval is interrupted or shortened as part of a transition into a preemption sequence.

- Equip the LED countdown pedestrian signal with a screen, visor, or other device to eliminate all phantom conditions.
- Furnish visors if the LED countdown pedestrian signal display will be visible to motorists stopped at a red traffic signal indication facing perpendicular to the display of the LED countdown pedestrian signal.
- Equip the LED countdown pedestrian signal timer to monitor the pedestrian change intervals and automatically adjust for any changes made at the controller.
- Provide a LED countdown timer module with an internal conflict monitor to prevent any possible conflicts between the UPRAISED HAND / WALKING PERSON signal indications and the time

display. When the steady UPRAISED HAND is illuminated, make it impossible to display any number other than zero (0).

5. Warranties. Provide all warranty documentation to the Representative at final acceptance.

(g) LED Lane-Use Traffic Control Signal Heads. Bulletin 15 manufacturer and conforming to the following:

- ITE Standard for "Lane-Use Traffic Control Signal Heads"
- MUTCD
- ITE Standard for "Vehicle Traffic Control Signal Heads, Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules," Sections 3, 5, and 6 (excluding Sections 6.3.2 and 6.4.2, "Maintained Minimum Luminous Intensity").

1. Housings. Section 1104.06(a)1

2. Warranties. Provide all warranty documentation to the Representative at final acceptance.

(h) Mounting Assembly and Hardware. Furnish signal mounting assemblies and hardware of a type and design that adequately supports the loading indicated and as indicated on the Standard Drawings.

1104.07 DETECTORS—

(a) General.

1. Sealant. Furnish a nonshrinking, flexible sealant for the encapsulation of loop or magnetometer sensor and as follows:

- Number of Components—One or two
- Application Temperature—32F to 100F, unless otherwise specified by manufacturer
- Tack Free—1 hour maximum
- Maximum Curing Time—30 hours
- Permanent Flexibility—to -20F
- Chemically Resistant To:
  De-Icing Chemicals
  Gasoline
  Calcium Chloride (5%)
  Motor Oils
  Hydraulic Brake Fluid

2. Detector Lead In Cable. 14 AWG minimum conforming to IMSA Specification 50-2.

3. Card Rack Assembly.

3.a Power Supply. Furnish a switching-type power supply and as follows:

- Input Voltage—95 V to 135 V (ac), 57Hz to 63 Hz
- Output Voltage—24 V ± 0.3 V (dc)
- Minimum Output Voltage—22.8 V (dc)
- Efficiency—70% minimum
- Full Load Current—3 A minimum
- Line Regulation—0.1% over entire input range
- Load Regulation—0.2% from no load to full load
- Ripple Noise—40 mV (p-p) typical, 75 mV (p-p) at full load
- Environmental—NEMA TS 1, Part 2

Provide a front panel incorporating a pilot lamp, test points for monitoring output voltage, and a circuit breaker or fuse. Ground all exterior metal surfaces to the chassis safety ground.

3.b Card Rack. A standard EIA, 19-inch rack for mounting the detector amplifier units, as follows:

- Aluminum front rails, drilled and tapped (10-32), with EIA spacing.
- Aluminum chassis supporting angles, 10 inches deep and 3 inches wide, for mounting on the sides of the controller cabinet.
- Aluminum connector panels, with connector mounting holes, tapped (4-40) on 0.200-inch centers, then mounted to form a cage 19 inches wide, 5 1/4 inches high, and 6 1/2 inches deep.
- Nonmetallic guides and Cinch-Jones No. 50-44A-30M rear connectors, mounted at 1.200-inch spacings.

4. Re-Enterable Splice Kit. Reusable molded body, internal and external hardware, clear polyurethane compound. Provide an appropriate size to accommodate in-line, wye, "x," butt, and dead-end splicing of cables rated at 1000 V or less, with outside diameters from 0.25 inch through 2.50 inches. Supply with the following components:

- Two-part transparent mold body of PVC construction, with tongue-and-groove seams and built-in spacer web.
- Two flexible end caps, each with double-stepped cable entry ports to accommodate the many possible splicing configurations.
- Snap-in caps to cap off the fill ports, after compound pouring.
- Strain bars with insulator sleeves.
- Four shield connectors to provide shield continuity, with strain bars for shielded cables.
- Stainless steel base clamps to secure splice body, end caps, and strain bars.
- Re-enterable electrical insulation and sealing compound, capable of continuous operation at 194F, with an emergency overload temperature rating at 266F, a viscosity of approximately 1,100 centipoise at 79F, a gel time of approximately 20 minutes at 73F, and zero growth fungus resistance, according to ASTM G21.
- An instruction booklet, showing proper installation and re-entry techniques.

(b) Vehicular Detection.

1. Loop Detector.

1.a Loop Sensor. 14 AWG minimum, conforming to IMSA Specification 51-5.

1.b Loop Amplifier, Shelf-Mounted. Self-tuning, loop amplifier, shelf-mounted, enclosed in a shock-proof housing with relay output and one or two channels as indicated, conforming to NEMA TS 1, Section 7.

1.c Loop Amplifier with Timers, Shelf-Mounted. Self-tuning, loop amplifier, shelf-mounted enclosed in a shock-proof housing with relay output and one or two channels as indicated, conforming to NEMA TS 1, Section 11.

1.d Loop Amplifier, Rack-Mounted. Self-tuning, loop amplifier, mounted on an edge-connected, printed circuit board with an electrically isolated solid-state output and two or four channels as indicated, conforming to NEMA TS 1, Section 7.

1.e Loop Amplifier with Timers, Rack-Mounted. Self-tuning, loop amplifier, mounted on an edge-connected, printed circuit board with an electrically isolated solid-state output and two or four channels as indicated, conforming to NEMA TS 1, Section 11.

2. Video Detection System. Provide model approved by the Representative, that is capable of being IP addressable. As indicated on the approved plans and as follows:

Provide catalog cuts to the Representative for approval before ordering the system.

Provide all equipment, connections, software, mounting system, etc. to provide the video vehicular detection for all locations identified on the approved plans.

Provide a video detection system that meets the latest NEMA TS-2 Standards.

Provide mounting system with all required camera mounting hardware, clamps, field wiring, and all remaining hardware necessary to accomplish installations and operation of the video detection device. As necessary, provide multiple units per approach if multiple zones are required and a single unit cannot provide adequate coverage.

Include four channel cards, unless otherwise directed, along with expansion cards. Have adequate memory to allow for future software and firmware updates. Remove or disable all video recording capabilities. Have all units Ethernet port and IP addressable. Include all incidental cables and power supplies.

Provide sunshield for each camera.

Replace or repair video detection system at no additional expense to the local municipality or the Department if the system fails to function as intended due to faulty work or material defects.

Adjust and realign detection zone settings and provide and install software updates for 1 year after acceptance by the Department.

2.a Video Camera Lens.

- Continuous focus zoom
- Minimum 10X zoom

2.b Housing and Sunshield.

- Sealed waterproof, dust-tight NEMA-4 housing.

2.c Environmental.

- Capable of operating during all hours and under all weather conditions.
- Temperature -30 F to 140 F
- Relative Humidity 0% to 100%

2.d Detection Zones.

- Minimum of four separate detection zones per camera
- Capable of determining which direction of travel, presence calling, pulse calling, delay, extension, sensitivity settings, and channel output.

2.e Cables and Mounting Hardware.

- As per manufacturer's recommendations.

3. Radar Detector. Provide Bulletin 15 approved equipment, with mounting assembly, to detect the presence or passage of vehicles in accordance with Sections 1104.01 and 1104.07. As indicated on the approved plans and as follows:

Provide mounting system with all required radar sensor mounting hardware, clamps, field wiring, and all remaining hardware necessary to accomplish installation and operation of the radar device. Detector unit must be Ethernet port and IP addressable compatible.

3.a Detection Zones.

- Capable of determining which direction of travel, presence calling, pulse calling, delay, extension, sensitivity settings, and channel output.
- Minimum detection pattern: Oval 50 feet by 25 feet typical at 50 feet.
- Hold time: 0.5 to 5 seconds, adjustable.
- Detection of stationary vehicles within the detection zones depicted on the approved plans shall remain valid until the vehicle resumes movement.
- Vehicle presence detection accuracy of 98% minimum.
- Travel speed detection accuracy of 90% minimum.
- Maximum permissible error of 5% in the detection of the direction and magnitude of radial speed

and 10% in the case of transverse speed.

3.b Environmental.

- Capable of operating during all hours and under all weather conditions.
- Operate without degradation in performance under temperature range of -40F to 165F and relative humidity 0% to 100%, non-condensing, without auxiliary heating or cooling.

3.c Housing.

- Sealed, waterproof, dust-tight NEMA-4 housing.

3.d Cables and Mounting Hardware.

- As per manufacturers recommendations.

3.e. Communication.

- Radar vehicle detector sensor must include a minimum of one serial or Ethernet communications interface.
- All wireless communication must be secure.
- Wireless devices must be FCC certified and FCC identification number must be displayed on an external label.
- All detectors must operate within their FCC frequency allocation.

3.f Electrical.

- Operating frequency: 10.525 GHz ±25 megahertz or another FCC approved spectral band.
- Must comply with limits of a Class A digital device pursuant to part 15 of the FCC rules or the appropriate spectrum management authority and must not interfere with any adjacent equipment.
- Power: 89 – 135 V(ad), 15W.
- Radiated energy must not exceed 10 milliwatts.
- Relay contacts: Form C, rated at 5 amps.

4. Radar Detection System. Provide Bulletin 15 approved equipment, with mounting assembly, to detect the presence of passage of vehicles in accordance with Sections 1104.01 and 1104.07. As indicated on the approved plans and as follows:

Provide catalog cuts to the Representative for approval before ordering the system.

Provide all equipment, connections, software, mounting system, ect. to provide the radar vehicle detection for all locations identified on the approved plans.

Provide a radar vehicle detection system that meets the latest NEMA TS-2 Standards.

Provide mounting system with all required radar sensor mounting hardware, clamps, field wiring, and all remaining hardware necessary to accomplish installation and operation of the radar device. As necessary, provide multiple units per approach if multiple zones are required and a single unit cannot provide adequate coverage.

Have all units Ethernet port and IP addressable compatible. Include all incidental cables and power supplies. Adjust and realign detection zone settings and provide and install software updates for 1 year after acceptance by the Department.

4.a Detection Zones. Section 1104.07(b)3.a

4.b Environmental. Section 1104.07(b)3.b

4.c Housing. Section 1104.07(b)3.c

4.d Cables and Mounting Hardware. Section 1104.07(b)3.d

4.e Configuration and Management.

- Provide software that allows local and remote configuration and monitoring.
- Provide a system that is easily configurable and expandable to meet traffic management applications for various intersection control strategies.
- Display detection zones and detection activations in graphical format.
- Enable the operator to edit previously defined configuration parameters, including size, placement, and sensitivity of detection zones.
- Retain programming within an internal, non-volatile memory.
- All communication addresses must be user programmable.
- System software offers an open API and software development kit available to the Department and no cost for integration with third party software and systems.

4.f Communication.

- Radar vehicle detector sensor must include a minimum of on serial or Ethernet Communications interface.
- Seral interface and connector must conform to TIA 232 standards.
- Serial ports must support data rates up to 115200 bps.
- Radar detector system must transmit data in serial RS-232 or RS-422 format.
- Furnish terminal server to convert signals to Ethernet format where required.
- All wireless communication must be secure.
- Wireless devices must be FCC certified and FCC identification number is displayed on an external label.
- All detection systems must operate within their FCC frequency allocation.
- All unshielded twisted pair/shielded twisted pair network cables and connectors must comply with TIA-568.

4.g Electrical. Section 1104.07(b)3.f and as follows:

- If any system device requires operation voltages other than 120 V(ac) supply a voltage converter.

5. Magnetometer Detector.

5.a Magnetometer Sensor. As indicated and as follows:

- Physical Size—Cylindrical housing, nonferrous, moisture-proof, suitable for direct burial in roadway pavement, with no damage due to subsurface stresses, and with a lead-in cable of proper length for hookup.
- Operational—No moving parts and compatible with the magnetometer detector amplifiers furnished.

5.b Magnetometer Amplifier, Shelf-Mounted. Enclosed in a shock-proof housing and as follows:

- Operation—Solid-state design with two independent detection channels in each unit, designed so the sensing element of one channel has no effect on the other.

- Bimodal—Pulse mode—Provides an output closure of 125 ms ± 25 ms duration for each vehicle entering the detection area.

  Bimodal—Presence mode—Continually indicates the presence of a vehicle, until the vehicle leaves the area of detection, at which time the indication is to cease within 100 ms.

- Sensing Elements—One to six magnetometer sensors per channel capability at a distance of up to 3,000 feet between sensor and amplifier.

- Indicators and Switches—Provide on front panel: an LED indicator, sensitive to vehicle detection; fused or circuit breaker overcurrent protection; mode switch, calibration controls; and switch or switch position per channel for disabling the output of a channel and placing a call on a channel.

- Output—Optically isolated Darlington—An opto-isolated, NPN open collector capable of sinking 50 mA at 30 V (dc).

- Connector—MS-3106A20-29P, 17-pin connector with the following pin assignments:

		Channel 1		**Channel 2**
	White	D		T
	Black	E		N
Probe Sets	Red	P		J
	Green	R		S
	Common (-)	B		K
Output	Detect (+)	G		M
	Neutral		A	
ac Power	High		C	
	Chassis Ground		H	

- Power Requirements—Maximum 11 V·A at 105 V to 125 V (ac), 57 Hz to 63 Hz without originating, nor being susceptible to, electrical transients in excess of the NEMA, TS 1, Section 2.

- Environment—NEMA TS 1, Section 2.

5.c Magnetometer Amplifier, Rack-Mounted. Mounted on an edge connected, printed circuit board for rack-mounting and as follows:

- Physical—Provide a hand pull to facilitate insertion and removal from the rack.
- Operation—Section 1104.07(b)5.b
- Modes—Section 1104.07(b)5.b
- Sensing Elements—Section 1104.07(b)5.b
- Indicators and Switches—Section 1104.07(b)5.b, excluding overcurrent protection.
- Output—Section 1104.07(b)5.b
- Connector—Cinch Jones Number 50-40-A-30M, 22-pin edge connector, with the following pin assignments:

Pin Function

A dc Ground
B +24 V (dc)
C Reset
D Sensing Element #1 Input
E Sensing Element #1 Input
F Control Unit Output #1 (Collector)
H Control Unit Output #1 (Emitter)
J Sensing Element #1 Excitation
K Sensing Element #1 Excitation
L Equipment Ground
M Reserved
N Reserved
P Sensing Element #2
R Sensing Element #2
S Control Unit Output #2 (Collector)

T Control Unit Output #2 (Emitter)
U Sensing Element #2 Excitation
V Sensing Element #2 Excitation
W NA
X NA
Y NA
Z NA

Connector—Slotted for keying (Between Pins B&C and Pins M&N).

- Power Requirements—Maximum current 300 mA from 33 V to 28 V (dc).
- Environmental—NEMA TS 1, Section 2.

6. Magnetic Detector.

6.a Magnetic Sensor.

- Physical—Cylindrical case, nonferrous, moisture-proof, suitable for burial within rigid nonmetallic conduit, and with a lead-in of sufficient length.
- Operation—No moving parts and compatible with the magnetic-detector amplifier furnished.

6.b Magnetic Amplifier, Shelf-Mounted. Shelf-mounted, enclosed in a shock-proof housing, and as follows:

- Operation—Solid-state design, with one channel in each unit.
- Sensing Elements—One or more magnetic sensor capability at a distance of up to 1,000 feet between the sensor and amplifier.
- Indicators and Switches—Provide on front panel: indicator for detection of a vehicle, fused or circuit breaker overcurrent protection, calibration controls, and a switch or switch position for disabling the output and placing a call.
- Output—Section 1104.07(c)2
- Connector—Relay output—MS3106A-18-1S, Solid-State (Isolated)—MS3106A-8-15W.
- Power Requirements—Maximum power consumption of 2 W at 120 V (ac) and 60 Hz.
- Environmental—NEMA TS l, Section 2.

6.c Magnetic Amplifier, Rack-Mounted. Mounted on an edge-connected, printed circuit board for rack-mounting and as follows:

- Physical—With a handpull to facilitate insertion and removal from the rack. The four-channel, magnetic-detector amplifier in the front panel space of two, two-channel magnetic-detector amplifiers.
- Operation—Solid-state design with two or four independent detection channels in each unit, as indicated, designed that the sensing element of one channel has no effect on the other.
- Sensing Element—One or more magnetic sensors per channel, capable of sensing at a distance of up to 1,000 feet between the sensor and amplifier.
- Indicators and Switches—Section 1104.07(b)5.b, excluding overcurrent protection.
- Output—Section 1104.07(b)5.b
- Connector—Cinch-Jones Number 50-40-A-30M, 22-pin edge connector, with the following pin assignments:

Pin Function

A dc Ground
B +24 V (dc)
C Not Connected
D Detector #1 Element
E Detector #1 Element

F Detector #1 Output (C)
H Detector #1 Output (E)
J Detector #2 Element
K Detector #2 Element
L Chassis Ground
M Reserved
N Reserved
R Detector #3 Element
S Detector #3 Output (C)
T Detector #3 Output (E)
U Detector #4 Element
V Detector #4 Element
W Detector #2 Output (C)
X Detector #2 Output (E)
Y Detector #4 Output (C)
Z Detector #4 Output (E)

Connector—Slotted for keying
(C)—Collector
(E)—Emitter

- Power Requirements—Maximum of 60 mA per channel from a 24 V (dc) power supply.
- Environmental—NEMA TS 1, Section 2.

6.d Rigid, Nonmetallic Conduit. Section 1104.05

(c) Pedestrian Detectors. Provide Bulletin 15 approved products.

1. Pedestrian Pushbutton. Capable of completing a momentary circuit closure as indicated on the approved plans and as follows:

- General—Furnish a tamper and weatherproof assembly with pushbutton contacts, entirely insulated from the housing and buttons. Use a pushbutton with 2-inch diameter, ADA-compliant, stainless steel non-moving pushbutton and a maximum force of 5 pounds. Furnish sign and mounting assembly as indicated. Conform to the regulations for the sign legend and Section 1103.04 for the fabrication. Use stainless steel hardware to mount the pushbutton assembly.
- Housing—Die-cast aluminum alloy housing, with a curved back or a flat back as required to conform to the mounting surface. Paint the assembly highway yellow, as specified in Section 1104.06(a)1. Provide a rear cable entry.
- Electrical—Provide a switch mechanism consisting of a direct push-type button, with a single momentary contact switch, contacts rated at 10 A minimum, 125 V (ac) for operation at 24 V (dc).
- Latching LED—provide light emitting diode (LED) light with luminous intensity greater than 1200 mcd in ultra bright red color and a viewing angle of 160 degrees that activities only during non-walk phases upon pedestrian actuation and stays on until the beginning of the walk phase.

2. Accessible Pedestrian Signals (APS). MUTCD and the following as included on the approved plans:

- The type of WALK indication as specified (tone or speech)
- The significance of the “extended button press” function
- The requirement for audible and tactile feedback of the pushbutton activation
- Location of pedestrian buttons, pedestrian heads, and speakers
- Orientation of tactile arrow
- WALK indication tone volume (minimum, maximum and amount over ambient)
- Locator tone volume (minimum, maximum and amount over ambient)
- Any requirement for the street name in Braille or raised print
- Latching LED as specified in Section 1104.07(c)1

Furnish APS and hardware that satisfy industry standards. Ensure that there are no sharp edges that could injure a pedestrian.

Supply weatherproof hardware.

(d) Preemption Systems. Provide Bulletin 15 approved model in accordance with Sections 951, 1104.01, and 1104.03, approved plans, and as follows:

1. Optical Preemption. Include preemption devices, mounting and controller hardware, software, connectors, and cables as specified by manufacturer, to provide a functional system.

Provide optical emitter(s) responsive at a minimum distance of 500 feet.

Arrange for demonstration, as directed.

2. Acoustic Preemption. Provide a siren-activated Emergency Vehicle Preemption System. Include all necessary controller unit connectors, panel wiring, and miscellaneous hardware needed with the control cabinet. Provide field confirmation of detection at a minimum distance of 500 feet.

Certify that no false detection can occur. Arrange for demonstration, as directed.

3. Global Positioning Satellite (GPS) Based Preemption. Provide GPS units with a minimum 500 feet radio range at intersections indicated on approved plans, to gain preemption or priority. Provide all hardware and software necessary to provide a functional GPS-Based Preemption System with secure radio communications. Arrange for demonstration, as directed.

SECTION 1105—FABRICATED STRUCTURAL STEEL AND ALUMINUM

1105.01 GENERAL REQUIREMENTS—

(a) Prequalification. Structural steel and aluminum fabricators performing work for the Department are required to prequalify according to the American Institute of Steel Construction's (AISC) Quality Certification Program and obtain approval from the Chief Structural Materials Engineer. Plants and shops must be registered and certified under the AISC program with SBR: Certified Bridge Fabricator-Simple; IBR: Certified Bridge Fabricator-Intermediate; ABR: Certified Bridge Fabricator-Advanced; or CPT: Certified Component Manufacturer - Bridge, as applicable, and must submit a valid certificate to the Chief Structural Materials Engineer, at 81 Lab Lane, Harrisburg, PA, 17110. Annual submission of an endorsed copy of the certificate is required for continued prequalification. Fabricators applying for initial Bulletin 15 approval or approved fabricators wishing to upgrade certification must obtain approval to fabricate structures which have Publication 408 Section specific Bulletin 15 fabricator listings or to fabricate High Performance Steel (HPS) members and are required to furnish acceptable references for which the fabricator has successfully completed fabrication of similar members. If unable to furnish acceptable references, the fabricator must satisfactorily produce a sample member to obtain Department approval and listing in Bulletin 15.

Only fabricators having ABR certification, including the Fracture Critical endorsement, may fabricate the following:

- Main members for arches, continuous span trusses, cable-stayed bridges, and suspension bridges.

Only fabricators having either IBR or ABR certification, including the Fracture Critical endorsement, may fabricate the following:

- Fracture critical members and attachments, except as specified in Section 1105.01(a).

Only fabricators having either IBR or ABR certification may fabricate the following:

- Main bridge members, except for certain rolled beams
- Welded floor beams
- Cross frames and diaphragms for curved bridges
- Bracing, portals, and stiffening members for arches, trusses, cable-stayed and suspension bridges
- Rolled beams with butt welds, or that are heat-curved, heat-cambered, or cold cambered

Fabricators having either SBR, IBR, or ABR certification may fabricate the following:

- Rolled beams with bearing stiffeners and diaphragm connection or cover plates[2]
- Cross frames and diaphragms for straight bridges
- Shop-fabricated material for reinforcing existing bridges[1]
- Lateral bracing except for arches, trusses, cable-stayed, and suspension bridges[1]

Note 1: Fabricate in an IBR or ABR certified plant if welding is required.

Note 2: SBR certified plants must qualify for initial approval from the Chief Structural Materials Engineer to perform heat cambering or cold cambering on rolled beams.

Fabricators having SBR, IBR, ABR, or CPT certification may fabricate the following:

- Expansion dams
- Bridge drainage material
- Welded bearings
- Inspection walks
- Steel grid flooring
- Overhead sign structures
- Welded sound barrier supports

- Bridge railing
- Pedestrian railing
- Structure mounted guide rail
- Welded protective barrier
- Traffic, lighting or camera poles

AISC certification is not required for the following:

- Castings, forgings, and machined parts not welded
- Non-metallic bearing
- Protective fence
- Material not requiring shop fabrication or shop welding, such as plates and shapes for strengthening existing bridges and manufactured items accepted by certification

Prequalification of 'machine shops' (who provide services and materials to approved fabricators) for listing in Bulletin 15 is required. Approved fabricators are not required to prequalify as machine shops. Approved machine shops may perform one or more of the following operations[3]:

- Cutting or shearing materials to finish size
- Grinding
- Drilling or punching
- Cold bending
- Machining
- Flattening

Note 3: Individual shop operations may be limited. Refer to Bulletin 15 for limitations.
Machine shops cannot produce fracture critical members without project specific approval from the Chief Structural Materials Engineer except if the material is being produced for and shipped to a fabricator having AISC IBR or ABR certification, including Fracture Critical endorsement.

(b) Coordination of Plans and Specifications. Section 105.04

(c) Shop Drawings. Section 105.02 and as follows:

Shop drawings stamped "Accepted as Noted" allow fabrication only. The fabricator will make the noted changes to the drawings and resubmit for final acceptance before shipping. "ACCEPTED" Drawing are required for shipment to project.

Bridge members and other structures are generally designed in lengths, depths, and widths that can be transported from the fabrication source to the project. Field splices, if required, must be indicated and detailed on the shop drawings. If required by the District Executive, submit design computations prepared by a Professional Engineer registered in the State according to the Design Manual, Part 4, Structures. The District Executive will not review requests for elimination of field splices unless a notice is included from the BOMO that a hauling permit can be obtained to ship beams exceeding the dimensions shown on the structure drawings.

(d) Erection Drawings. Section 1050.3(c) 2.d

(e) Inspection.

1. General. The BDTD's Structural Materials Section will oversee and manage in-plant QA inspection. The fabricator is responsible for notifying their assigned consultant inspection firm a minimum of 48 hours (excluding weekends and holidays) before the beginning of work so that arrangements can be made for inspection.

The Representative may waive shop inspection and make a complete inspection at a later stage in the construction sequence. Furnish certified mill reports, in duplicate, covering the structural steel used.

2. Facilities for Inspection. Furnish necessary facilities for the inspection of material and quality of work. Furnish an Inspector's Field Office, Type C, as specified in Section 714.5(a), except provide a four-drawer, -fire-resistant (-Dlabel) metal file cabinet in place of a -two-drawer, -fire-resistant (-D-label-) metal file cabinet and a

wired broadband Internet service, for exclusive use by Department personnel. Choose a service that provides the fastest available highspeed broadband internet access, with a minimum connection of 5 Mbps per inspector, to the account by means of a Cable or Digital Subscriber Line (DSL). Provide a wireless broadband router, with a minimum-security setting of WPA2, to connect to the provided wired broadband. Based on the specific type of high-speed connection provided, furnish a compatible modem with built-in hardware firewall protection. If such high-speed wired broadband connection is not attainable at the Inspector Office desk area, alternate internet connectivity options must be submitted to the Chief Structural Materials Engineer for review and acceptance. Demonstrate connectivity with the Internet Service Provider once the service is initiated. To ensure reliability and continued access, audits of this connection may be done at any time by qualified PennDOT/OA IT Personnel.

Allow inspectors employed by the Department unrestricted access to work in process and stored material during plant working hours.

3. Plant Inspector's Authority. Plant Inspectors have the authority to reject any material or work not conforming to the requirements of these Specifications. In case of dispute, the Contractor may appeal to the Representative, whose decision will be final.

4. Rejections. Material, quality of work, or finished members accepted by the inspector at the shop may be rejected later if they do not conform to the specifications. Repair or replace rejected material or members.

5. Testing. If directed, furnish test specimens of material, as well as equipment, tools, and labor necessary to prepare the specimens and to make the tests.

6. Mill Orders and Shipping Statements. Furnish copies of mill orders and shipping statements as directed. Show the weights of the individual members on the statement. Ensure that the fabricator submits a copy of the shipping invoice to the Department's Shop Inspector to be stamped for verification of inspection and acceptance of steel items before shipment. Forward the stamped copy of the shipping invoice with the shipment for the project file. The Shop Inspector will review and accept mill certifications and return them to the fabricator.

(f) Storage of Materials. Section 106.05 and as follows:

Store materials on platforms, skids, or other supports. Place and support materials to avoid overstress, deformation, or damage. Exercise special care for curved members. Keep materials free from dirt, grease, and other foreign materials. Ensure proper drainage and protect materials from corrosion.

(g) QC.

1. General. Establish and maintain a level of QC based on uniform fabrication practices. Do not initiate fabrication without an approved QC plan.

2. QC Plan. Shops seeking prequalification must submit a QC Plan to the Chief Structural Materials Engineer for review and approval. Develop the plan according to the criteria established in AASHTO-NSBA Steel Bridge Collaboration document S4. 1-2002 “Steel Bridge Fabrication QC/QA Guide Specification” (refer to Publication 135 for an outline of the QC plan criteria). Facilities performing welding that require non-destructive testing must submit their written practice according to the current version of ASNT- SNT-TC-1A. Pre-qualified shops must submit an updated QC Plan to the Chief Structural Materials Engineer if there are any changes in materials, processes, or personnel.

3. QC Personnel. Assign sufficient qualified personnel with structural steel and/or aluminum fabrication experience to be responsible for QC during the fabrication process, storage, and shipment. Do not proceed with fabrication until qualified QC personnel are present and approved by the Department. Provide an AWS Certified Welding Inspector (CWI) on site as the Fabricator's designated QC Representative to oversee all processes of fabrication that involve welding, application of heat, or straightening of material.

1105.02 MATERIAL—

(a) Structural Steel and Aluminum.

1. General. ASTM A6

2. Carbon Steel. AASHTO M 270 (ASTM A709), Grade 36, Grade 50S, ASTM A36 and ASTM A992 (Structural Steel Shapes).

2.a Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes. ASTM A500, Grade A, B, or C. or ASTM A1085 Grade A.

2.b Hot-Formed Welded and Seamless Carbon Steel Structural Tubing. ASTM A501

3. High-Strength Low-Alloy Structural Steel for Welding.

3.a High-Strength Low-Alloy, Quenched and Tempered High Performance Steel (HPS) Structural Steel Plate. AASHTO M 270 (ASTM A709), Grade HPS 70W and Grade HPS 100W including requirements for Non-Fracture Critical Material Toughness Testing or Fracture Critical Material Toughness Testing, for Zone 3, as applicable. Identify Fracture Critical Material (FCM) on the shop drawings. Grade substitution for any HPS material indicated on the plans is not allowed.

Provide mill test reports that indicate either Quenched and Tempered (Q&T) or Thermo-Mechanical Control Process (TMCP) and also indicate on the accepted shop drawings. Mill orders must stipulate that no welded repairs are to be performed by the producing mill.

Limit plate length to 50 feet maximum mill delivery length for Q&T plate.

3.b High-Strength Low-Alloy TMCP Structural Steel Plate. AASHTO M 270 (ASTM A709), Grade HPS 70W, up to 2 inches thick and meeting the requirements as specified in Section 1105.02(a)3.a.

3.c High-Strength Low-Alloy Structural Steel. AASHTO M 270 (ASTM A709), Grades 50, 50W, or HPS 50W, ASTM A572, Grade 50, of a quality suitable for welding.

3.d High-Strength Low-Alloy Columbium-Vanadium Steel of Structural Quality. AASHTO M 270 (ASTM A709), Grade 50, ASTM A572, Grade 50.

3.e High-Strength Low-Alloy Structural Steel with 50,000 pounds per square inch Minimum Yield Point to 4 inches Thick. AASHTO M 270 (ASTM A709), Grade 50W, ASTM A588 (Grades A, B, and C only[4]).

Note 4: Plate thicknesses greater than 4 inches are required to conform to the physical properties listed in the specification for plate thicknesses 4 inches and under.

3.f High-Yield Strength, Quenched and Tempered Alloy Steel Plate.

3.f.1 High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding. AASHTO M 270 (ASTM A709), Grade HPS 100W.

3.f.2 High-Strength Alloy Steel Plates, Quenched and Tempered, for Pressure Vessels. ASTM A517. Conforming to the supplementary notch toughness requirements of ASTM A20.

3.f.3 Quenched and Tempered Alloy Steel Structural Shapes and Seamless Mechanical Tubing. Products conforming to all of the mechanical and chemical requirements of ASTM A709, Grade HPS 100W steel, except with a maximum tensile strength of 140,000 pounds per square inch for structural shapes and 145,000 pounds per square inch for seamless mechanical tubing, are to be considered as ASTM A709.

3.g. Stainless Steel. As indicated on the plans. Use only prequalified base metals listed in AWS D1.6M/D1.6 – 2007.

4. Aluminum. As indicated on the plans. Use only prequalified base metals listed in AWS D1.2M/D1.2 – 2014

5. Supplemental Requirements for Notch Toughness. Unless otherwise indicated, provide structural steel conforming to the supplementary notch toughness requirements for the longitudinal Charpy V-notch tests specified for Zone 2 of the applicable AASHTO Materials Specifications. Unless otherwise indicated, the supplemental requirements are mandatory for the following Primary Member Components subject to tensile stress:

- Girders, beams, stringers, floorbeams, bent caps, bulkheads, and straddle beams
- Truss chords, diagonals, verticals, and portal and sway bracing members
- Arch ribs and built-up or welded tie girders
- Rigid frames
- Gusset plates and splice plates in trusses, arch ribs, tie girders, and rigid frames
- Splice plates and cover plates in girders, beams, stringers, floorbeams, bent caps, and straddle beams
- Bracing members supporting arch ribs
- Permanent bottom-flange lateral bracing members and mechanically fastened or welded bottom-flange lateral connection plates in straight and horizontally-curved bridges
- Diaphragm and cross-frame members and mechanically fastened or welded crossframe gusset plates in horizontally-curved bridges or straight girder bridges if the skew is less than 70 degrees.
- Mechanically fastened or welded longitudinal web and flange stiffeners
- Mechanically fastened or welded batten plates and stay plates, lacing, and continuous nonperforated or perforated plates in built-up members
- Eyebars and hanger plates
- Miscellaneous structural components or attachments not mentioned above joining two primary members

The requirements are not mandatory for Secondary Member Components:

- Top flange lateral bracing members or struts and top flange lateral connection plates in horizontally-curved bridges or straight girder bridges if the skew is 70 degrees or greater
- Diaphragm and cross-frame members and mechanically fastened or welded cross-frame gusset plates in straight bridges if the skew is 70 degrees or greater
- Bearings, filler plates, sole plates, and masonry plates
- Mechanically fastened or welded transverse intermediate web stiffeners, transverse flange stiffeners, bearing stiffeners, and transverse connection plates
- Miscellaneous nonstructural components or attachments (e.g., expansion dams, drainage material, brackets, other miscellaneous attachments)

If directed, provide samples for Charpy V-Notch testing from steel used in fabricating plates and shapes. Submit the samples to the Chief Structural Materials Engineer, BDTD - Structural Materials Section, 81 Lab Lane, Harrisburg, PA 17110. Obtain the samples from plates delivered to the fabricator.

(b) Bedding Material for Bridge Shoes. Section 1113.03(h)

(c) Bolts, Nuts, and Washers. From a manufacturer listed in Bulletin 15 and as follows, unless otherwise indicated or specified:

1. Bolts for General Application.

- ASTM A307, Grades A or B

1.a Nuts. Use ASTM A563 nuts of the Grade and Style conforming to the Grade and Diameter of ASTM A307 bolts, of all surface finishes, as follows, unless otherwise specified:

Bolts (inch)	Nuts
Grade A, 1/4 to 1 1/2	Grade A, Hex
Grade A, over 1 1/2 to 4	Grade A, Heavy Hex
Grade B, 1/4 to 4	Grade A, Heavy Hex

Nuts of other grades and styles having specified proof load stresses (ASTM A563, Table 3) greater than the grade and style of nuts shown above are also suitable. Overtap and lubricate galvanized nuts in conformance with ASTM A563.

1.b Washers. ASTM F436, Type 1 or ANSI B18.22M

2. Anchor Bolts. AASHTO M 270 (ASTM A709), Grade 36, anchor bolts (headed or non-headed, either straight or bent) and cap screws, hot dip or mechanically galvanize as specified in Section 1105.02(s).

2.a Nuts. ASTM A563, of suitable style according to the contract documents. Hot dip or mechanically galvanize to match anchor bolt coating process as specified in Section 1105.02(s). Galvanized nuts must be Grade DH. Overtap and lubricate galvanized nuts according to ASTM A563. Overtap only to the minimum extent necessary to allow assembly on the bolt threads.

2.b Washers. ASTM F436, Type 1, hot dip or mechanically galvanize as specified in Section 1105.02(s).

3. Anchor Bolts. ASTM F1554, Grades 36, 55, 105, anchor bolts (headed or non-headed, either straight or bent) and cap screws (fully threaded shank), hot dip or mechanically galvanize as specified in Section 1105.02(s).

3.a Nuts. ASTM A563, of suitable style according to ASTM F1554, Section 6.7, unless otherwise specified in the contract documents. Hot dip or mechanically galvanize to match anchor bolt coating process as specified in Section 1105.02(s). Galvanized nuts must be Grade DH. Overtap and lubricate galvanized nuts according to ASTM A563. Overtap only to the minimum extent necessary to allow assembly on the bolt threads.

3.b Washers. ASTM F436, Type 1, hot dip or mechanically galvanize as specified in Section 1105.02(s).

(d) High-Strength Bolt Assemblies. Provide high-strength, heat treated, steel structural bolts, suitable nuts, hardened washers and, if specified, direct tension indicator devices (DTIs) for structural joints, from manufacturers listed in Bulletin 15, and unless otherwise indicated or specified, conforming to the following requirements:

For painted, galvanized or metalized steel structures, including coated portions of weathering steel structures, use Type 1 bolts, nuts, and washers mechanically galvanized (except ASTM F3125 Grade A490 assemblies) according to ASTM B695 as specified in Section 1105.02(s). ASTM F3125Grade A490 bolts, if approved for use, must not be galvanized under any circumstances. Galvanized bolts, nuts, and washers of an assembly must each be galvanized by the same process. For uncoated, bare AASHTO M 270 (ASTM A709), Grades 50W, HPS 50W, HPS 70W, or HPS 100W weathering steel structures, use plain (uncoated) Type 3 bolts, nuts, and washers conforming to atmospheric corrosion resistance requirements of AASHTO M 270 (ASTM A709), Grade 50W.

Perform testing of bolts, nuts, and washers, including initial rotational capacity testing of assemblies, as specified in Section 1105.02(d)7 below.

1. Identifying Marks. Permanently mark all bolts, nuts, and washers by the respective manufacturers in conformance with the “Product Marking” section of the applicable AASHTO or ASTM standards.

2. Dimensions. Ensure bolt and nut dimensions conform to the requirements for Heavy Hex Structural Bolts and for Heavy Hex Nuts given in ANSI/ASME Standards B18.2.6 and B18.2.2, respectively. Conform to the

requirements of ASTM F436 for washer dimensions.

3. Bolts. F3125 Grade A325 or Grade A490, except as amended and revised below: (Grade A490 bolts are prohibited unless specifically approved for use by the Chief Bridge Engineer.)

Provide a lot number on the supplier's certification corresponding to that appearing on the shipping package and certification Form CS-4171. Note on the supplier's certification when and where all testing was done, including the rotational capacity tests specified. If galvanized Grade A325 bolts are used, include the zinc thickness on the supplier's certification.

Furnish bolts with diameters of 1/2 inch to 1-1/2 inch inclusive. ASTM F3125 Grade A325 bolts must have a maximum hardness of 33 HRC. Provide plain (uncoated) bolts "oily" to the touch when installed.

4. Nuts. Heavy Hex ASTM A563 or AASHTO M 292 (ASTM A194), as applicable, except as otherwise specified.

Use only the Grade and finish of nuts corresponding to the bolt Type and finish as listed below:

F3125 Bolts	Nuts
Grade A325 Type 1, uncoated	ASTM A563 Grades C, C3, D, DH, DH3; or A194 Grade 2H; uncoated
Grade A325 Type 1, galvanized	ASTM A563 Grade DH; or A194 Grade 2H; galvanized
Grade A325 Type 3, uncoated	ASTM A563 Grades C3, DH3; uncoated
Grade A490 Type 1, uncoated	ASTM A563 Grades DH, DH3; or A194 Grade 2H; uncoated
Grade A490 Type 3, uncoated	ASTM A563 Grade DH3; uncoated

Mechanically galvanize all nuts according to ASTM B695 as specified in Section 1105.02(s). Lubricate all galvanized nuts. Use a lubricant containing a dye of any color that contrasts with the color of the galvanizing so that a visual check can be made for the lubricant at the time of field installation. At a minimum, apply lubricant to the threaded portions and to both bearing faces of each nut.

Plain nuts must have a minimum hardness of 89 HRB. Maximum hardness cannot exceed the limits in ASTM A563.

Furnish galvanized nuts that are tapped oversize only to the minimum extent necessary to allow assembly on the bolt thread in the coated condition. Tap oversize before galvanizing. When ASTM A194 Grade 2H nuts are supplied, the zinc coating, overtapping, lubrication, and rotational capacity testing must be according to these specifications and ASTM A563. Furnish plain (uncoated) nuts "oily" to the touch when installed.

5. Washers. Hardened steel washers, ASTM F436, except as otherwise specified. When indicated, mechanically galvanize according to ASTM B695 as specified in Section 1105.02(s). Use Type 1 washers with Type 1 bolts and Type 3 washers with Type 3 bolts.

6. Direct Tension Indicator (DTI) Devices. When contract documents specify the use of DTIs, use ASTM F959, except as amended as follows:

Each lot of DTIs delivered to a PennDOT project must be sampled and tested by PennDOT before use. Select at random, according to PTM No. 1, a minimum of 16 samples from each lot and forward these, along with Form TR-447, to the LTS for testing.

Provide DTIs with each having a hardness not greater than 109 HRB (35 HRC) and within ± 2 HRB of the lot's target HRB (as indicated on the CS-4171 certification provided by the manufacturer). Furnish Type 325 or Type 490 DTIs for use with ASTM F3125 Grade A325 Type 1 or ASTM F3125 Grade A490 Type 1 bolts, respectively. Furnish Type 325-3 or Type 490-3 DTIs with ASTM F3125 Grade A325 Type 3 or ASTM F3125 Grade A490 Type 3 bolts, respectively. Where galvanized DTIs are specified, mechanically galvanize according to ASTM B695 as specified in Section 1105.02(s).

Ship each lot in protective containers marked with the type, lot number, quantity, and total lot size. Include a copy of the certification with each shipment.

Handle and store DTI devices according to the manufacturer's recommendations.

7. Testing. Test bolts, nuts, washers, and assemblies according to their applicable ASTM standards and as follows:

7.a Bolts. Perform proof load tests according to ASTM F606, Section 3.2.1, Method 1. Perform wedge tests according to ASTM F606, Section 3.5. Perform the tests on full size bolts unless otherwise approved by PennDOT,

and at the minimum frequency according to ASTM F3125 Section 9.5 for Grade A325 or Grade A490, and Section 11.4 for ASTM F1852 and ASTM F2280, as applicable.

If ASTM F3125 Grade A325 bolts are to be galvanized, perform testing after galvanizing. Determine the thickness of zinc coating on galvanized bolts by taking measurements on the wrench flats or on the top of the bolt head.

7.b Nuts. Perform proof load tests according to ASTM F606, Section 4.2, at the minimum frequency specified in ASTM A563, Section 9.3, or AASHTO M 292 (ASTM A194), Section 4.4, as applicable.

If nuts are to be galvanized, perform testing after galvanizing, overtapping, and lubricating. Determine the thickness of zinc coating on galvanized nuts by taking measurements on the wrench flats.

7.c Washers. If galvanized washers are supplied, perform hardness testing after galvanizing. Remove the galvanized coating before taking hardness measurements.

If galvanized washers are supplied, measure the thickness of zinc coating.

7.d Assembly Testing and Installation. Manufacturers and suppliers of bolt, nut, and washer assemblies are required to perform initial rotational-capacity tests on all plain (uncoated) and galvanized bolt, nut, and washer assemblies before delivery to the fabricator or contractor. Test galvanized assemblies after galvanizing. Washers are required as part of the test, even if not required as part of the installation procedure. Perform rotational capacity testing according to ASTM F3125, except as modified by the AASHTO Bridge Construction Specifications (2017, Edition 4) Section 11.5.5.4.2, PTM No. 427, and as follows, unless otherwise approved by PennDOT:

- When DTIs are planned for use in the assembly, omit the DTIs from the rotational capacity test.
- Test each bolt production lot, nut lot, and washer lot in combination as an assembly. If washers are not required as part of the installation procedure, do not include in the lot identification.
- Assign a rotational-capacity lot number to each combination of lots tested.
- Test a minimum of two assemblies per rotational-capacity lot.
- Test the bolt, nut, and washer assembly in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device. Test bolts too short to test in a calibrator according to PTM No. 427.

7.d.1 Installation. Install, test, and inspect high strength bolt assemblies as specified in Section 1050.3(c)7, according to PTM No. 427, and PTM No. 429, unless otherwise specified.

8. Documentation. Report the results of all tests (including zinc coating thickness) on the appropriate test reports as required in the applicable PennDOT, AASHTO, and/or ASTM standards and as specified below. Report the location where tests were performed and date of testing. Ensure that the manufacturer or distributor performing tests certifies that the results recorded are accurate.

8.a Mill Test Report (MTR). Furnish a MTR for all mill steel used in manufacturing bolts, nuts, and washers. Indicate where the material was melted and manufactured.

8.b Manufacturer Certified Test Report (MCTR). Provide a MCTR for each item furnished. Ensure that the manufacturer performing the rotational-capacity test include the following on the MCTR:

- The Lot Number of each of the items tested.
- The Rotational-Capacity Lot Number.
- The results of required tests.

- The location where tests were performed and date of testing.
- Certification that the MCTR's for the items conform to this specification and the applicable AASHTO or ASTM standards.
- The location where the bolt, nut, and washer assembly components were manufactured and coated.

8.c Distributor Certified Test Report (DCTR). Ensure that the distributor performing tests furnish a certified test report including the following:

- The MCTR for the various bolt, nut, and washer assembly components.
- The results of all required tests, including the rotational-capacity test if performed by the distributor instead of the manufacturer.
- The location where tests were performed and date of testing.
- The Rotational-Capacity Lot Number.
- Certification that the MCTR's conform to this specification and the applicable AASHTO or ASTM standards.

(e) Welded Stud Shear Connectors.

1. Materials. Provide shear connector studs conforming to AASHTO M 169 (ASTM A108), cold drawn bars, Grade 1015, 1018, or 1020, either semi-or fully-killed. If flux retaining caps are used, furnish caps of low carbon grade steel suitable for welding and conforming to ASTM A109.

2. Testing. Determine tensile properties of either bar stock after drawing or of finished studs according to the applicable sections of ASTM A370. Perform tensile tests of finished studs on studs welded to test plates using a test fixture similar to that shown in Figure 7.2 of AASHTO/AWS D1.5M/D1.5 - 2015. If fracture occurs outside of the middle half of the gage length, repeat the test.

The required tensile properties are:

Tensile Strength	60,000 psi (min.)
Yield Strength*	50,000 psi (min.)
Elongation	20% in 2 inches (min.)
Reduction of area	50% (min.)

* As determined by a 0.2% offset method.

3. Finish. Provide finished studs of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends, or other injurious defects. Produce finish by cold drawing, cold rolling, or machining.

4. Certification. Provide the manufacturer's certification that the studs, as delivered, conform to the material requirements of this section. Furnish certified copies of in-plant QC test reports to the Representative upon request.

5. Check Samples. If required, provide check samples of studs of each type and size used under the contract. The Representative will select the samples.

(f) Steel Forgings and Steel Shafting.

1. Steel Forgings. Furnish steel forgings conforming to AASHTO M 102 (ASTM A668), Classes C, D, F, or G.

2. Cold-Finished Carbon Steel Shafting. Furnish cold-finished carbon steel shafting conforming to AASHTO M 169 (ASTM A108), UNS Designations G10160-G10300, inclusive, unless otherwise indicated or specified.

(g) Steel Castings.

1. Mild Steel Castings. Furnish steel castings for use in highway bridge components conforming to AASHTO M 103 (ASTM A27). Provide steel of Grade 70-36, Class 1 or 2 as indicated, unless otherwise specified.

2. Chromium-Alloy Steel Castings. Furnish chromium, alloy-steel castings conforming to AASHTO M 163 (ASTM A743), Grade CA 15, unless otherwise indicated or specified.

3. Quality of Work and Finish. Furnish castings true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow-holes, and other defects in positions affecting the castings' strength and value for the service intended. Provide boldly filleted angles and sharp and perfect arrises.

The Contractor may correct defects not affecting the strength and value of the casting for the service intended if allowed in writing by the Chief Bridge Engineer. The Representative may reject castings containing:

- A blow-hole having a length greater than 1 inch, a cross-sectional area greater than 1/2 square inch, or a depth greater than 1/2 inch.

- A group of holes in a straight line with a total length greater than or equal to 1 foot, measured on the surface of the casting, and with an aggregate length greater than 1 inch.

4. Testing.

4.a Major Castings. Major castings are those subject to high loading whose failure in service would cause major damage (e.g., bridge bearings or machinery parts in movable bridges). All castings over 1,000 pounds are major castings. Test major castings by radiographing with x-ray or gamma ray apparatus according to ASTM E1030 and E186, E280 or E446, as applicable, and according to Table A below.

4.b Minor Castings. Minor castings are those whose failure would not lead to failure of main bridge members (e.g., scuppers or gratings). Test minor castings by suspending them and hammering them all over.

4.c Rejection. The Representative may reject castings that contain cracks, flaws, or other defects that appear during or after testing.

(h) Iron Castings.

1. Gray Iron Castings. Furnish gray iron castings conforming to AASHTO M 105 (ASTM A48), Class 35B, unless otherwise indicated or specified.

For castings subject to traffic loads furnish gray iron castings conforming to AASHTO M 105 (ASTM A48), Class 35B and AASHTO M 306, unless otherwise indicated or specified.

2. Malleable Iron Castings. Furnish malleable iron castings conforming to ASTM A47, Grade 32510, unless otherwise indicated or specified.

3. Ductile Iron Castings. Furnish ductile iron castings conforming to ASTM A536, Grade 60-40-18, unless otherwise indicated or specified. In addition to the specified test coupons, test specimens from parts integral with the castings, such as risers, for castings having a weight more than 1,000 pounds. Ensure that the required quality is obtained in the castings in the finished condition.

TABLE A
Severity Levels - Radiographically Inspected Castings*

Specification ASTM Designation	Discontinuity Type Designation	Acceptable** Severity Level	Remarks
E446 up to 2 inches	A	3	
	B	3	
	Ca	3	
	Cb	3	
	Cc	3	
	Cd	3	
	D	-	None Allowed
	E	-	None Allowed
	F	-	None Allowed
	G	-	None Allowed
E186 2 inches to 4 1/2 inches	A	3	
	B	3	
	Ca	2	
	Cb	3	
	Cc	3	
	D	-	None Allowed
	E	-	None Allowed
	F	-	None Allowed
E280 4 1/2 inches to 12 inches	A	3	
	B	3	
	Ca	2	
	Cb	3	
	Cc	3	
	D	-	None Allowed
	E	-	None Allowed
	F	-	None Allowed

* Radiograph all critical areas, but not less than 25% of each casting, or 25% of all castings, as indicated or as directed.

** If unacceptable defects are found in more than 10% of the radiographs, radiograph 100% of castings until the accumulated rejection level falls to 10% or less. The Contractor may then resume testing 25% of castings.

4. Quality of Work and Finish. Furnish iron castings true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting the castings' strength and value for the service intended. Provide boldly filleted angles and sharp and perfect arrises.

5. Cleaning. Remove scale and sand from all castings to provide a smooth, clean, and uniform surface.

(i) Bronze Bearing and Expansion Plates. AASHTO M 107 (ASTM B22), Alloy No. C91100 or C91300, except with a maximum of 2 1/2% lead, unless otherwise indicated or specified.

If indicated, make surfaces permanently self-lubricated. Provide a coefficient of friction of less than 0.10 or as indicated.

(j) Steel Pipe.

1. Pipe and Couplings. ASTM A53

2. Flanges and Pipe Fittings. ASTM A338

3. Welded Fittings. ASTM A234

4. Threaded Parts. Apply one coat of primer to all threads immediately before assembly. Wipe clean after assembly.

(k) Low-Alloy Steel Pipe.

1. Pipe and Couplings. Manufactured from low-alloy steel AASHTO M 270 (ASTM A709), Grade 50 or Grade 50W, Type 2 or AASHTO M 270 (ASTM A709) Grade 50W, and conforming to either ASTM A53, or to ASTM A714, Class 4, Grade V.

2. Flanges and Pipe Fittings. ASTM A338

3. Welding Fittings. ASTM A234

4. Threaded Parts. Apply one coat of primer to all threads immediately before assembly. Wipe clean after assembly.

(l) Not Used.

(m) Steel Tubing. ASTM A500 or ASTM A501

(n) Cast Iron Pipe. ASTM A74 or ASTM A377

(o) Not Used.

(p) Sheet Copper. ASTM B152, and conforming to the requirements of the Embrittlement Test, ASTM B152 Section 11.2 and ASTM B577.
Make lapped joints by soldering or by riveting and soldering.

(q) Sheet Zinc. ASTM B69, Type II.
Make lapped joints by soldering.

(r) Sheet Lead. Common desilverized lead A, according to ASTM B29 for pig lead.

(s) Galvanizing. From a galvanizer listed in Bulletin 15 and as follows:

1. General. If indicated or specified, galvanize materials according to the applicable material specifications. If the applicable material specifications do not include galvanizing, galvanize according to ASTM A153; ASTM B633; ASTM A392, Class 2 coating; ASTM B695 and B696; AASHTO M 111(ASTM A123); or AASHTO M 232 (ASTM A153), as applicable.
Test for the specified weight of galvanizing according to AASHTO T 65 (ASTM A90).
Comply with ASTM A143 and ASTM A385.
Before galvanizing, blast beams and girder to SSPC-SP6 (commercial blast). Solvent wipe to SSPC-SP1 prior to blast cleaning as necessary. Grind cut edges as needed to remove any skim,scale or deleterious material that is present.
2. Repair of Damaged Galvanizing. After erecting galvanized material in place, repair according to ASTM A780.

3. Quenching after Galvanizing. Quenching after galvanizing is allowed for the following items:

- Non-welded secondary bridge members
- Railings
- Drainage Scuppers
- Downspouts
- Inlet grates

- Utility brackets
- Angle Supports
- Embedded plates

Quenching after galvanizing is not allowed for the following items without approval of the Engineer:

- Primary bridge members
- Welded secondary members
- Sign Structures
- Traffic and lighting poles
- Any member to be painted after galvanizing

Items not listed may not be quenched without approval of the Engineer.

(t) Welding Material. AASHTO/AWS D1.5M-D1.5-2015, modified as specified in Section 1105.03(m)1.

(u) Paint. Section 1060.2

(v) Certification. Section 106.03(b)3

(w) Eyebars. Acceptable grades include:

- Structural steel for bridges, AASHTO M 270 (ASTM A709), Grade 36, ASTM A36.
- Structural steel for bridges, AASHTO M 270 (ASTM A709), Grades 50, 50W, and HPS 50W, ASTM A572, Grade 50, ASTM A588, Grades A, B, and C only.

1105.03 FABRICATION—

(a) Straightening Material and Curving Rolled Beams and Welded Girders. Section 1050.03(c)5 and as follows:

1. Materials.

1.a General. Flanges of curved, welded girders may be cut to the radii as indicated or curved by the application of heat as specified in Sections 1105.03(a)2 through 1105.03(a)8. Do not heat straighten or heat curve steels that are manufactured to a specified minimum yield point greater than 50,000 pounds per square inch without approval.

1.b. High Performance Steel. Section 1105.02(a)3.a. Use procedures approved by the Chief Structural Materials Engineer when applying short term application of heat to High Performance Steel for heat curving, heat straightening or camber and sweep adjustments. Limit heat to 1,100F maximum unless otherwise approved.

2. Type of Heating. Curve beams and girders by either continuous or V-type heating, unless otherwise approved.

2.a Continuous Heating. For the continuous method, heat a strip or intermittent strips along the edge of the top and bottom flange approximately simultaneously depending on flange widths and thicknesses. Use a strip of sufficient width and temperature to obtain the required curvature.

2.b V-type Heating. For the V-type heating, heat the top and bottom flanges in truncated triangular or wedge-shaped areas having their base along the flange edge and spaced at regular intervals along each flange. Use the spacing and temperature necessary to obtain the required curvature and to allow heating to progress along the top and bottom at approximately the same rate. Terminate the apex of the truncated triangular area applied to the inside flange surface just before the junction of the web and the flange is reached. When heating the inside flange surface (the surfaces that intersect the web), do not apply heat directly to the web. If the radius of curvature is 1,000 feet or more, extend the apex of the truncated triangular heating pattern applied to the outside flange surface to the juncture of the flange and web. If the radius of curvature is less than 1,000 feet, extend the apex of the truncated triangular heating pattern applied to the outside flange surface past the web for a distance equal to one-eighth of the flange or 3 inches, whichever is less. For the truncated triangular pattern, provide an included angle of approximately 15 to 30 degrees, but do not exceed 10 inches for the base of the triangle. Do not make variations in the patterns prescribed above unless allowed.

For both types of heating, heat the flange edges that will be on the inside of the horizontal curve after cooling. Heat both the inside and outside flange surfaces only if the flange thickness is 1 1/4 inches or greater. Heat the two surfaces concurrently.

3. Geometric Limitations for Heat Curving. Heat curving of rolled beams and constant depth welded I-section plate girders will be allowed if all of the following criteria specified in Section 1105.03(a)3.a through Section 1105.03(a)3.d below are satisfied.

3.a Cross-Sectional Criteria.

- $R > 1{,}000$ feet, if ($t_f > 3.0$ in.) or ($b > 30.0$ in.), otherwise $R > 150$ feet
- $\Psi \leq 2.0$
- $\Psi_f \geq 0.20$
- $t_{nf} \leq t_f$

in which:

$$\Psi = \frac{b_{nf}t_{nf} + bt_f + D_w t_w}{b_{nf}t_{nf} + bt_f}$$

$$\Psi_f = \frac{b_{nf}t_{nf}}{bt_f} \leq 1.0$$

where:

R = horizontal radius of curvature measured to the centerline of the girder web
b = width of wider flange (inch)
b_{nf} = width of narrower flange (inch)
D_w = clear distance between flanges (inch)
t_f = thickness of wider flange (inch)
t_{nf} = thickness of narrower flange (inch)
t_w = web thickness (inch)

3.b Minimum Radius for Doubly-Symmetric Beams and Girders. The horizontal radius of curvature measured to the centerline of web, in inches, for heat curved doubly-symmetric beams and girders cannot be less than a value calculated from the following:

- If $\frac{D_w}{t_w} > \frac{592}{\sqrt{F_{yw}}}$, then

$$R = 0.0365\,\frac{b}{\Psi}\left(\frac{D_w}{t_w}\right)^2$$

- Otherwise

$$R = \frac{12{,}800b}{F_{yw}\Psi}$$

where:

F_{yw} = specified minimum yield strength of a web (kilopound per square inch)

3.c Minimum Radius for Singly-Symmetric Beams and Girders. The horizontal radius of curvature measured to the centerline of web, in inches, for heat curved singly-symmetric beams and girders cannot be less than that calculated for doubly-symmetric members in Section 1105.03(a)3.b. Additionally, for singly-symmetric girders with Ψ greater than or equal to 1.46, and with Ψ_f less than Ψ_{fo}, the radius cannot be less than the value calculated from the following:

$$R = \left[1.43\Psi\left(1 - \frac{\Psi_f}{\Psi_{fo}}\right)^2 + 1\right]\left(\frac{12{,}800b}{F_{yw}\Psi}\right)$$

in which:

$$\Psi_{fo} = 0.68\Psi - 0.79$$

3.d Minimum Radius for Hybrid Girders. Heat curving of hybrid girders which meet the following criteria will be allowed:

- $\eta_w \leq \eta_f$, and
- $\eta_w = \eta_f$ if $\eta_f < 1$
- $b_{yf} > b_{yfw}$ if $\eta_f < 1$

in which:

$$\eta_f = \frac{F_{yfw}}{F_{yf}}$$

$$\eta_w = \frac{F_{yw}}{F_{yf}}$$

where:

F_{yfw} = yield stress of flange with lower yield stress (kilopound per square inch)
F_{yf} = yield stress of flange with higher yield stress (kilopound per square inch)
F_{yw} = yield stress of web (kilopound per square inch)
b_{yfw} = width of flange with lower yield stress (inch)
b_{yf} = width of flange with higher yield stress (inch)

For hybrid sections with η_f = 1 and η_w < 1, the horizontal radius of curvature measured to the centerline of the girder, in inches, cannot be less than the minimum radius determined from Section 1105.03(a)3.b and Section 1105.03(a)3.c, with F_{yf} substituted for F_{yw} in Section 1105.03(a)3.c.

For hybrid sections with η_f < 1, the horizontal radius of curvature measured to the centerline of the girder, in inches, cannot be less than the minimum radius determined from Section 1105.03(a)3.b. Additionally, for girders with Ψ_{fo} greater than or equal to $0.2\sqrt{\eta_f}$ and with Ψ_f less than $\frac{\Psi_{fo}}{\sqrt{\eta_f}}$, the radius cannot be less than that determined as:

$$R = \left(1.43\left(1 - \frac{\Psi_f\sqrt{\eta_f}}{\Psi_{fo}}\right)^2 * \Psi + 1\right)\left(\frac{12{,}800b}{F_{yw}\Psi}\right)$$

4. Temperature. Conduct the heat-curving operation in such a manner that the steel temperature does not exceed 1,150F as measured by temperature indicating crayons or other suitable means. Do not artificially cool the girder until after it naturally cools to 600F. Obtain approval for the method of artificial cooling.

5. Position for Heating. Heat-curve the girder with the web in either a vertical or a horizontal position.

If curved in the vertical position, brace or support the girder in such a manner that the tendency of the girder to deflect laterally during the heat-curving process will not cause the girder to overturn.

If curved in the horizontal position, support the girder near its ends and at intermediate points, as necessary, to obtain a uniform curvature. Do not allow the bending stress in the flanges due to the dead weight of the girder to exceed the usual allowable design stress. Maintain intermediate safety catch blocks at the mid-length of the girder within 2 inches of the flanges at all times during the heating process to guard against a sudden sag due to plastic flange buckling.

6. Sequence of Operations. Heat-curve the girder in the fabrication shop before it is painted. Conduct the heat curving operation either before or after all the required welding of transverse intermediate stiffeners is completed. However, unless provisions are made for girder shrinkage, locate and attach connection plates and bearing stiffeners after heat curving. If longitudinal stiffeners are required, heat-curve or oxygen-cut them separately and then weld them to the curved girder. When cover plates are to be attached to rolled beams, attach them before heat curving if the total thickness of one flange and cover plate is less than 2 1/2 inches and the radius of curvature is greater than 1,000 feet. For other rolled beams with cover plates, heat-curve the beams before the cover plates are attached; either heat-curve or oxygen-cut cover plates separately, then weld them to the curved beam.

7. Camber. Camber girders before heat curving. Obtain camber for rolled beams using approved heat-cambering or cold cambering methods. For plate girders, cut the web to the prescribed camber with suitable allowance for shrinkage due to cutting, welding, and heat-curving. However, if permitted, correct moderate deviations from specified camber by a carefully supervised application of heat. Correct deviations from the specified camber according to Publication 135.

8. Measurement of Curvature and Camber. Measure horizontal curvature and vertical camber after all welding and heating operations are completed and the flanges have cooled to a uniform temperature. Check horizontal curvature with the girder in the vertical position.

(b) Finish. Finish exposed work. Shear, flame cut, and chip carefully and accurately. Make sharp corners and round edges by grinding or other acceptable means.

When AASHTO M 270 (ASTM A709), Grade 50W, Grade HPS 70W, Grade HPS 100W, or ASTM A588, Grades A, B, and C weathering steels are specified for beams or girders, blast clean only the fascia side of exterior beams or girders according to SSPC-SP6, Commercial Blast Cleaning. At a minimum, blast clean from the top outside (fascia) edge of the top flange to the inside edge of the bottom flange including the bottom of the bottom flange. Blast clean the faying surfaces of splices and connections of all structural elements according to SSPC-SP-10-85. Re-blast unpainted elements that remain unassembled for a period of 12 months following the initial cleaning.

(c) Bolt Holes.

1. General. Unless otherwise specified, only punch or drill holes for bolts as indicated below. Provide a standard hole diameter for bolts smaller than 1.0 inch in diameter as the nominal diameter of the bolt plus 1/16 in. For bolts 1.0 inch in diameter and larger, provide the hole diameter as the nominal diameter of the bolt plus 1/8 in.

Unless subpunching and reaming is specified, holes may be punched full-size, 1/16 inch larger than the nominal diameter of the bolt, in material forming parts of a member composed of not more than five thicknesses of metal 1/16 inch larger than the nominal diameter of the bolts whenever the thickness of the material is not greater than 3/4 inch for structural steel, 5/8 inch for high-strength steel or 1/2 inch for quenched and tempered alloy steel. If there are more than five thicknesses or if any of the main material is thicker than 3/4 inch for structural steel, 5/8 inch for high-strength steel, or 1/2 inch for quenched and tempered alloy steel, either subdrill and ream or drill all holes full size.

When subpunching and reaming is specified, either subpunch (or subdrill if thickness limitation governs) all holes 3/16 inch smaller than the nominal diameter of the bolts and, after assembling, ream to 1/16 inch larger than the nominal diameter of the bolts.

Holes in fillers, cross frames, lateral bracing components and corresponding holes in connection plates between girders and cross frames or lateral components not designated as primary members may be punched full size. Do not punch full size holes in longitudinal main load carrying members, transverse floor beams and any components designated as fracture critical (FCM); this restriction does not apply to fillers used in connections of FCMs. Where punching full size is permitted, holes may also be formed by plasma cutting or water-jetting as approved by the Chief Structural Materials Engineer.

If reaming is not specified, drill all holes full size.

When indicated, provide enlarged or slotted holes with high-strength bolts. Obtain advance approval from the Chief Structural Materials Engineer to produce round or slotted holes using plasma, laser, water jet, or oxygen-acetylene methods. Provide samples when requested, to verify dimensional accuracy and edge quality in advance of fabrication for the size of places to be used in production.

2. Punched Holes. Furnish dies with diameters that do not exceed the diameter of the corresponding punch by more than 1/16 inch. Ream any holes that must be enlarged to admit the bolts. Cut holes clean without torn or ragged edges. The slightly conical hole that naturally results from punching operations is considered acceptable.

3. Reamed or Drilled Holes. Furnish reamed or drilled holes perpendicular to the member, cylindrical, and conforming to the size requirements specified in Section 1105.03(c)1. Where practical, direct reamers by mechanical means. Remove burrs on the outside surfaces. Use twist drills, twist reamers, or rotobroach cutters for reaming and drilling. Assemble and securely hold connecting parts while they are being reamed or drilled. Match mark the connecting parts before disassembling.

4. Accuracy of Holes. Furnish holes not more than 1/32 inch larger in diameter than the true decimal equivalent of the nominal diameter. The slightly conical hole that results from punching operations is acceptable. Ensure that the width of slotted holes produced by flame cutting or a combination of drilling and flame cutting or punching and flame cutting are not more than 1/32 inch greater than the nominal width. Grind the flame cut surface smooth to obtain a maximum surface roughness of ANSI 1 mil.

5. Computer Numerically Controlled Drilled Field Connections. Instead of reaming sub-sized holes or drilling full-sized holes while assembled, the Contractor may use computer numerically controlled (CNC) drilling or punching equipment to drill or punch full-sized bolt holes in unassembled pieces, connections, and templates. The Contractor may use CNC equipment to either drill or punch holes through individual pieces or drill through any combination of pieces held tightly together. Provide full-size punched holes that meet the requirements of Section 1105.03(c)2.

If CNC drilling or punching equipment is used, demonstrate the accuracy of the drilling or punching procedure by means of check assemblies as specified in Section 1105.03(g).

6. Holes for Turned Bolts or Other Approved Bearing Type Bolts. Subpunch or subdrill all holes 3/16 inch smaller than the nominal diameter of the bolt for turned bolts or other approved bearing-type bolts. After assembling, either ream, drill to a steel template, or drill from the solid. Provide a driving fit for the finished holes as indicated or according to the special provisions.

(d) Preparation of Field Connections. Unless otherwise approved, prepare bolt holes for field connections and field splices as follows:

- Field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames – subpunch or subdrill and subsequently ream while assembled or drill full size through a steel template while assembled.

- Holes in cross frames, lateral bracing components and the corresponding hole in connection plates between girders and cross frames or lateral components not designated as primary member material may be punched full size. Do not punch holes in longitudinal main load carrying members, transverse floorbeams and any components designated as fracture critical members (FCMs).

- Field splices of rolled beam stringers continuous over floor beams or cross frames – the fabricator may drill full size unassembled to a steel template.

- Floor beams or cross frames – the fabricator may drill full size unassembled to a steel template.

- Floor beam and stringer field end connections – subpunch and ream while assembled or drill full size to a steel template while assembled.

For any connection, instead of subpunching and reaming, or subdrilling and reaming, the fabricator may drill holes full size with all thicknesses of material assembled in proper position.

When using a steel template, ream and drill full size all field connection holes through the template after the template has been placed in the proper position and angle and firmly bolted into place. Use templates that are exact duplicates for reaming matching members or the opposite faces of a single member. Accurately locate templates used for connections on like parts or members so that the parts or members are duplicates and require no match-marking.

(e) Accuracy of Hole Group.

1. Accuracy Before Reaming. Punch full size, subpunch, or subdrill holes such that after assembling, and before any reaming is done, a cylindrical pin 1/8 inch smaller in diameter than the nominal size of the hole may be entered perpendicularly to the face of the member without drifting in at least 75% of the contiguous holes in the same plane. The Representative will reject pieces that do not conform to this requirement. Also, the Representative may reject any piece that contains at least one hole that will not pass a pin 3/16 inch smaller in diameter than the nominal size of the hole.

2. Accuracy After Reaming. After holes are reamed or drilled, ensure that the offset between adjacent thicknesses of metal is no greater than 1/32 inch for at least 85% of the holes in any contiguous group.

For all steel templates, provide hardened steel bushings in holes accurately dimensioned from the centerlines of the connection as inscribed on the template. Use the centerlines to accurately locate the template from the milled or scribed ends of the members.

(f) Bolting. Clean surfaces of metal in contact before assembling. Assemble, pin, and firmly draw together the parts of a member before drilling, reaming, or bolting. If necessary, dismantle assembled pieces to remove burrs and shavings produced by the operation. Furnish members free from twists, bends, and other deformation.

When assembling, allow enough drifting to bring the parts into position, however, do not allow the drifting to enlarge the holes or distort the metal.

(g) Preassembly of Field Connections.

1. General. As necessary, preassemble field connections of main members of trusses, arches, continuous beams, plate girders, bents, towers and rigid frames before erection to verify the geometry of the completed structure or unit and to verify or prepare field splices.

Submit an appropriate method of preassembly for approval. Provide a method and details of assembly consistent with the erection procedure indicated on the approved erection plans and camber diagrams. At a minimum, provide a preassembly procedure consisting of assembling three contiguous panels accurately adjusted for line and camber.

Provide a procedure for progressive assemblies consisting of at least one section or panel of the previous assembly (repositioned if necessary and adequately pinned to ensure accurate alignment) plus two or more sections or panels added at the advancing end. For structures longer than 150 feet, furnish a procedure for assemblies not less than 150 feet long regardless of the length of individual continuous panels or sections. The Contractor may start the sequence of assembly from any location in the structure and proceed in one or both directions provided that the preceding requirements are satisfied.

Use the Progressive Truss and Girder Assembly unless otherwise specified in the proposal.

2. Bolted Connections. For bolted connections, prepare holes as specified in Section 1105.03(c). Where applicable, assemble major components of compression members with finished-to-bear ends in full bearing, and then ream the sub-sized holes to the specified size.

3. Check Assembly-Numerically Controlled Drilling. When using numerically controlled, CNC drilling, furnish a check assembly for each major structural type of each project unless otherwise indicated or specified in the special provisions. Provide check assemblies consisting of at least three contiguous shop sections or, for a truss, all members in at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths (i.e., length between field splices). Base check assemblies on the proposed order of erection, joints in bearings, special complex points, and similar considerations. Special complex points include the portals of skewed trusses.

Use the first sections of each major structural type to be fabricated as the check assemblies.

Obtain approval for each CNC drilled check assembly before reaming or dismantling the assembly. If a check assembly fails to demonstrate that the required accuracy is being obtained for camber, alignment, accuracy of holes, and fit of milled joints, the Representative may require additional check assemblies. Additional check assemblies will be at no additional cost to the Department.

4. Field Welded Connections. Preassemble field welded connections as specified in Section 1105.03(g)1 and verify the fit of members, including the proper space between abutting flanges.

(h) Match-Marking. Match-mark connecting parts preassembled in the shop to ensure proper fit in the field. Furnish a diagram showing match-marks to the Representative.

(i) Connections Using Unfinished or Turned Bolts.

1. General. When unfinished bolts are specified, furnish unfinished or turned bolts conforming to ASTM A307, Grade A Bolts. Provide bolts with single self-locking nuts or double nuts unless otherwise indicated or specified in the special provisions. Use beveled washers where bearing faces have a slope of more than 20:1 with respect to a plane normal to the bolt axis.

For bolted connections fabricated with high-strength bolts, assemble connections as specified in Section 1105.03(j).

2. Turned Bolts. Provide turned bolts with an ANSI roughness rating value of 125 for the surface of the body of the bolts. Furnish hexagonal heads and nuts with standard dimensions for bolts of the nominal size specified or the next larger nominal size. Provide thread diameters equal to the body of the bolt or the nominal diameter of the bolt specified. Carefully ream holes for turned bolts with bolts furnished to provide for a light driving fit. Furnish bolts with threads that are entirely outside of the holes. Provide a washer under the nut.

(j) Connections Using High Strength Bolts. Section 1050.3(c)7 and as follows:

1. General. Furnish bolts, nuts, and washers as specified in Section 1105.02(d). Provide bolt holes as specified in Section 1105.03(c). When Turn-of-Nut Tightening Method is used, provide hardened washers as specified in Section 1105.02(d)5, under the element turned in tightening.

2. Bolted Parts. Use steel for all material within the grip of the bolt; do not use compressible material such as gaskets or insulation within the grip. Ensure that bolted steel parts solidly fit together after the bolts are tightened. Bolted steel parts may be coated or uncoated. Do not exceed a slope of 20:1 for the surfaces of parts in contact with the bolt head or nut with respect to a plane normal to the bolt axis.

3. Surface Conditions. At the time of assembly, ensure that all joint surfaces, including surfaces adjacent to the bolt head and nut, are free of scale (except tight mill scale), dirt, or other foreign material. Remove burrs that would prevent solid seating of the connected parts.

Paint is allowed on the faying surface in connections except for slip-critical connections as defined in Article 6.13.2.1.1 of the LRFD Specification. Prepare faying surfaces for slip-critical connections according to the following requirements, as applicable:

3.a Non-coated Joints. Exclude paint, including any inadvertent over spray, from the area within the bolt pattern and areas closer than one bolt diameter, but not less than 1 inch, from the edge of any hole.

3.b Joints with Painted Faying Surfaces. Blast clean joints specified to have painted faying surfaces. Except as specified in Section 1105.03(j)3.c, coat the joints with a Class A or B paint according to Section 6.13.2.8 of the LRFD Specification.

3.c Coatings with Low Slip Coefficient. If allowed and provided that the mean slip coefficient is established (tested according to Section 6.13.2.8 of the LRFD Specification) and the allowable slip load per unit area is achieved, the Contractor may use a coating providing a slip coefficient less than 0.33.

3.d Minimum Coating Curing Time. Do not assemble coated joints before the coating has cured for the minimum time used in the qualifying test.

3.e Galvanized Faying Surfaces. Hot-dip galvanize faying surfaces specified to be galvanized according to AASHTO M 111 (ASTM A123).

3.f Existing Field Surfaces. For connections to existing structures, provide surface conditions as indicated.

(k) Plate Cut Edges.

1. Edge Planning. Plane, mill, grind, or thermal cut to a depth of 1/4 inch the sheared edges of plates more than 5/8 inch thick that carry calculated stress.

2. Thermal Cutting and Other Cutting Methods. Section 1105.03(p).

3. Visual Inspection and Repair of Plate Cut Edges. Perform visual inspection and repair of plate cut edges according to the AASHTO/AWS D1.5M/D 1.5-2015.

(l) Not used.

(m) Welding. All Weld Procedure Specifications must be based upon Weld Procedure Specification (WPS) qualification tests, pre-tests and verification tests. All non-Fracture Critical (FCM) approved PQR's are valid indefinitely unless application of the WPS results in consistently substandard welds. Submit WPS for review and acceptance not more than 60 months in advance of the production welding. WPS qualification welding must be witnessed by a Department representative unless otherwise approved by the Chief Structural Materials Engineer.

For welding aluminum structures, conduct welding, welder qualification, prequalification of weld details and inspection of welds according to AWS D1.2M/D1.2-2014. For the purpose of establishing weld acceptance criteria, define all welded aluminum structures as 'Class II' structures.

For welding sheet steel, conduct welding, welder qualification, prequalification of weld details and inspection of welds according to AWS D1.3M/D1.3-2008.

For welding stainless steel or stainless steel to carbon steel, conduct welding, welder qualification, prequalification of weld details and inspection of welds according to AWS D1.6M/D1.6-2007.

Unless otherwise indicated or specified, for tubular steel structures, conduct welding, welder qualifications, prequalification of weld details, and inspection of welds according to AASHTO/AWS D1.1M/D1.1-2015 subject to the following limitations:

- Use on low-hydrogen electrodes
- Provide a minimum preheat and interpass temperature of at least 50F.

Conduct welding, welder qualifications, prequalification of weld details, and inspection of welds according to the AASHTO/AWS D1.5M/D1.5-2015.

Do not weld or tack brackets, clips, shipping devices or other material not indicated or specified in the special provisions to any member unless shown on the shop drawings and approved.

1. Weld structural steel for highway bridges according to the AASHTO/AWS D1.5M/ D1.5-2015 with the following modifications:

- Section 1.1.3. Revise completely as follows:
  All references to acceptance or approval will denote acceptance or approval by the Engineer. The term Engineer refers to the Chief Bridge Engineer or the Chief Bridge Engineer's representative; namely, the Chief Structural Materials Engineer.

- Section 1.3.1. Delete reference to EGW. ESW may be used if approved by the Engineer.

- Section 1.3.3. Delete this section.

- Section 1.3.4 Add: Electrosag Welding (ESW) may be used if preapproved by the Engineer.

- Section 1.3.7. Welding of Ancillary Products. Delete this section.

- Section 2.3.3. Plug and Slot Welds. Delete this section.

- Section 2.9. Details of Plug and Slot Welds. Delete this section.

- Section 2.17.6.1 Revise second sentence as follows:
  Design connections or splices made with fillet welds for the average of the calculated stress and the strength of the member, but no less than 75% of the strength of the member.

- Section 3.5.1.6(2). Revise completely as follows:
  Use web flatness tolerances for all girders according to the following equation and the Web Flatness Tolerance Table below.

$$0.75t\left(1+\frac{\frac{D}{t}-50}{150}\right)$$

Where, D = web depth, in.
t = web thickness, in.

Verify web flatness in all girder panels in the presence of the Department inspector. Flatness variations and locations exceeding the allowable tolerance must be documented. Submit a repair procedure to the Chief Structural Materials Engineer for review and approval before repair.

Web Flatness Tolerance Table																
Web Thickness, in.	Web Depth, in.															
	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
5/16	1/4	5/16	5/16	5/16	3/8	3/8	7/16	7/16	7/16	1/2	1/2	9/16	9/16	9/16	5/8	5/8
3/8	5/16	5/16	5/16	3/8	3/8	7/16	7/16	7/16	1/2	1/2	9/16	9/16	9/16	5/8	5/8	11/16
7/16	5/16	3/8	3/8	3/8	7/16	7/16	1/2	1/2	1/2	9/16	9/16	5/8	5/8	5/8	11/16	11/16
1/2	3/8	3/8	3/8	7/16	7/16	1/2	1/2	1/2	9/16	9/16	5/8	5/8	5/8	11/16	11/16	3/4
9/16	3/8	7/16	7/16	7/16	1/2	1/2	9/16	9/16	9/16	5/8	5/8	11/16	11/16	11/16	3/4	3/4
5/8	7/16	7/16	7/16	1/2	1/2	9/16	9/16	9/16	5/8	5/8	11/16	11/16	11/16	3/4	3/4	13/16
3/4	1/2	1/2	1/2	9/16	9/16	5/8	5/8	5/8	11/16	11/16	3/4	3/4	3/4	13/16	13/16	7/8
7/8	9/16	9/16	9/16	5/8	5/8	11/16	11/16	11/16	3/4	3/4	13/16	13/16	13/16	7/8	7/8	15/16

Note: For actual dimensions not shown, use the next higher value. For values beyond the table dimensions shown, calculate web flatness according to the equation above and round to the next higher 1/16-inch increment.

- Section 3.5.1.9. Revise the first paragraph in this section completely as follows:
  Fit bearing stiffeners as specified in Section 1105.03(u). Flatness tolerance of sole plates after welding as specified in Section 1111.03(c), Class B.

- Section 4.1.6. Delete this section.

- Table 4.2. Matching Filler Metal Requirements for WPSs Qualified according to 5.13. Delete all references to electroslag welding.

- Clause 4. Part E, Electrogas Welding (EGW). Delete this part.

- Clause 4. Part G, Plug and Slot Welds. Delete this part.

- Section 5.3. Duration. Add the following. Submit WPS for review and acceptance not more than 60 months in advance of the production welding.

- Section 5.14. Electrogas Welding. Delete this section.

- Table 5.4. Additional PQR Essential Variable Changes Requiring WPS Requalification for Electroslag or Electrogas Welding. Delete this table.

- Section 5.7.7.1. Delete this section in its entirety. FCAW-s is not allowed.

- Section 5.16.4. Delete EGW in Item (2).

- Section 5.19.5.2. Delete reference to EGW Specimens.

- Clause 6, Part B – Radiographic Testing (RT) of Groove Welds in Butt Joints. Digital Radiography is allowed with the approval of the Chief Structural Materials Engineer. If approved, code variations from Clause 6 will be incorporated into a formal procedure and included in the QC Plan.

- Section 6.7.1. Revise completely as follows:
  Non-destructively test complete penetration groove welds as specified in Section 1105.03(m)8.

- Section 6.7.1.1. Delete EGW.

- Section 6.7.1.2(2). Revise completely as follows:
  Twenty-five percent of each joint subject to compression or shear.

- Section 6.7.1.2(2)(d). Delete this section.

- Section 6.7.2.1. Revise the first sentence as follows:
  At least 12 inches will be tested in every 10-foot length and 12 inches of such welds less than 10 feet length of each size of weld and type joint in primary members including the end connections of such members.

- Section 6.7.8 Can be used if approved.

- Section 6.13.2 add “Steel produced with the Thermo-Mechanical Control Process (TMCP) are considered a variation and require submittal of independent procedures with performance mock-ups”.

- Annex K: use of PAUT must be approved by the Chief Structural Materials Engineer.

- Section 12.6. Consumable Requirements – Delete all references to optional supplemental diffusible hydrogen designator H16.

- Section 12.7.4, Period of effectiveness: 36 Months for all FCM WPS's, 60 Months for PQR's and fillet weld soundness test.

1.a Grades HPS 70W and HPS 100W. Conform to Section 1105.03(m)1 and the following additional requirements.

For final welds, only use the submerged arc and shielded metal arc welding processes. Remove all mill scale by grinding or blasting from the weld area of the Grade HPS 70W and Grade HPS 100W steel before welding.

Processes other than shielded metal arc welding (SMAW) may be approved, including GMAW, when the manufacturer's consumable certification shows that the deposited weld metal has a diffusible hydrogen level equivalent of H4 or less.

1.b Filler Metal Requirements.

1.b.1 Use filler metals that conform to AASHTO/AWS D1.5M/D1.5-2015, Table 4.1, Hydrogen control level H8 or less for AASHTO M 270/ASTM A709, Grade 50W, Grade HPS 50W or Grade HPS 70W, as applicable, for the base metal for all fillet welds, unless otherwise required by design or noted on the plans. Use "undermatched" welds for flange-to-web welds of Grades HPS 70W or HPS 100W when welded to Grade 50W or Grades HPS 50W and HPS 70W respectively. Use only electrodes with the designator "HZ" or "R", where "HZ" indicates the diffusible hydrogen level of either H4 or H8 depending on the preheat and where "R" indicates a moisture-resistant coating. The higher preheat and interpass temperatures listed in Table 1 also apply to H8 electrodes.

1.b.2 Make all 5/16 inch and smaller fillet welds in a single pass. Make all fillet welds larger then 5/16 inch with a root pass of sufficient size to prevent cracking.

1.b.3 Conform to the requirements for Grade 50W or Grade HPS 50W base metal, as listed in AASHTO/AWS D1.5M/D1.5-2015, Table 4.1, or those listed in Section 1105.03(m)1.c, at the Fabricator's option, for filler metals in all full penetration groove welds connecting a Grade HPS 70W plate to a Grade 50W or Grade HPS 50W plate.

Similarly, conform to the requirements for Grade HPS 70W base metal, as listed in AASHTO/AWS D1.5M/D1.5-2015, Table 4.1, or those listed in Section 1105.03(m)1.c, at the Fabricator's option, for filler metals in all full penetration groove welds connecting a Grade HPS 100W plate to a Grade HPS 70W plate.

1.c Groove Weld Requirements-Matching Base Metals. Conform to the following requirements for either two Grade HPS 70W plates or two Grade HPS 100W plates.

1.c.1 SAW Consumables. Use SAW consumables meeting the hydrogen control level of H4, as discussed in AASHTO/AWS D1.5M/D1.5-2015, Annex G, Section G6.2.2.1. Follow the minimum preheat and interpass temperature limits and other conditions listed in Table 1. Fabricators with multiple plants under a common umbrella of welding equipment, welding training and supervision, need to perform the Hd testing only once per combination of consumables for each location. Plants audited as a single facility by the AISC as part of their Quality Certification Program are considered one location. Multiple plants not falling under the AISC Single Facility audit definition are considered separate facilities and additional WPS and Hd tests are required.

1.c.1.a Grade HPS 70W SAW Consumables. Use electrodes conforming to Table 4.1 of AASHTO/AWS D.1.5M/D1.5-2015.

1.c.1.b Grade HPS 100W SAW Consumables. Use LA100 electrode with Mil800HPNi flux manufactured by Lincoln Electric Company.

1.c.1.c Alternate Grade HPS 100 SAW Consumables. In lieu of the filler metals for SAW in Section 1105.03(m)1.c.1.a and Section 1105.03(m)1.c.1.b, request approval of alternate consumables from the Engineer.

In addition to the requirements for WPS, qualification according to AASHTO/AWS D1.5M/D1.5-2015, when using "alternate" consumables, perform diffusible hydrogen (Hd) tests on the weld metal. Provide the full range of weld tests as required by AASHTO/AWS D1.5M/D1.5-2015 Section 12.6. Use minimum preheat and interpass temperatures with "alternate" consumables according to AASHTO/AWS D1.5M/D1.5-2015, Table 4.4. Provide a diffusible hydrogen level equivalent to 4 mL/100g or less in the deposited weld metal. Prepare Hd test specimens at the fabrication plant. Test specimens according to AWS A4.3. Test results in excess of 4 mL/100g are unacceptable, and a retest is required, with or without revised welding procedures. AASHTO/AWS D1.5M/D1.5-2015, Section 5.7.6, Exemption from Further Testing, is applicable, but WPS or Hd results are not transferable from fabricator-to-fabricator.

1.c.2 SMAW Consumables.

- Grade HPS 70W: E9018M-HZR (H8 or less)
- Grade HPS 100W: E110M-HZR (H4 only)

The designator "R", for moisture-resistant coating, is required for all SMAW electrode used for welding Grade HPS 70W and Grade HPS 100W.

Use SAW consumables and SMAW electrodes producing weld deposits meeting the requirements of AASHTO/AWS D1.5M/D1.5-2015, Table 4.3, except for single pass fillet welds (up to 1/4 inch maximum for SMAW and up to 5/16 inch for SAW), or welds that will be fully incorporated into a finished weld with satisfactory weathering characteristics.

1.d Qualification Testing. Filler Metal Procedure Qualification Test Requirements for groove (matching) welding of Grade HPS 70W are as listed in Table 4.1 of AASHTO/AWS D1.5M/D1.5-2015. For matching (groove) welds using Grade HPS 100W, meet the minimum properties equal to or greater than Base Metal requirements, according to ASTM A709 for Qualification, Pretest and Verification Test Requirements.

Filler metal qualification test requirements for all hybrid designs and undermatched fillet welds are listed in AASHTO/AWS D1.5M/D1.5-2015, Table 4.1, for the lowest strength base metal used in the hybrid design, as applicable.

Individually qualify WPSs for joint welding combinations of different strength Grades such as Grade HPS 70W to Grade 50W or Grade HPS 50W; or Grade HPS 100W to Grade HPS 70W according to AASHTO/AWS D1.5M/D1.5-2015, Clause 5. For example, when welding Grade 50W webs to Grade HPS 70W flanges will require a procedure plate composed of half Grade 50W and half Grade HPS 70W.

In addition to radiographic testing, all Procedure Qualification tests must be ultrasonically tested in conformance with the requirements of AASHTO/AWS D1. 5M/D1.5-2015, Clause 6, Part C. Evaluate according to AASHTO/AWS D1. 5M/D1.5-2015, Table 6.3 Ultrasonic Acceptance - Rejection Criteria - Tensile Stress. Disregard indications found at the interface of the backing bar regardless of defect rating.

1.e. Preheat and Interpass Temperature:

1.e.1 Matching Strength Welds. Use minimum preheat and interpass temperatures for "matching strength" fillet and groove welding for two Grade HPS 70W steel plates using consumables listed in Sections 1105.03(m)1.b.4.1 and .03(m)1.b.4.2, according to Table 1.

Limit the maximum interpass temperature for welding Grades HPS 70W and HPS 100W steel to 450F and 400F respectively. For hybrids, welds joining both grades, limit the maximum interpass temperature to 400F.

1.e.2 Undermatched Fillet Welds/ Fillet Welds on Hybrid Members. Use preheat/interpass temperature requirements according to Note (b) of Table 1.

1.e.3 Drying Preheat. As an absolute minimum for all permanent welds, apply to the joint a drying preheat sufficient to remove any existing moisture before to welding.

Table 1 Minimum Preheat and Interpass Temperature					
Thickness of Thickest Part at Point of Welding					
Grade	Welding Process (Base Metal)	To 3/4 in. inclusive	Over 3/4 in. to 1-1/2 in. inclusive	Over 1-1/2 in. to 2-1/2 in. inclusive	Over 2-1/2 in.
HPS 70W; HPS 100W	SAW; SMAW	50	125	175	225
Notes:					
(a) If satisfactory results are not achieved with the above minimum preheat and interpass temperatures during development of the WPS and increased preheat temperatures are used to produce a satisfactory PQR, use the higher preheat temperature during bridge fabrication used for the PQR.					
(b) Where joints are composed of base metals with different minimum preheats, use the highest of the minimum preheat and interpass temperature from above or from Table 4.4 in AASHTO/AWS D1.5M/D1.5-2015.					
(c) For fracture critical members, comply with the above requirements including the additional requirements of AASHTO/AWS D1.5M/D1.5-2015, Chapter 12.					

1.f Heat Input (HI).

1.f.1 SAW. For HPS Grade 70W or hybrid combinations of HPS Grade 70W and HPS Grade 100W, limit heat input to 40 kilojoules per inch, minimum; 90 kilojoules per inch maximum according to AASHTO/AWS D1.5M/D1.5-2015, Section 5.12. Heat inputs about 90 kilojoules per inch for Grade HPS 70W or hybrid Grade HPS 70W to Grade HPS 50W joints where multiple wire SAW applications are used may be approved if qualified according to the provisions listed herein.

For HPS Grade 100W, limit heat input to 40 kilojoules per inch, minimum; 70 kilojoules per inch maximum according to AASHTO/AWS D1.5M/D1.5-2015, Section 5.12.

1.f.2 SMAW. Use welding heat input parameters recommended by the individual consumable manufacturer.

1.g Backing. Whenever possible, use steel backing material for WPS test plates from the same grade as the weld test plates. For Production and Qualification welding of Grade HPS 70W, steel backing material for WPS test plates that is either Grades 50W or HPS 70W may be used. For Production and Qualification welding of Grade HPS 100W, steel backing material for WPS test plates that are either Grades 50W, HPS 70W, or 100W may be used.

For all cases, limit the maximum sulfur content of the backing material to 0.025% maximum.

2. Do not weld to flanges in tension areas unless indicated.

3. Show specification, grade, type, and any supplementary requirements for each steel indicated on the shop drawings.

4. Do not weld temporary fabrication and construction details, such as rails for deck finishing equipment, bar supports, or deck-forming devices, to beams, girders, or other main members, unless permitted. Identify locations of such welds on the shop drawings.

5. Do not use electroslag or electrogas welding.

6. Gas Metal Arc Welding (GMAW) and Flux Cored Arc Welding (FCAW) – Shop Application only.

6.a Primary Load Carrying Bridge Members. Do not use the GMAW or FCAW processes (including tack welding except as otherwise approved herein) for any of the following conditions:

- web-to-web welds[5];
- web-to-flange welds[5];
- flange-to-flange welds[5]; and
- welds on truss members and gusset plates[5].

Note 5: Including rolled shapes

For stiffener and connection plate welds to flanges and webs and for X-frames and diaphragms considered primary members, the fabricator may use the FCAW-G (gas shielded) process and the GMAW process, subject to the following restrictions:

- Use only GMAW spray and constant voltage pulsed spray transfer modes.
- Use only metal cored electrodes for GMAW on fracture critical members.
- Use only GMAW equipment with the following features:
  - A 'lock out' feature to prevent the operator from adjusting the equipment outside the approved WPS parameters.
  - An adaptive mode capable of automatically correcting amperage, etc. due to operator variations (stick-out, etc.) to maintain the desired transfer mode.

- Single-pass GMAW tack welds and root passes are allowed for all joints on all primary members provided the Contractor can demonstrate that such welds are completely re-melted by subsequent SAW passes.
- Other applications may be allowed by the Engineer if prior approval is received.

6.b Secondary Members and Other Welded Structures. Either the GMAW or FCAW-G process may be used for welding bridge drainage material, expansion dams, bearings, bracing, those X-frames and diaphragms not considered main members, soldier piles, sound barrier posts, and other welded structures. Both Globular and Short Circuit GMAW transfer modes are prohibited unless otherwise specifically approved or specified.

7. Do not use plug welds to repair misplaced holes.

8. Non-destructively test all groove welds in primary members according to the AASHTO/AWS D1.5M/D1.5-2015. Unless otherwise indicated or specified, use radiographic testing on butt joints. Use radiographic or ultrasonic testing for corner or "T" joints. Use magnetic particle testing according to AASHTO/AWS D1.5M/D1.5-2015, Section 6.7.2.

8.a Grade HPS 70W and HPS 100W. For non-fracture critical members, radiographically test 100% of all complete penetration groove welds for Grade HPS 70W steel plates, regardless of the type of stress in the plate.

Test fillet welds according to AASHTO/AWS D1. 5M/D1.5-2015, Section 6.7.2.1, on Grade HPS 70W and HPS 100W steel by magnetic particle testing. Use the yoke technique as described in AASHTO/AWS D1. 5M/D1.5-2015, Section 6.7.6.2, as specified in Section 1105.03(m) 1. The prod technique is not allowed. For non-fracture critical members, perform testing not less than 48 hours after completion of welding. For fracture critical members, comply with the above including any additional requirements of AASHTO/AWS D1.5M/D1.5-2015, Chapter 12.

9. All welding consumables (electrodes and electrode/flux combinations) used for welding of fracture critical members will conform to the diffusible hydrogen requirements of the AWS filler metal specifications optional supplemental designator H4 or H8 only.

10. Perform weld repairs according to specified welding code and Department approved procedure(s). Do not repair individual locations more than three times without written permission of the Engineer. Following the third unsuccessful attempt, submit a proposed repair procedure for review.

11. Do not repair any individual area on welded pole to base or splice plate to chord or gusset plate connections for luminaire supports, traffic signal supports, and sign structure supports more than one time without written permission of the Engineer.

(n) Weld Repairs and Geometric Corrections using Applied Heat. For non-fracture critical members only, refer to Publication 135 for pre-approved base metal repair procedures and heat correction procedures. The fabricator may use the pre-approved procedures after the Department's inspector has verified that the discontinuity to be repaired is covered by the specific procedure. Any repairs performed are subject to inspection by the Department's inspector.

(o) Not used.

(p) Thermal Cutting. Unless otherwise approved, cut steel and weld metal using oxy-fuel gas, air plasma arc, or oxygen plasma arc processes. Conduct cutting for all processes according to the AASHTO/AWS D1.5M/D1.5-2015. Do not submerge base metal in water during any process unless otherwise indicated.

1. Other Cutting Methods. Laser and water jet cutting may be used with approval from the Chief Structural Materials Engineer.

(q) Facing of Bearing Surfaces. Ensure that the surface finishes of bearing and base plates and other bearing surfaces in contact with each other or concrete conform to the ANSI surface roughness requirements defined in ANSI/ASME B46.1 and listed below:

• Steel slabs	ANSI 2 mils
• Heavy plates in contact with shoes to be welded	ANSI 1 mil
• Milled ends of compression members, finished-to-bear (milled or ground) ends of stiffeners and fillers	ANSI 0.5 mil
• Bridge rollers and rockers	ANSI 0.25 mil
• Pins and pin holes	ANSI 0.13 mil
• Sliding bearing	ANSI 0.13 mil
• Sliding bearings—Stainless Steel to Polytetrafluoroethylene (PTFE)	ANSI 0.008 mil

Fabricate bearing surfaces according to the following additional requirements:

- Machine sliding bearings having a surface roughness of 0.063 mil or rougher so the lay of the cut is parallel to the direction of movement.
- Provide machined surfaces plane and true, conforming to the indicated dimensions.
- For surfaces designed to be flat, machine surfaces to within 0.01 inch of flatness. Determine flatness as specified in Section 1111.03(c).
- Maintain uniform and even contact when assembling adjacent bearing surfaces. Unless a closer tolerance is indicated or specified, do not exceed a gap of 0.040 inch between bearing surfaces. Machine all sliding surfaces of base plates.
- Do not machine any surfaces of fabricated members until all fabrication and welding of the assembly or subassembly is complete. Machine heat-treated components after completion of heat treating.

(r) Abutting Joints. Mill or saw-cut abutting joints in compression members of trusses and columns to obtain a square joint and uniform bearing. Do not allow the opening at other joints not required to be faced to exceed 3/8 inch.

(s) Plates: Direction of Rolling. Fabrication of Members. Unless otherwise indicated, cut and fabricate steel plates for primary members and splice plates for flanges and main tension members (not secondary members) so that the primary direction of rolling is parallel to the direction of the main tensile and compressive stresses. Unless otherwise indicated or specified, fabricate I-shaped beams and girders so that when erected and under their own weight, the webs are within the allowable tolerance of vertical. Provide flanges normal to the web, unless otherwise indicated.

(t) Bent Plates.

1. General. Fabricate bent, unwelded, load-carrying, rolled-steel plates from the stock plates so that the bend lines will be at right angles to the direction of rolling. If allowed, cold-bent ribs for orthotropic-deck bridges may be bent with bend lines in the direction of rolling. When bend lines must be oriented parallel to the direction of the plate, increase the bend radii specified in Section 1105.03(t)2 by an additional factor of 1.5, unless otherwise specified or approved.

Before bending, round the corners of the plate where bending is to occur to a radius of 1/16 inch.

2. Cold Bending. Cold bend such that no cracking of the plate occurs. Unless otherwise approved, provide a minimum bend radii, measured to the concave face of the metal, of 5.0t for all grades and thickness of AASHTO M 270 (ASTM A709) steel, including material substitutions allowed for AASHTO M 270 (ASTM A709), where t is the thickness of the plate in inches. For cross-frames, diaphragm connection plates up to 0.75 inches thick that are not considered main members, the minimum bending radii may be taken as 1.5t. When bend lines are oriented parallel to the final rolling direction, increase the minimum bend radius to not less than 7.5 times the plate thickness. For all other Grades of steel, provide minimum bend radii according to the applicable material specification, where provided or as follows:

Thickness (t) in inches	Up to 1.0	Over 1.0 to 2.5	Over 2.5 to 4.0
Bend radii	2.5t	3.5t	4.0t

Provide allowance for springback of Grade HPS 100W steels of about three times that for Grade 36 steel. For break press forming, provide a lower die span of at least 16 times the plate thickness. Multiple hits are advisable. Cold Bending of fracture critical members is prohibited without the approval of the Chief Structural Materials Engineer.

3. Hot Bending. If a radius shorter than the minimum specified for cold bending is necessary, hot bend bars and plates at a temperature not less than 800F and not greater than 1,200F. Submit the heating and bending procedure to the Chief Structural Materials Engineer for review and approval. Limit hot bending temperatures for Grade HPS 100W steel plates to not greater than 1,100F.

(u) Fit of Stiffeners. Ensure that at least 75% of the bearing area of end bearing stiffeners for girders and stiffeners intended as supports for concentrated loads have full bearing on the flanges that they transmit load to or receive load from. Full bearing is defined as a gap not exceeding 0.005 inch. The maximum gap between the bearing stiffener and the flange on the remaining 25% may not exceed 1/32 inch. Mill or grind the ends of bearing stiffeners to achieve the required bearing on the flanges. For weldable steel in compression areas of flanges, weld stiffeners as indicated or specified.

Provide a tight fit against the compression flange for intermediate stiffeners not intended to support concentrated loads unless otherwise indicated or specified. Tight fit is defined as a gap not exceeding 1/16 inch.

(v) Eyebars. Flame cut pin holes at least 2 inches smaller in diameter than the finished pin diameter. Securely fasten together all eyebars that are to be placed side by side in the structure in the order that they will be placed on the pin and bore both ends while clamped. No welding is allowed on eyebars or to secure adjacent eyebars. Pack and match-mark eyebars for shipment and erection. Stamp all identifying marks on the edge of one head of each member with steel stencils after fabrication is completed so that the marks are visible when the bars are nested in place on the structure. Provide low stress type steel die stamps.

Furnish eyebars straight and free from twists. Accurately locate pin holes on the centerline of the bar. Limit inclination of any bar to the plane of the truss to 1/16 inch to a foot.

Simultaneously cut the edge of eyebars that lie between the transverse centerline of their pin holes with two mechanically operated torches abreast of each other and guided by a substantial template. Prevent distortion of the plates.

(w) Annealing and Stress Relieving. Anneal (full annealing) and normalize structural members indicated according to ASTM A941. Finish machining, boring, and straightening structural members subsequent to heat

treatment. Maintain the temperature uniformly throughout the furnace during heating and cooling so that the temperatures of any two points on the member differ by no more than 100F at any one time.

Do not anneal or normalize members consisting of Grades HPS 70W and HPS 100W steel. Stress relieve these members only if permitted. Do not allow the holding temperatures for stress relieving Grade HPS 100W or Grade HPS 70W steels to exceed 1,100F and 1,050F, respectively.

Furnish a record of each furnace charge identifying the pieces in the charge and showing the temperature and schedule actually used. Provide proper instruments, including recording pyrometers, to determine the temperatures of members in the furnace at any time. Submit the records of the treatment operation for approval.

When indicated or specified, stress relieve members such as bridge shoes, pedestals, or other parts that are built up by welding sections of plate together according to Section 4.4 of the AASHTO/AWS D1.5M/D1.5-2015.

(x) Pins and Rollers. Turn pins and rollers to the dimensions indicated and ensure that they are straight, smooth, and free from flaws. Forge and anneal pins and rollers more than 9 inches in diameter. Either forge and anneal or use cold-finished, carbon-steel shafting for pins and rollers 9 inches or less in diameter.

In pins larger than 9 inches in diameter, bore a hole not less than 2 inches in diameter full length along the axis of the pin after the forging has cooled to a temperature below the critical range and before annealing. Bore the hole under suitable conditions to prevent damage by cooling too rapidly.

(y) Boring Pin Holes. Bore pin holes true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise indicated or specified. Produce the final surface by a finishing cut.

Do not allow the diameter of the pin hole to exceed that of the pin by more than 1/50 inch for pins 5 inches or less in diameter, or by more than 1/32 inch for pins larger than 5 inches in diameter. Do not allow the distance outside to outside of end holes in tension members and inside to inside of end holes in compression members to vary more than 1/32 inch from that indicated or specified. Bore pin holes in built-up members after the member has been assembled.

(z) Threads for Bolts and Pins. Provide threads for all bolts and pins for structural steel construction conforming to Unified Standard Series UNC ANSI B1.1, Class 2A for external threads and Class 2B for internal threads, except furnish pin ends having a diameter of 1 3/8 inches or threaded more than six threads to 1 inch.

(aa) Full Size Tests. When full size tests of fabricated structural members or eyebars are indicated or specified, provide suitable facilities, material, supervision, and labor necessary for making and recording the required tests.

(bb) Marking and Shipping. Paint or mark each member with an erection mark for identification. Furnish an erection diagram to the Representative indicating the location of the erection marks on each member, so that the marks can be located in the field.

Furnish copies of material orders, shipping statements, and erection diagrams to the Representative. Show the weights of the individual members on the statements. Mark the weights of members with a weight greater than 3 tons on the members. Load structural members on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged.

Pack bolts of one length and diameter and loose nuts or washers of each size separately. Ship pins, small parts and packages of bolts, washers, and nuts in boxes, crates, kegs, or barrels, but do not allow the gross weight of any package to exceed 300 pounds. Plainly display a list and description of contents on the outside of each shipping container.

(cc) Painting. Section 1060.3 and as follows:

Include the manufacturer of the complete self-curing inorganic zinc system consisting of the primer, intermediate tie, and finish coats on the shipping papers.

(dd) Identification of Steel During Fabrication. Use a system of assembly-marking individual pieces and issuing cutting instructions to the shop (generally by cross-referencing the assembly-marks indicated on the shop drawings with the corresponding item covered on the mill purchase order) that maintains the identity of the original piece.

Only furnish steel from stock material that can be identified by heat number and mill test report.

During fabrication, up to the point of assembling members, clearly and legibly show the grade designation on each piece of steel other than Grade 36 steel. Either write the grade designation on the piece or submit an alternate marking procedure to the Chief Structural Materials Engineer for approval.

Use low stress die stamp or firmly attach a substantial tag to identify the grade designation of those pieces of steel, other than Grade 36 steel, that before being assembled into members will be subjected to fabricating operations such as blast cleaning, galvanizing, heating for forming, or painting that might obliterate paint color code markings.

If requested by the Representative, furnish an affidavit certifying that the identification of the steel was maintained according to this specification throughout the fabrication operation.

(ee) Welded Connections. Ensure that surfaces and edges to be welded are smooth, uniform, clean, and free of defects that would adversely affect the quality of the weld. Prepare edges according to the AASHTO/AWS D1.5M/D1.5-2015.

(ff) Numerically-Controlled Drilled Field Connections. Section 1105.03(c)5.

(gg) Facing of Bolted Surfaces. ASTM A6, and as follows:

- Provide surfaces plane and true, within the specified tolerances.
- Variations for surfaces designed to be flat: Conforming to ASTM A6, Tables A1.13, A1.14, and A1.15, unless otherwise indicated or specified.
- Complete all welded attachments to bolted surfaces before machining surfaces to required tolerances.
- Grind only on surfaces less than 2 inches wide, unless otherwise allowed.
- Use milling or other acceptable procedures to correct plate flatness to within the specified tolerances.
- Provide plate thickness as indicated.
- Identify each plate and the methods used to correct plate flatness to the specified tolerances.
- Replace rejected plates at no additional cost to the Department.

(hh) Determination of Surface Flatness.

Furnish surfaces having flatness as determined by the following method:

- Place a precision straightedge that is a minimum of 6 inches longer than the surface to be measured in contact with and as parallel as possible to the surface. The straightedge may be located in any position on the surface being evaluated and not necessarily at 90 degrees to the edge.
- Attempt to insert a feeler gage having the required tolerance under the straightedge.
- Flatness is acceptable if the feeler gage does not pass between the straightedge and the surface.

SECTION 1107—PRESTRESSED CONCRETE BRIDGE BEAMS

1107.01 GENERAL REQUIREMENTS—

(a) Description. This work is the fabrication, storage, and transportation of prestressed concrete bridge beams.

(b) Shop Drawings. Section 105.02, and as follows:

1. Drawing Details. Include the following details:

- Items such as chairs, hold downs, tie rod tubes, inserts, and steel bearing plates incorporated into the beams. List inserts and steel bearing plates by source, type, and supplier.
- Incidental items such as plain neoprene bearings, tie rods, and anchor bolts.
- Subassemblies.
- Strand patterns.
- Type of strand.
- Debonding.
- Deviation from tolerances as specified in Section 1107.03(e).
- Anticipated camber, based on the contract drawings.
- Vertical Adjustment Device Assemblies, as shown on the Standard Drawings. Include design related calculations with submission.

If draped strands are used, show the following additional information:

- Hold up and hold down forces.
- Other required data.

1.a Deviations from the Contract Drawings. The total force and the center of gravity of the strands may be adjusted to fit the strand type selected. Forming aid strands tensioned to 3,000 lbs. may be added, as indicated on the shop drawings. If fabricating beams with different strand patterns on the same set-up, full-length debonding may be permitted.

Alternate strand patterns and the provision of additional strands in the beam for convenience may be used. Submit bridge shop drawings as specified in Section 105.02(d) for review and acceptance showing the alternate pattern and stress computation documenting the change.

1.b Debonding of Strands. Compute stresses in the beam end zones at each stress change location. Submit computations documenting these stresses. Stress calculations in the beam end zones for I-beams using debonding are not required.

Reduce tensile stresses due to initial prestress force in the end sections of box beams to a maximum of $3\sqrt{f'ci}$ by selective strand debonding. If this cannot be accomplished, provide additional reinforcement bars to carry the full tensile force of the tensile stress block. NOTE: f'ci = Cylinder strength of concrete (pounds per square inch) at initial prestress. For box beam end block crack control, do not debond more than 25% of the total number of strands for the end 36 inches and 50% of the total number of strands for the end 6 inches.

If debonding of I-beams is not specified, the fabricator may debond up to 50% of the total number of strands for the end 6 inches. Do not debond more than 50% of the strands in any one row.

If debonding results in an number of strands in a row, the number of debonded strands may be rounded up to the next higher number. Strand debonding must maintain a symmetric pattern about the vertical centerline of the beam. Debonding the exterior strands of any row in the bottom flange is not allowed. Show debonding on the shop drawings. Deboning in the web region of the beam is prohibited.

2. Other Shop Drawings. Prepare separate shop drawings for prestressed beam sub-items or items fabricated separately, such as steel bearings, moment connections, and post-tensioning operations.

Shop drawings are not required for such items as closed cell neoprene sponge, waterproofing, and laminated metal shim neoprene bearing pads.

(c) Definitions of Terms.

1. Pretensioning. Prestressing, with strands or wires called tendons, to a predetermined force before placing concrete. After the concrete hardens, the tendons are released and the concrete is stressed by bonding.

2. Post-tensioning. Stressing the concrete after it has hardened by tensioning the tendons, which are free to move in sheaths, and anchoring them at each end of the member, introducing the required force.

3. Pre-Post-Tensioning. A combination of pretensioning and post-tensioning.

(d) Rejections. The Representative may reject members accepted at the plant if they are found to be defective. Members which do not meet all specification requirements but may be suitable for use may be submitted to the Department for evaluation and final disposition in accordance with Section 106.07(c). Replace rejected members.

1107.02 MATERIAL—Conforming to the following requirements:

(a) Cement. Type I, IP, IS, II, or III—Section 701. Use the same cement source and type for all beams in the structure for each contract.

(b) Supplementary Cementitious Material. Section 724.

(c) Fine Aggregate. Type A—Section 703.1

(d) Coarse Aggregate. Type A, No. 8, or No. 67—Section 703.2

(e) Water. Section 720.1

(f) Admixtures. Section 711.3

(g) Reinforcement Bars. Section 709.1

(h) Steel Dowels. Certify as specified in Section 106.03(b)3.

- Plain bars—ASTM A 615; Grade 40 or 60
- Threaded bars—ASTM A 615; Grade 40 or 60
- Threaded bars—ASTM A 663; Grade 45, 50, 55, or 60
- Threaded bars—ASTM A 675; Grade 45, 50, 55, or 60

(i) Steel Anchor Bolts. Section 1105.02(c)

(j) Corrosion Resistant Fabricated Structural Steel for Bearings. AASHTO M 270 (ASTM A 709), Grade 50 or 50W. Certify as specified in Section 106.03(b)3.

(k) Burlap. Section 711.1(d)

(m) Box Beam Void Forms. Construct using preformed cellular polystyrene, ASTM C 578, Type 1; or another acceptable material. The use of cardboard void forms is prohibited.

Construct box beam void forms to be watertight and resistant to breakage and deformation during concrete placement. Waterproof the outside of forms if not constructed of approved preformed cellular polystyrene or an acceptable hot-melt wax coated, polymer coated, or asphalt-penetrated material.

Test load or subject box beam void forms to a successful member installation, as directed, before acceptance.

Certify as specified in Section 106.03(b)3.

(n) Tendons.

1. General. Include two copies of typical load-elongation curves with each shipment. Give one copy to the inspector. Attach identification tags to each shipment.

At the fabrication plant, a representative of the Department will select samples to be submitted to the LTS.

Do not use strand larger than 0.60-inch diameter.

Certify as specified in Section 106.03(b)3.

2. Samples for Testing Post-Tension Members.

- 5 feet of wire requiring heading.
- Enough wire, not requiring heading, to simulate 5-foot parallel-lay cable.
- 5 feet of strand between fittings.
- 5 feet of bar between threads, one sample per heat, and not less than one sample per 100 bars.
- Two anchorage assemblies of each size and type; each assembly complete with distribution plates.

3. Description.

3.a Prestressing Wire, Low-Relaxation. ASTM A 881

3.b 7-Wire, Uncoated, Low-Relaxation Strand. AASHTO M 203 (ASTM A 416), Grade 270. Unless otherwise indicated, use strand conforming to the following requirements:

Nominal Diameter of Strand, (in.)	Minimum Breaking Strength of Strand, (lbf)	Minimum Load at 1% Extension, (lbf)	Minimum Elongation at Breaking Strength, (%)
0.500	41,300	37,170	3.5
0.520	45,000	40,500	3.5
0.600	58,600	52,740	3.5

3.c High Tensile Strength Alloy Bars. Manufacture and process from steel conforming to ASTM A 322,A 29, and A722. Stress-relieve by heat treatment and cold-stretch (proof stretch) to the minimum yield strength specified below.

Required physical properties after cold-stretching:

- Guaranteed minimum ultimate tensile strength, as certified by the manufacturer— 150,000 pounds per square inch
- Minimum yield strength, measured by the 0.7% extension under load method and 0.2% in the offset method— 85% and 80% of ultimate for Type I and Type II bars, respectively
- Minimum modulus of elasticity— 29,700,000 pounds per square inch
- Minimum elongation length in 20 bar diameters after rupture— 4% and 7% for Type I and Type II bars, respectively.
- Minimum reduction of area after rupture— 20%
- Diameter tolerance— +0.03 inch, -0.01 inch

Calculate physical properties using nominal bar areas.

3.d Special Grade High Tensile Strength Alloy Bars. Required physical properties are identical to those for High Tensile Strength Alloy Bars as specified in Section 1107.02(n)3.c, except a guaranteed minimum ultimate tensile strength of 160,000 pounds per square inch is required. Tag and identify these bars for verification with mill certification.

(p) Neoprene Joint Material. Identify neoprene material according to the type, class, and grade. Print, stencil, or otherwise affix this code to each pad at intervals of not more than 24 inches and in letters and numerals of not less than 1/4-inch height. Additional information such as lot or batch numbers, date, plant and place of manufacture, trademark, or name of manufacturer may also be added.

Certify as specified in Section 106.03(b)3.

1. Closed-Cell Neoprene Sponge. Pads may be manufactured as sponge neoprene or expanded neoprene and may be composed of laminations. Use material conforming to the following:

- ASTM D 1056, Type 2, Class C, Grade 2, including the requirements of suffixes B3 and F1
- ASTM D 1171, Quality Retention Rating of 100% after 6 weeks exposure

1107.03 BEAM CONSTRUCTION—

(a) Plants and Plant Sites.

1. General. Submit plans to the Chief Bridge Engineer for review and acceptance of the design, redesign, or change in the use of accepted beds, anchorage, abutments, and the deflecting facilities for draped strands.

Provide adequate lighting for operations not completed in the daylight. Provide a drainage system for the removal of rainfall and curing water. For member storage, stabilize areas and grade to a level surface.

Furnish necessary facilities for the inspection of material and workmanship. The necessary facilities for inspection include a plant office, as specified in Section 714.5(a), except a four-drawer fire-resistant (D-label) metal file cabinet will be required in place of a two-drawer fire-resistant (D-label) metal file cabinet. Allow the Representative unrestricted access to work in process and stored materials during plant working hours.

2. Plant Chief Engineer. Engauge the Chief Engineer who has the overall responsibility for the adequacy of production facilities, QC, testing, and the fabrication of members and who will ensure beams are fabricated as designed. For plants that offer design service, the Chief Engineer is required to be a Professional Engineer, registered in the State.

3. Beds and Forms. Support casting beds on unyielding foundations.

For standard members, use fixed and movable steel forms. For nonstandard members and bulkheads that have limited use, forms may be of lumber, plywood, or other material.

Maintain accurate form alignment during the casting operation. Check alignment and grade for each setting and for proper strand clearance. Verify the pallet is flat and level in the bearing area. Make joints smooth and tight to prevent leakage of mortar. Plug holes and slots in the forms.

For exposed members, use form ties, chairs, and inserts that are recessed in the concrete by at least 1 inch, or use stainless steel accessories.

Do not use continuous soffit forms longer than 120 feet if the forms are rigidly anchored to the bed. If slight differential movements between forms and beds can cause damage to the member, anchor the forms to prevent differential movements, or loosen them so movements can occur without damage to the member or forms.

Clean beds and forms after each use. Prevent accumulation of coatings used for bond breakers.

4. Plant Acceptance.

4.a General. Do not begin fabrication before the Chief Structural Materials Engineer's inspection and acceptance of the plant. Plant expansions are subject to the same inspection and acceptance. All beams are to be produced from a single producer and plant location.

Provide a permanent building for the Department's acceptance. New plants will be required to produce a sample beam and demonstrate an acceptable level of QC and conformance with specifications and product tolerances before receiving approval to begin production.

Currently accepted plants will retain approved status unless the acceptance is rescinded for failure to comply with the plant requirements as specified in Section 1107.03(a), or until ownership changes. Reinstatement will be based on conformance with the plant requirements as specified in Section 1107.03(a).

Material, equipment, testing procedures, methods of fabrication, handling, storage, and transportation are subject to inspection and acceptance.

Plants may be accepted to fabricate one or more of the following beam types:

- Box beams—with straight strands
- I-beams—with straight strands
- PA Bulb-Tee Beams—with straight strands
- Box beams—with straight and draped strands

- I-beams—with straight and draped strands
- PA Bulb-Tee Beams—with straight and draped strands
- Box beams—with straight and debonded strands
- I-beams—with straight and debonded strands
- PA Bulb-Tee Beams—with straight and debonded strands
- Box beams—with pre-post-tensioned tendons
- I-beams—with pre-post-tensioned tendons
- PA Bulb-Tee Beams—with pre-post-tensioned tendons
- Next-Beam
- Nonstandard beam sections

Each beam type will be subject to inspection during manufacturing, storage, and shipment.

Register and certify the plant under the Prestress Concrete Institute (PCI) plant certification program and submit a valid certificate to the Chief Structural Materials Engineer, at 81 Lab Lane, Harrisburg, PA, 17110. Submit an annual endorsed copy for continued qualification.

4.b Bed Approval. For each casting bed offered for production, submit a complete set of construction drawings and detailed design calculations sealed and signed by a Professional Engineer, registered in the State to the Chief Bridge Engineer for review. Theoretical analysis and applicable design code review must be based on a test load equal to 1.5 times the maximum working load and include the following:

4.b.1 Non-self-stressing beds

- Overturning safety factor of abutments for beds having vertical uprights embedded into the foundation
- Stress analysis of embedded vertical uprights, including buckling and foundation analysis
- Buckling analysis of bed slab, including the effects of hold down forces for draped strands, if applicable
- Bulkhead design for transferring the strand forces to the uprights
- Computed theoretical shortening of the bed under full test load
- Cumulative deflections of all structural components, including tilting of uprights into the full test load and flexure of the bulkhead beams

4.b.2 Self-stressing beds

- Anchorage of the bed to the foundation, buckling and overturning safety factors, and theoretical bed shortening under the full test load

When the above requirements are satisfied, test load each bed for approval under the supervision of the Department. Each bed will be approved for and limited to a maximum allowable bed moment (force and eccentricity) that may be used during production and equal to the maximum bed moment applied during the bed test divided by 1.5.

(b) QC.

1. General. Establish a level of QC based on uniform production practices. Submit a QC Plan developed in accordance with the guidelines listed in Publication 145, including mix design(s) to the Chief Structural Materials Engineer, Bridge Design and Technology Division, Structural Materials Section (SMS), for review and approval. Include with the QC Plan a plant organizational chart indicating a separate chain of command from the QC Manager to the Owner/Plant Manager independent of the Production Manager. Resubmit the QC Plan, mix design, and organizational chart, if required, due to changes in materials, processes, or personnel.

2. QC Manager. Provide a QC Manager who has overall responsibility for the adequacy of production facilities, QC, sampling and testing, and fabrication of the product, and who will ensure items are fabricated as designed and specified. Assign plant QC managers certified in the PCI Quality Control Personnel Certification Program, Level III with overall responsibility for the Quality Control program. These requirements may be waived

by the Chief Structural Materials Engineer if alternative experience or certifications or both are submitted and considered to be equivalent.

3. QC Personnel. Do not proceed with production until qualified personnel are present and approved by the Department. Assign sufficient qualified personnel with prestress concrete fabrication experience to be responsible for QC and sampling and testing during the complete fabrication process, storage, and shipment. Technicians responsible for concrete sampling and testing are required to provide written evidence they successfully completed the certification requirements for an ACI Grade I Field Technician or have approval from the Chief Structural Materials Engineer as a technician-in-training. Assign plant QC personnel certified in the PCI Quality Control Personnel Certification Program, Level II during tensioning, detensioning and casting operations. These requirements may be waived by the Chief Structural Materials Engineer if alternative experience or certifications or both are submitted and considered to be equivalent.

(c) Prestressing. For all methods of tensioning, determine force in the tendons through application of applied force and verified by elongation.. Do not have the jacking stress exceed 80% of the specified minimum ultimate tensile strength of the prestressing steel (0.80 f'_s). Measure elongations to an accuracy of 0.0625 inches. Verify at the completion of tensioning that the two control measurements, force and elongation, agree algebraically within 5% of the computed theoretical values. Suspend the tensioning operation if discrepancies are in excess of 5% until the source of error is determined and corrected. If the measurements do not agree within 5%, a load cell may be added at the 'dead end.' If force measurements agree within 5% between the gauge at the live end and the load cell, the elongation agreement may be waived.

1. Safety. Provide safety measures to prevent accidents due to breakage of prestressing steel or slippage of grips.

2. Methods of Force Measurement. Measure forces using a primary measuring system. Check primary measurements using a secondary measuring system. Acceptable methods of stressing force measurement consist of:

2.a Curves. Elongation, determined from current stress-strain or load-elongation curves furnished by the manufacturer. An average modulus may be used if acceptable, provided the force indicated falls within the specified tolerance limits.

2.b Pressure Gauges. Pressure gauges that measure force by the pressure applied to hydraulic jacks. Furnish digital readouts or dials for these gauges, a minimum of 5 inches in diameter and calibrated with the jacking system.

2.c Dynamometers. Dynamometers connected in tension into the stressing system for the initial force application.

3. Gauging System. Equip tensioning systems with accurately calibrated gauges for measuring the stressing forces. Calibrate hydraulic gauges, dynamometers, load cells, or other devices used to measure the stressing load to an accuracy of reading within 2%. Ensure a qualified testing laboratory calibrates and issues a certified calibration curve with each gauge. Recalibrate at intervals not greater than 1 year and if a gauging system shows indication of erratic results. Gauges for single strand jacks may be calibrated by an acceptable and calibrated load cell. Calibrate gauges for large, multiple strand jacks, acting singly or in parallel, by proving rings or by load cells placed on either side of the movable end carriage.

Provide pressure gauges and dynamometers with a full-pressure or load capacity of approximately twice their normal working ranges. Limit the loads to not less than 25% or more than 75% of the total graduated capacity, unless calibration data establish consistent accuracy over a wider range.

Each gauge is required to indicate loads directly in pounds or be accompanied by a chart with which the dial reading can be converted into pounds. Direct reading gauges are preferred.

Equip tensioning systems employing hydraulic gauges with appropriate by-pass pipes, valves, and fittings so the gauge pointers remain steady until the jacking force is released.

Mount gauges near eye level, within 6 feet of the operator, and position so readings can be obtained without parallax.

4. Control of Jacking Force. Use either manual or automatic pressure cutoff valves for stopping the jacks at the required force. For automatic pressure cutoff valves, use valves capable of adjustment so the jacking force

corresponds to the required force. At the beginning of each day's operation and whenever there is reason to suspect improper results the automatic pressure cutoff valve settings shall be verified for accuracy.

5. Wire Failure in Tendons. Locate wire breaks and tie the ends to the strand with wire to preclude the possibility of raveling during concrete vibration.

For seven-wire strands, remove and replace strands with more than one broken wire, or with more than the following number of wire breaks in a strand pattern:

- Less than 20 strands, no wire breaks allowed
- 20 to 39 strands, one wire break allowed
- 40 to 59 strands, two wire breaks allowed
- 60 and more strands, three wire breaks allowed

Failure of wires in parallel-wire, post-tensioned tendons is acceptable, provided the total area of wire failure is not more than 1% of the total area of tendons in any member or no more than one wire fails in any tendon.

6. Pretensioning.

6.a General. In systems of pretensioning, apply the load in two increments. Apply the initial load to the individual strands to straighten them, to eliminate slack, and to provide a starting or reference point for measuring elongation. Apply the final load for which elongation of tendons is computed and measured.

Without verification of strand tension by load cells, the maximum permissible holding time for tensioned strands before starting concrete placement is 72 hours. If it is anticipated the holding time for tensioned strands will exceed 72 hours, place load cells during initial tensioning on two separate strands selected by the Representative to verify the strand tension remains within 5% of the theoretical value.

Upon limited request, re-pulling of strands may be accepted instead of the use of load cells. Submit requests to the Structural Materials Engineer before tensioning the bed.

The Representative will select 20%, or 2 minimum whichever is more, of the beam strands to be re-pulled for tension verification. Tension must remain within 5% of the theoretical value.

6.b Forms, Bond Breakers, Strand Surfaces. Before stringing strands, inspect the bottom of forms for cleanliness and accuracy of alignment.

Apply bond breaker coating to the contact surface of forms. Use a form coating that dries to a surface hardness and does not contaminate the strands. Make sure the coating is dry before the strands come in contact with it.

6.c Stringing Strands. Furnish strands in either coils, packs without reels, or on reels. String strands individually or in multiples. Relieve the strand rotation if strands are pulled from coils or packs without reels.

Do not reuse strands containing former vise-grip points, unless the points are outside the new strand vise locations. Do not reuse portions of strands that have been in contact with draping mechanisms.

6.d Strand Vises. Use strand vises capable of anchoring stressing loads positively with minimal slippage. Assemble strand chucks with compatible components from the same manufacturer to avoid improper fit and seating on strands. Clean, lubricate, and inspect the vises between each use. Do not use grips that become visibly worn, distorted, or that allow slippage in excess of 1/4-inch.

Clean and inspect a full set of strand vises before starting each stressing operation.

6.e Measurement of Forces. For gauge readings, elongation measurements, and calculations for elongation, include appropriate allowances for operational losses in the tensioning system. Losses include strand slippage, movement of anchorages and abutments, elongation of abutment anchorage rods, strand rotation, temperature variation, friction, bed shortening, and other forces and influences acting on the strands. Make calculations for elongation available for inspection.

After applying initial tensioning, establish reference points for measuring the elongation due to final tensioning.

6.f Operational Losses.

6.f.1 Friction in Jacking System.

6.f.1.a Single Strand Tensioning. If rams used in jacks for single strand tensioning are small, friction losses in the jacking system may usually be ignored. Verify gauge pressure by measured elongation or load cells.

6.f.1.b Multiple Strand Tensioning. In multiple strand tensioning systems, clean and lubricate the sliding surfaces to minimize friction. Determine and establish a force override (compensatory operational loss correction) for strand patterns if the primary and secondary force measurement systems exceed the allowable 5% variation.

6.f.2 Thermal Effect. For anchored abutment (non-self-stressing) beds, make thermal adjustments to compensate for the loss in stress due to the change in temperature if the prestressing steel is tensioned at a temperature more than 25F lower than the estimated temperature of the concrete and the prestressing steel at the time of initial set of the concrete. Increase the calculated elongation 0.5% for each 5F of temperature variation. Prestress strands only if the ambient temperature is above 40F. After the strands are tensioned, maintain the temperature of the air surrounding the strand at 40F or more.

6.g Initial Tensioning. For 0.500 inch and 0.520 inch diameter strand, do not exceed 15% of the specified final tensioning force, or 3,000 pounds, whichever is greater. If 0.600 inch diameter strands are approved for use, do not exceed 4,000 pounds.

Measure the initial load within a tolerance of ±100 pounds. Do not use elongation measurement as an initial force measure.

In single strand tensioning, the initial and final loads may be applied in immediate succession on each strand.

Acceptable methods of applying initial stress are:

6.g.1 Pressure Jacks. Use the same jack for single strand tensioning as for initial tensioning, provided the jack is equipped with a proper gauging system for measuring the initial force.

6.g.2 Fence Stretchers. Apply load using fence stretchers and measure with a dynamometer. Refer to Section 1107.03(c)3 for capacity.

6.g.3 Other Methods. Acceptable methods that provide a definite and uniform load.

6.h Final Tensioning. Use paint or other acceptable method to permanently mark the reference point on strands to be used to check slippage.

6.h.1 Tensioning Straight Strands.

6.h.1.a Single Strand Tensioning. Use jack-mounted pressure gauges for the primary system of force measurement. Check elongation against pressure gauge readings on the first and last strands tensioned and at least 10% of the remaining strands, but on not less than six strands. Check slippage at strand vises.

The computed elongation, including operational losses and equivalent elongation for initial tensioning converted into force, is required to be within 5% of the pressure gauge reading.

At least every 90 calendar days, or as directed, use load cells as a check of the gauging or tensioning system.

6.h.1.a.1. Form Shortening. For self-stressing beds, if the loss in tension from form shortening is expected to exceed 5%, adjust the strand tension of the previously tensioned strands. Re-tension strands with losses exceeding 5%. Do not exceed a strand stress after seating of 80% of the specified minimum ultimate tensile strength.

6.h.1.b Multiple Strand Tensioning. Use jack-mounted pressure gauges for the primary system of force measurement. For uniform application of load to strand, the face of the anchorage at final load is required to be in a plane parallel to its position under initial load. Verify parallel movement by equal measurements of movement on opposite anchorage sides and check the plumb position of the anchorage before and after final load application. Check slippage at strand vises.

At least every 90 calendar days, or when directed, use load cells as a check of the gauging or tensioning system.

6.h.2 Tensioning Draped Strands. Tension draped, pretensioned strands, initially and finally, by one of the following methods:

- Tensioned in the final design position.
- Tensioned first, and then deflected to the final design position.

Use primary and secondary force measuring systems approved by the Department.

6.h.2.a Tensioning Strand in the Final Design Position.

6.h.2.a.1 Single Strand Tensioning. Stress the strands to their final value in their design position for the full-length of the bed. Pass the strands over saddles, roller fixtures, or pins with a minimum 3/4-inch diameter to minimize friction at deflection points and to prevent strand damage.

Design hold-up and hold-down devices with an adequate factor of safety, but not exceeding 75% of the yield strength of the material used. Maintain strand positions within required tolerances under the induced loads. Design hold-down devices that are free to move and are able to bisect the drape angle. If devices are not free to move, use safety procedures to eliminate strand bonding or restrain at hold-up or hold-down.

Measure strand force and elongation, as specified in Section 1107.03(c)2.

If final tensioning is done by jacking strands from one end of the bed, place two load cells at the dead anchor end of two different strands selected by the Representative. The force indicated by these load cells is required to be not less than 95% of the specified design value.

If the computed elongation has not been attained at the jacking end when the load value shown by the pressure gauge or load cells is exceeded by 5%, jack the strand from the other end to the balance of the computed elongation. If achieving the computed elongation results in an overstress in excess of 5%, as shown on the gauge, reduce the number of deflection points and, consequently, the number of members on the bed until the elongation can be attained with not more than 5% overload.

6.h.2.a.2 Multiple Strand Tensioning. For draped strands, control the specified tension in strands without exceeding the force tolerance limits specified in Section 1107.03(c)6.h.2.a.1.

6.h.2.b Tensioning of Strand in Straight Condition and Subsequent Deflection. Arrange beams symmetrically to midbed. Position deflection devices in longitudinal and vertical directions to fit the anchor system. Measure the intermediate force value by pressure gauge and elongation as specified in Section 1107.03(c)2.

Place two load cells on two separate strands selected by the Representative to verify the design load. At the discretion of the Representative, the application of these load cells may be required only at each third line of beams on the same bed for the same bed layout.

Provide for simultaneous lifting or depressing at all bed points in order to distribute friction and restraint at deflection devices. However, if acceptable, depressing may be done on at least 50% of the deflection points simultaneously and alternately symmetrical to the bed center.

Load cell readings are required to be within 3% of each other and each within 5% of the gauge reading.

6.h.3 Debonded Strand at Ends of Member. Debond as shown on the shop drawings. Use acceptable sleeves or taping.

6.h.4 Strand Splices. Only one splice per strand is allowed unless force measurement is by load cell.

For single strand tensioning, the number of strands that may be spliced in each bed is not restricted.

For multiple strand tensioning, either splice all strands and adjust the elongation for average slippage, or splice no more than 10% of the strands in which case no slippage allowance is required

Place strands in the same lay or direction of twist. Cut the ends using shears or abrasive cutting wheels.

Do not splice strand within the form where other strands are under applied force.

6.h.5 Strand Position. Position strands as indicated. Use chairs to eliminate sagging of strands in the bottom rows.

6.i Detensioning.

6.i.1 General. Transfer force to members after the concrete strength, determined by cylinder tests, has reached the specified transfer strength. Transfer force immediately following the curing period while the concrete is still warm and moist.

Remove or loosen forms, ties, inserts, hold-downs, or other devices that restrict the member's longitudinal movement along the bed, or perform alternate detensioning by a method and sequence to minimize longitudinal movement.

Keep the prestressing forces nearly symmetrical around the member's vertical axis and release the tension using a method to minimize sudden or shock loading. Limit eccentricity around the vertical axis to one strand.

6.i.2 Detensioning of Draped Strands. Detension using a procedure provided by the fabricator's Representative for the type of system used.

6.i.3 Multiple Strand Detensioning for Straight Strands or Draped Strands. Provide a length of 6 inches or more between bulkheads.

6.i.4 Strand Detensioning by Cutting. In single strand detensioning, release the strands by heat-cutting according to a pattern and cutting chart that is available at each cutting location along the bed. The fabricator's Engineer will provide a pattern and cutting chart for each plant and bed.

6.i.5. Coating of Strand Ends. As an option to a grouted recess as shown in BC-755M, and if the ends of the beams are to be incorporated into a continuity diaphragm, cut prestressing strands off flush with the end of the member, clean the exposed strand and the end of the beam within 1 inch of all exposed strands by wire brushing or abrasive blast cleaning to remove all dirt and residue that is not firmly bonded to the metal or concrete surfaces, and apply zinc-rich paint to the exposed strand conforming to the requirements of ASTM A 780 to achieve an average dry film thickness over the cut ends of not less than 3.1 mil.

7. Post-Tensioning. Fabricate members as indicated and as specified in Section 1108. Perform post-tensioning at the plant unless otherwise designated or specified.

8. Pre-Post-Tensioning. Fabricate members as indicated.

(d) Fabrication.

1. Protection of Prestressing Steel. Store prestressing steel under shelter and keep free of deleterious material such as grease, oil, wax, dirt, paint, loose rust, or other similar contaminants that reduce the bond between steel and concrete.

Do not use steel showing corrosion, etching, pitting, or scaling of the surfaces. A light coating of surface rust is acceptable if it can be removed completely from the steel by wiping with a cloth.

Do not store prestressing steel on a surface that contributes to galvanic or battery action. Do not use as a ground for electric welding. Protect from electric welding sparks.

2. Bars, Mesh Reinforcement, Inserts, and Chairs. Fabricate and place bar and mesh reinforcement as indicated and within specified tolerances. Secure reinforcing to beds and forms using chairs, blocking, or ties to tendons, so the reinforcing maintains its position during placement and vibration of concrete. Bars may be fabricated into cages by tying and tack welding using low-hydrogen electrodes. Use only qualified tack welders to perform tack welding. Inspect welds for soundness and for freedom from undercutting. Do not weld immediately adjacent to a cold bend. To provide maximum cover, bend tie wire- ends into the member. Do not support cages on tensioned strands.

Place inserts as shown on the shop drawings. Recess scaffolding inserts in the concrete at least 1/2-inch or as indicated. Recessing is not required for structural inserts intended to anchor threaded reinforcing bars for diaphragms or utility supports. Fabricate inserts for utility supports from corrosion resistant material, galvanize, or apply another acceptable equal coating. Install self-drilling inserts only at the fabrication plant, and test for soundness.

Use chairs that support and space the strands and mild reinforcing within the tolerances specified in Section 1107.03(e). Use stainless steel or plastic-coated legs for chairs set on the bottom pallet or set against a form side. Concrete block supports may be used on box-beam void form tops.

If indicated, place epoxy coated- reinforcement as specified in Section 1002 in the top slab of adjacent box beams.

3. Bearing Areas.

3.a Embedded Steel Bearing Plates. Set embedded plates level, align parallel to each other, and anchor in the exact location indicated.

3.b Concrete Bearing Areas. Finish concrete bearing areas that receive neoprene bearing pads to true, flat planes to ensure uniform bearing on the entire area. Use smooth and unyielding pallet forms.

4. Forms for Internal Voids. Use the type shown on the accepted shop drawings. During placement and vibration of concrete, maintain form positions within the limits of dimensional tolerances with respect to the horizontal and vertical axis of the member. Do not strap void forms to prestressed strands.

During vibration of the concrete, restrain the tendency of void forms to float.

Check void positions during casting at least every 10 feet.

Seal ends and splices by taping or by other acceptable means. Unless required, void forms manufactured to provide very tight seams need not be sealed.

Vent and drain rectangular void forms for each spliced sub-unit and for the full void compartment length.

Puncture box beam void forms at vent and drainage holes after removing the beam from the casting bed.

5. Concrete.

5.a Testing. Verify the concrete attains both the required detensioning and 28-day minimum strengths shown on the accepted shop drawings. If the test results of the acceptance cylinders fail to meet the required 28-day minimum concrete strength, the disposition of the concrete beams will be resolved as specified in Section 110.11.

5.b Air Content. Provide an air content of 6% ± 1.5% for traditional mixes and 7% ± 2% for self-consolidating (SCC) mixes. The air content requirement may be waived if the mix meets the following additional qualification tests before production:

- Rapid Chloride Permeability, AASHTO T 277: 1500 coulombs at 56-days
- Freeze Thaw Resistance, ASTM C 666, Procedure A or B: Minimum durability factor of 90 at 300 cycles.

5.c Mixture. Provide concrete conforming to Section 704, ACI 211, and meeting the specified compressive strength or other requirements shown on the accepted shop drawings. The use of Aggregate Mineral Filler (AMF) is permitted for beams. Use AMF replacements for fine aggregate as specified in Section 714.7(b)1.

Use enough water to obtain workability, but do not exceed a water cement ratio of 0.40. Use a maximum of 850 pounds of cement per cubic yard.

Make trial mixtures according to ACI 211. Mold, cure, and test cylinders using the procedures specified for the beam concrete.

Unless otherwise approved, produce all beams on a bridge from a single concrete mix design.

Fully automated batch systems utilizing in mixer moisture probes may be utilized, at the Fabricator's request and approval by the Chief Structural Materials Engineer. Fully automated batch systems must be operated according to Publication 145.

5.c.1 Traditional, Non-Self-Consolidating Mixtures. Select an appropriate slump value that will provide a workable mix for the prestressed beams. At no time is the slump upper limit to exceed 8 inches for mixes with high range water-reducing admixtures (superplasticizers). Reject the concrete if the upper limit is exceeded on any slump test. Maintain the cement concrete consistency with 1 1/2 inches on either side of the selected value.

5.c.2 Self-Consolidating Concrete Mixtures (SCC). Perform slump flow testing according to ASTM C 1611. Evaluate the Visual Stability Index (VSI) of the mixture when the slump flow is measured during testing. Reject mixtures with a VSI>1. Conduct J-Ring testing according to ASTM C 1621 whenever the slump flow test is performed. Establish a slump flow target for production of not less than 20 inches nor more than 30 inches and maintain the slump flow within a range of ± 3 inches of the target. Reject the concrete if the upper specification limit is exceeded. If the slump flow test result is less than the lower production range limit or the difference between the slump flow and J-Ring results is greater than 2.0 inches reject the concrete mixture unless the mixture has been approved for vibration and is subsequently vibrated. Take immediate corrective action whenever the slump flow limits or action points are exceeded and test succeeding batches until material control has been reestablished.

Perform the following additional qualification tests for SCC mixtures before production:

- Column Segregation Test, ASTM C 1610: 12% maximum
- Rapid Chloride Permeability, AASHTO T 277: 2000 coulombs at 56-days
- Freeze Thaw Resistance, ASTM C 666, Procedure A or B: Minimum durability factor of 80
- Strand Bond Qualification, PTM No. 630

5.d Mixing and Placing Conditions. Mix and deliver the concrete as specified in Section 704. Fully automated batch systems utilizing in mixer moisture probes may be utilized, at the Fabricator's request and approval by the Chief Structural Materials Engineer. Fully automated batch systems must be operated according to Publication 145.

Discard concrete that develops initial hardening or has become unsatisfactory for any reason. Do not remix or add water. Do not use materials containing frost, lumps, or crusts of hardened material.

Do not place concrete in forms, on casting beds, around reinforcement, on prestressing steel, or on other fixtures if the ambient temperature is below 40F or above 100F. Place only concrete having a temperature of 70F ± 20F.

5.d.1 During Cool Weather. If the air temperature is below 50F, but not lower than 40F, heat the mixing water to not less than 50F, or more than 150F. Ensure the aggregate is free of frozen lumps and maintains a temperature not less than 40F, or more than 100F at the time the aggregate is charged into the mixer. Do not use water hotter than 90F until the cement has been mixed with the aggregate.

5.e Placing Concrete. Place concrete without segregation using an acceptable method. Deposit the concrete in its final position in each part of the form. Do not work or flow the concrete along the forms from the point of deposit. Work the concrete under and around the prestressing steel and reinforcement. Once concrete placement has begun, continue for all beams on the bed.

If the concreting operation is stopped for an extended period of time due to mechanical failure, inclement weather, or other causes, begin curing completed beams. Remove the concrete from unfinished beams. Strands may be reused if not damaged during concrete removal and with approval from the Chief Structural Materials Engineer.

Place concrete in lifts as shown on the shop drawings or as otherwise directed.

Do not consolidate SSC mixtures without approval and unless the mixture was qualified within 2 inches of the upper production slump flow limit during the trial batching and evaluation phase. For traditional mixtures, consolidate the plastic concrete by internal vibration. Use vibrators with 1-inch to 1 3/8-inch heads for penetrating the strand pattern. Use vibrators only to consolidate the concrete after it has been properly placed. Operate vibrators vertically, pushing into and pulling out of the concrete slowly. Do not hold the vibrators in one spot long enough to cause segregation.

External vibrators may be used to reduce surface blemishes.

5.e.1 Test Cylinders. Mold a minimum of four concrete acceptance cylinders for each beam cast under the supervision of a Department representative. Mold the cylinders according to PTM No. 631 with the concrete being placed into each beam. Handle and cure the cylinders in the same manner as the beam.

Remove test cylinders from the bed a minimum of 1 hour before the scheduled time for detensioning. Cool cylinders from heat-cured beds for approximately 1/2-hour if bonded capping methods are used according to PTM No. 631. Cure the capped cylinders for 1/2-hour before testing.

Test the cylinders according to PTM No. 604 to verify minimum concrete transfer strength and 28-day minimum concrete strength. Test cylinders under the supervision of a Department representative. Match and mark test cylinders with the beams they represent and record test results so the beams can be readily identified. Submit the test results to the Department representative at the plant.

If acceptance test cylinders fail to meet the 28-day minimum strength requirement, evaluation and disposition the beam(s) as specified in Section 110.11.

5.e.2 Finishing. Make concrete surfaces true and even, free from rough, open, or honeycombed areas, depressions, or projections. Do not use brush or bag finishing. Do not paint with grout or neat cement. Do not add water to the concrete to facilitate finishing.

After the concrete has been placed as specified in Section 1107.03(d)5.e, use a template to strike-off the top of beams level. Before the concrete has initially set, finish the top surface with a stiff wire bristle broom, flat tine wire

broom or template. Run the broom or template from edge to edge of the beam in a transverse direction to produce not less than 4 scores per inch, to achieve a final texture from 1/16 inch to 3/16 inch in depth. Do not penetrate the concrete to depths where the brooming or tining operation pulls coarse aggregate to the surface.

Finish the top of the beam with the type of finish shown on the shop drawings.

5.f Repairs and Patching. Do not repair damaged areas unless pre-approved procedures according to Publication 145 are used or otherwise approved by the Chief Structural Materials Engineer. Ensure uniform appearance and color. The Department's representative will inspect repairs.

Maintain a minimum 50F environment until the repaired areas have cured. If at any time during the curing period the curing temperature falls below 50F, the Department's representative will consider the work deficient and will reject the work.

Before patching, clean holes left by tie rods, strand hold-down devices, recessed strand pockets, or other temporary inserts. Use a hammer to pack the holes with stiff dry mortar of the same material used in the concrete. Fill surface blemishes on the outside fascia beam surfaces with mortar as specified in Section 1001.2(d).

5.g Curing Concrete. Cure and protect concrete until prestress transfer has been accomplished. Construct and maintain a suitable curing enclosure to retain heat and moisture around the beams. Do not use membrane curing. The full concrete curing cycle consists of the initial curing phase, the intermediate curing phase, and the final curing phase.

5.g.1 Initial Curing Phase. The initial curing phase begins when each beam is completely covered with saturated covering.

After each beam has been cast and immediately after the concrete has initially set, cover exposed surfaces using a double thickness of saturated burlap or cotton or jute mats. Place covering carefully to avoid damaging the concrete. During the initial curing phase, which extends over a period of not less than 2 hours or more than the time required to achieve initial set, apply artificial heat, if necessary, to maintain the temperature at approximately 70F within the enclosure.

5.g.2 Intermediate Curing Phase. Cure beams using either steam curing or saturated cover curing. Maintain curing for 12 hours or until at least one hour after the required transfer strength is attained, whichever is greater. An additional hour of curing is not required if the transfer strength is attained after 20 hours.

5.g.2.a Steam Curing. Raise the temperature within the enclosure to between 100F and 160F, at a rate not exceeding 40F per hour. Use steam of 100% relative humidity. Ensure full circulation between the beams and the enclosure. Do not direct steam jets onto forms or beams.

5.g.2.b Saturated Cover Curing. Raise the temperature within the enclosure and the temperature of the covering material to between 120F and 160F, at a rate not exceeding 40F per hour. Keep the covering thoroughly saturated throughout the curing process. Use water with a temperature no more than 10F from the enclosure temperature. Control the temperature of the water to maintain a uniform enclosure temperature at the beam surface. Forms may be removed after 5 hours; provided saturated cover curing is continued on all beam surfaces up to the time of transfer.

5.g.2.c Record of Curing Temperatures. Record curing temperatures for the full curing cycle, up to removal of beams from the bed. Provide one continuous record chart of curing temperatures for every 100 feet of casting bed.

Use accurate, automatic recording devices with temperature pickup devices properly placed either within the curing enclosure or embedded in the beam. Locate the temperature pickup devices away from direct contact with steam or water jets. If enclosures are removed to facilitate form removal, place any non-embedded pickup devices on top of a 3/4-inch board directly on the saturated covering and overlay three additional layers of saturated covering. If embedded probes must be temporarily disconnected from the beam during this process, reattach immediately. Mark the curing chart to indicate the point at which this change of pickup location is made.

Use recording charts covering a minimum of 24 hours and a maximum of 72 hours per one full revolution, or as otherwise permitted. Record beam number, shop drawing number, date, start time and time concrete placement was completed, and time of prestress transfer on the chart.

Every year, certify the accuracy of the recording device. Display the certificate with the recorder. Place the recorder so the chart may be observed at all times during the curing cycle.

After completion of curing, submit the charts to the Representative.

5.g.3 Final Curing Phase. This phase consists of prestress transfer and beam storage.

Following prestress transfer, lower the enclosure temperature to 100F at a rate not exceeding 40F per hour until ambient temperature is reached. Conduct transfer of prestress as specified in Section 1107.03(d)5.h. Store beams as specified in Section 1107.03(f) for a minimum of 48 hours.

5.h Transfer of Prestress. Do not transfer prestress before the specified concrete strength has been attained. Retain the saturated covering on the top and sides of the beams and continue curing until final prestress transfer is complete. Transfer prestress as specified in Section 1107.03(c)6.i.

Transfer prestress not later than 5 days after casting, provided the minimum specified concrete strength at transfer has been reached. If this strength has not been reached, the Representative will declare the concrete, "deficient in strength" and may reject the deficient member.

(e) Tolerances.

1. Prestressed Concrete Members. Fabricate members to plan dimensions within the following tolerances (tolerances are not cumulative). The Representative will not accept members that deviate from tolerances unless they are accepted in accordance with Section 106.07 (c) .

1.a Prestressed Concrete I-Beams/PA Bulb-Tee Beams.

• Depth (flanges, web, and fillets)	±1/4 inch
• Depth (overall)	+1/2 inch -1/4 inch
• Width (flanges and fillets)	+3/8 inch -1/4 inch
• Width (web)	+3/8 inch -1/4 inch
• Length of beam (longitudinal tolerances based on design length, as indicated at centerline)	+1/2 inch -1 inch
• Center-to-center of bearings	+1/2 inch -1 inch
• Web Perpendicularity	Greater of 1/4 inch or 1/8 inch/vertical foot
Measurement:	While the beam is on the fabrication bed, verify web perpendicularity at beam ends, midspan, and quarter points using a bubble level. If the level indicates the web is not truly vertical, verify and record measurements establishing offset from center of top flange to center of bottom flange using a plumb bob, square, or other method acceptable to the Chief Structural Materials Engineer at beam ends, midspan, and

	quarter points along the length of the beam.
• Centerline of bearing to beam end	±3/4 inch
• Exposed beam ends (deviation from square or designated skew):	horizontal ±1/4-inch; vertical, ±1/8 inch per inch of beam height, but not more than 1/2 inch for beams up to 63 inches in depth and 3/4 inch for beams over 63 inches in depth.
• Threaded inserts (spacing between the center of inserts and from center of inserts to ends of beams)	±1/2 inch
• Concrete bearing area (deviation from plane at bottom of beam)	±1/16 inch
• Dap depths, (deviation from the specified dap depth dimensions) as measured from a straight-edge, parallel to the centerline of the beam.	±1/8 inch
• Out of plane deviation from one beam end relative to the other beam end, measured on the bottom of the beam with a level at a right angle to the beam length.(1)	±1/4 inch
• Stirrup bars (projection above top of beam)	±3/4 inch
• Stirrup bars (longitudinal spacing):	-2 inches, +1 inch for 12 inches or greater spacing and ±1/2-inch for spacing less than 12 inches
• Horizontal alignment (deviation from a straight line parallel to the beam centerline) (1)	±1/8 inch per 10 feet
• Horizontal misalignment of adjacent form sections	3/16-inch max.
• Location of each strand	±1/4 inch
• Location of each deflected strand at the beam end	±1/2 inch
• Position of post-tensioning duct	±1/4 inch
• Longitudinal position of hold-down points for deflected strands	±10 inches

• Longitudinal position of handling devices	±6 inches
• Camber differential between adjacent beams(1):	1/8 inch per 10 feet of span up to a maximum of 1 1/4 inches for beams up to 100 feet in length and 1 1/2 inches for beams over 100 feet in length.
• Camber deviation from plan camber, as measured at release or at beginning of beam storage at the fabricating plant:	
Plan camber 1 inch or greater	±50%
Plan camber less than 1 inch	±1/2 inch
• Position of positive moment connection reinforcement bars (beams made continuous):	
Horizontal position of the bar at end face of beam and end of projection, measured perpendicular to the end face of beam	3/8 inch
Projection from end face of beam	1/2 inch

Note (1) - Verify tolerance approximately 2 weeks before shipping.

1.b Prestressed Concrete Box Beams.

• Depth (overall)	+1/2 inch -1/4 inch
• Width (overall)	±1/4 inch
• Beam length at centerline (longitudinal tolerances based on design length indicated)	+1/2 inch -1 inch
• Wall thickness (web)	+3/8 inch -1/8 inch
• Depth (top slab)	±1/2 inch spread box; +1/2 inch, -1/8 inch adjacent box
• Depth (bottom slab)	+1/2 inch -1/8 inch
• Web Perpendicularity	Greater of 1/4 inch or 1/8 inch/vertical foot
Measurement:	While the beam is on the fabrication bed, verify web perpendicularity at

	beam ends, midspan, and quarter points using a bubble level. If the level indicates the web is not truly vertical, verify and record measurements establishing offset from center of top flange to center of bottom flange using a plumb bob, square, or other method acceptable to the Chief Structural Materials Engineer at beam ends, midspan, and quarter points along the length of the beam.
• Horizontal alignment (deviation from a straight line parallel to the beam centerline) [(1)]:	
Up to 40-foot lengths	1/4 inch
40-foot to 60-foot lengths	3/8 inch
Greater than 60-foot lengths	1/2 inch
• Horizontal misalignment of adjacent form sections	3/16-inch max.
• Camber deviation from plan camber, as measured at release or at beginning of beam storage at the fabrication plant:	
Plan camber 1 inch or greater	±50%
Plan camber less than 1 inch	±1/2 inch
• Camber differential between adjacent beams[(1)]:	1/4 inch per 10 feet, but not greater than 3/4-inch for beams up to 90 feet in length and 1 1/4 inches for beams over 90 feet up to 160 feet in length.
• Camber differential between minimum and maximum camber in one span[(1)]	2 inches max.
• Location of each strand	±1/4 inch
• Stirrup bars (projection above top of beam)	±3/4 inch spread box; ±1/4 inch adjacent box
• Stirrup bars (longitudinal spacing):	-2 inches, +1 inch for 12 inches or greater spacing and ±1/2-inch for spacing less than 12 inches
• Longitudinal position of hold-down points for deflected strands	±10 inches
• Bridge barrier bars (projection above top of beam)	+1-inch -0-inch* *-1/2” if shop drawings position bar above minimum shown on contract

	plans. Additional projection must be noted on accepted shop drawings.
• Longitudinal position of handling devices	±6 inches
• Concrete bearing area (variation from plane surface, when tested with a straightedge through middle half of member)	±1/8-inch
• Dap depths, (deviation from the specified dap depth dimensions) as measured from a straightedge, parallel to the centerline of the beam.	±1/8-inch
• Out of plane deviation from one beam end relative to the other beam end, measured on the bottom of the beam with a level at a right angle to the beam length.(1)	±1/4 inch
• Dowel tubes (spacing between the tube centers and from the tube centers to the member ends)	±1/2-inch
• Tie rod tubes (spacing between the tube centers and from the tube centers to the member ends)	±1/2-inch
• Tie rod tubes (spacing from tube centers to the beam bottom)	±3/8-inch
• Threaded inserts (spacing between the center of inserts and from center of inserts to ends of beams)	±1/2-inch
• Square ends (deviation from square)	±1/2-inch
• Skew ends (deviation from designated skew)	±1/2 inch
• Vertical and slanted ends (deviation from plan dimension)	±3/8-inch for beams up to 48 inches in depth and ±5/8-inch for beams over 48 inches in depth.
• Slab void position	±1/2-inch from end of void to center of post-tensioning hole
• Position of post-tensioning duct	±1/4 inch
• Position of positive moment connection reinforcement bars (beams made continuous):	
Horizontal position of the bar at end face of beam and end of projection, measured	3/8 inch

perpendicular to the end face of beam	
Projection from end face of beam	1/2 inch

Note (1) - Verify tolerance approximately 2 weeks before shipping.

1.c Prestressed Concrete Next Beams.

• Depth (stem and fillets)	±1/4 inch
• Thickness (top flange)	+1/4 inch -1/8 inch
• Depth (overall)	±1/4 inch
• Width (flanges)	±1/4 inch
• Width (stem)	±1/8 inch
• Length of beam (longitudinal tolerances based on design length, as indicated at centerline)	+1/2 inch -1 inch
• Center-to-center of bearings	+1/2 inch
• Centerline of bearing to beam end	±3/4 inch
• Stem Perpendicularity	1/8 inch/vertical foot
Measurement:	While the beam is on the fabrication bed, verify stem perpendicularity at beam ends using a special constructed jig.
• Distance between stems	±1/4 inch
• Exposed beam ends (deviation from square or designated skew)	horizontal ±1/4-inch; vertical, ±1/8 inch per foot of beam height, but no more than 1/2 inch
• Deviations of ends (vertical batter)	±3/8 inch
• Threaded inserts (spacing between the center of inserts and from center of inserts to ends of beams)	±1/2 inch
• Concrete bearing area (deviation from plane at bottom of beam)	±1/16 inch
• Blockout/Dap depths, (deviation from the specified dap depth dimensions) as measured from a straight-edge, parallel to the centerline of the beam	±1/8 inch

• Stirrup bars (projection above top of beam)	±3/4 inch
• Stirrup bars (longitudinal spacing):	-2 inches, +1 inch for 12 inches or greater spacing and ±1/2-inch for spacing less than 12 inches
• Horizontal alignment (deviation from a straight line parallel to the beam centerline) (1)	±1/8 inch per 10 feet
• Horizontal misalignment of adjacent form sections	3/16-inch max.
• Location of each strand	±1/4 inch
• Position of post-tensioning duct	±1/4 inch
• Longitudinal position of handling devices	±6 inches
• Camber differential between adjacent beams(1)	1/4 inch per 10 feet of span up to a maximum of 3/4 inch.
• Position of positive moment connection reinforcement bars (beams made continuous):	
Horizontal position of the bar at end face of beam and end of projection, measured perpendicular to the end face of beam	3/8 inch
Projection from end face of beam	1/2 inch

Note (1) - Verify tolerance approximately 2 weeks before shipping.

2. Void Forms, Outside Dimensions.

• Length	±1/2 inch
• Height and Width	-1 inch +1/8 inch

3. Closed-Cell Neoprene Sponge. Do not exceed ± 1/8 inch for laminate unevenness at the edge of finished, laminated, closed-cell neoprene sponge pads.

4. Maximum Width of Deck. (out-to-out of beams) Specified width plus 1/2 inch per joint for adjacent boxes.

5. Steel Bearings. Section 1105.03(q)

(f) Handling and Storage. Members may be handled immediately after completion of stressing. If stressing is not done in a continuous operation, do not handle members before they are sufficiently stressed to sustain the forces and bending moments due to handling. For handling, lift beams from the locations shown on the shop drawings using accepted devices.

If the air temperature is below 40F, do not remove beams from the beds until they are surface-dry. If the air temperature is below 32F, do not place beams outside the beds unless the differential between the beam temperature and the air temperature is less than 50F.

Store beams to maintain the same direction of reactions as in the final position in the bridge deck. Support stored beams as shown on the accepted shop drawings. Store the beams in areas that are suitable and accessible for inspection until the 28-day compressive strength is attained. Maintain beams in horizontal and upright positions at all times.

Separate stacked members and support them by battens placed across the full width of each bearing point or as detailed on the accepted shop drawings. Stack members so lifting devices are accessible and undamaged. Do not use the upper members of a stacked tier as storage areas for shorter members or for heavy equipment.

Before shipment, provide a rough texture to the entire keyway on adjacent box beams and completely remove oil, grease, dirt, or other material that would prevent bonding by sandblasting or other methods approved by the Chief Structural Materials Engineer.

Before shipment, mark each beam with an individual and consecutive identification mark at a permanently exposed beam location. Use the identification mark shown on the accepted shop drawings and erect beams according to the framing plan.

Do not ship beams until the Inspector places a stamp of acceptance on each beam.

(g) Transportation. Unless authorized by the Representative, do not ship beams until they have attained the minimum 28-day compressive strength shown on the shop drawings, or until 48 hours total storage time has elapsed following prestress transfer, whichever is greater.

Support the members as shown on the accepted shop drawings using adequate bracing to maintain the vertical position. Ensure supports, bracing, and shipment methods dampen vibrations. Provide adequate padding material between tie chains or cables to prevent concrete chipping.

For medium length members, pole-type trailers are satisfactory, with the member serving as the connection between truck and trailer. Trucks with double bolsters are generally satisfactory, provided:

- Fabricator provides stability calculations according to AASHTO LRFD Bridge Design Specifications. Calculations must be prepared and sealed by a Professional Engineer, registered in the State.

Observe hauling restrictions as specified in Section 107.23.

SECTION 1108—POST-TENSIONING OPERATIONS

1108.01 GENERAL REQUIREMENTS—

(a) Description. This work is prestressing, grouting, and other work related to post-tensioning operations.

(b) General. Perform post-tensioning operations in the presence of an authorized representative of the Department, either in a prestressing plant or on the project site.

Retain a Professional Engineer, registered in the State and experienced in post-tensioning operations, to be present and in charge of tensioning and grouting operations. Submit, in writing, the Engineer's name and the date and place of post-tensioning to the Structure Control Engineer 3 weeks before the start of the post-tensioning operations. A Professional Engineer, registered in the state is not necessary for post-tensioning box culverts or transversely post-tensioning adjacent box beam bridges.

At the approval of the District Structure Control Engineer, post-tensioning operations may be done under the direct supervision of a qualified supervisor maintaining an active Post-Tensioning Institute (PTI) Bonded Post-Tensioning Level 2 certification with a minimum of 3 years of related experience instead of the use of a Registered Professional Engineer. At the approval of the District Structure Control Engineer, grouting operations may be done under the direct supervision of a qualified supervisor maintaining an active American Segmental Bridge Institute (ASBI) Grouting Certification with a minimum of 3 years of related experience in lieu of a Registered Professional Engineer.

Submit, in writing to the Structure Control Engineer, the grouting crew's verifiable experience three weeks before grouting operations. At a minimum two of the grouting crew members and the grout pump operator must have current ASBI certifications.

(c) Shop Drawings. Section 105.02 and as follows:

Show the proposed method, material, and equipment including all changes to reinforcing steel. Shop drawings must show the following:

- method and sequence of stressing including complete specifications
- details of the prestressing steel
- details of the anchoring devices, bearing devices, location of splices or couplings,
- details of the working stresses, anchoring stresses,
- type of ducts,
- steel corrosion protection,
- proposed arrangement of the prestressing steel in the members,
- pressure grouting- material and equipment, and
- vent details including size, type, spacing, and location and direction of grouting.

Provide a detailed stressing force diagram showing the following:

- deviations from design forces;
- sequence of loading stages;
- friction coefficients for the duct and tendon combinations;
- friction and jacking forces;
- jacking techniques, e.g., overjacking;
- friction loss diagram, superimposed on the force diagram; and
- elongation computations.

Provide shop drawings that are signed, dated, and sealed by a Professional Engineer, registered in the State.

Unless indicated or specified, do not use a working stress greater than 0.6 f_u, a temporary stress greater than 0.75 f_u, or an anchoring stress greater than 0.7 f_u (f_u = specified minimum ultimate tensile strength of prestressing steel).

Working force and working stress are the force and stress remaining in the prestressing steel after losses including concrete creep and shrinkage, elastic concrete compression, steel losses due to stressing sequence, steel relaxation, friction and take up at anchorages, and other losses peculiar to the prestressing system.

1108.02 MATERIAL—

(a) Prestressing Steel. Use wire, strand, or bar conforming to the requirements specified in Section 1107.02(n).

(b) Corrosion Inhibitor. For use with Special Design Grout, Class D. Obtain from a manufacturer listed in Bulletin 15. Submit the grout mixture to the DME/DMM for review and approval before use.
Certify as specified in Section 106.03(b)3.

(c) Anchorages, Bearing Devices, Fittings, and Couplings. Design anchorages to develop 0.95 f_u. Design couplings to develop 1.0 f_u. Use bearing devices designed to transmit the anchor force to the concrete at bearing stress no greater than 3,000 pounds per square inch. Limit bearing device stress to 80% of its yield strength if the prestressing steel is stressed to 0.95 f_u.
Certify as specified in Section 106.03(b)3.

(d) Duct Sheathing. Unless otherwise indicated, use corrugated, rigid or semi-rigid type, galvanized steel sheathing. PVC plastic ducts, corrugated seamless polypropylene plastic duct, or smooth HDPE ducts may be used only if sufficiently secured to prevent internal bowing or sway.
Certify as specified in Section 106.03(b)3.
Minimum duct thickness for metal ducts shall be as follows:

- Strand tendons—26-gauge diameter for ducts less than or equal to 2.625 inches in diameter and 24-gauge diameter for ducts greater than 2.625 inches in diameter
- Bar tendons—31-gauge diameter

(e) Epoxy Resin. Section 1019.2(b)

(f) Water. Section 720.1

(g) Unbonded Prestressing Steel for Precast Box Culverts and Adjacent Box Beams. Encased, corrosion protected, prestressing strand for unbonded post-tensioning comprised of the following components:

1. Special Grade, 7-Wire, Uncoated, Low-Relaxation Strand. Section 1107.02(n)3.b

2. Polymer Sheathing.

2.a Material. Polypropylene, cell classification PP 210 B55542, conforming to ASTM D 4101, or polyethylene, High Density Type II, conforming to ASTM D 3350 and ASTM D 1248.

2.b Thickness and Diameter. Provide a minimum sheathing wall thickness of 0.05 inch and an inside diameter of 0.03 inch greater than the maximum diameter of the strand.

2.c Application. Apply around prestressing strand in a seamless hot-melt extrusion process. Provide a smooth, circular outside with no visible reveal of the lay of the strand.

3. Corrosion Inhibitor Compound.

3.a Material Properties. Provides corrosion protection to the strand; lubrication between the strand and sheathing; continuous non-brittle coating if exposed to a temperature of -10F; resists flow within temperature range of -10F to 110F; and chemically stable and nonreactive with prestressing strand, reinforcing steel, sheathing material, and concrete.

3.b Quantity. Not less than 2.5 pounds per 100 feet for 0.5-inch diameter strand and 3.0 pounds per 100 feet for 0.6-inch diameter strand. Completely fill the annular space between the strand and sheathing along the entire length of strand.

3.c Performance Criteria. Table A.

TABLE A
Performance Specification for Corrosion Inhibitor Compound

Test Description	Test Method	Acceptance Criteria
Dropping Point	ASTM D 566 or ASTM D 2265	Minimum 300F
Oil Separation at 160F	FTMS (Federal Test Method Standard) 791B Method 321.2	0.5% max by weight
Water Content	ASTM D 95	0.1% maximum
Flash Point (refers to oil content)	ASTM D 92	Minimum 300F
Corrosion test (5% salt fog at 100F 5 mils)	ASTM B 117	Rest Grade 7 or better after 1000 hours of exposure according to ASTM D 610
Water-soluble ions * a. Chlorides b. Nitrates c. Sulfides	 ASTM D 512 ASTM D 3867 APHA (American Public Health Association) 4500-S^2E	 10 ppm maximum 10 ppm maximum 10 ppm maximum
Soak test (5% salt fog at 100F 5 mils coating, Q Panel Type S. Immerse panels 50% in a 5% salt solution and expose to salt fog)	ASTM B 117 (modified)	No emulsification of the coating after 720 hours of exposure.
Compatibility with sheathing a. Hardness and volume after exposure of polymer to grease, 40 days at 150F b. Tensile strength change of polymer after exposure to grease, 40 days at 150F	 ASTM D 4289 (ASTM D 792 for density) ASTM D 638	 Permissible change in hardness 15%, volume 10%. Permissible change in tensile strength 30%.

* Procedure: The inside (bottom and sides) of a 1 L calibrated, graduated beaker (approximate outside diameter 105 mm, 145 mm height) is thoroughly coated with 100 ± 10 g of corrosion inhibitor compound. The coated beaker is filled with approximately 900 cc of distilled water and heated in an oven at a controlled temperature of 38 °C ± 1° for 4 hours. The water extraction is tested by the noted test procedures for the appropriate water-soluble ions. Results are reported as ppm in the extracted water.

1108.03 CONSTRUCTION—

(a) Post-Tensioning Systems. Include anchorages, fittings, sheathing, tendons, and grout.

(b) Corrosion Protection. Protect prestressing steel against physical damage, rust, and corrosion. Do not use prestressing steel with sustained physical damage, pitting, or rust that cannot be removed by wiping with a dry cloth. Do not retain prestressing steel in an ungrouted duct for more than 14 days without special acceptable corrosion protection. Pack prestressing steel in containers or other shipping forms for protection against physical damage and corrosion during shipping and storage. Place a corrosion inhibitor that prevents rust or other corrosion in the package or form or, if allowed, apply it directly to the steel or tendon.

Mark on the shipping package or form that the package contains high-strength, prestressing steel and the care to be used in handling. State the type, kind, and amount of corrosion inhibitor used, including placement date, safety orders, and instructions for use. When stressing and grouting are completed within 10 calendar days after the prestressing steel installation, rust that may form will not be cause for rejection. In this case, use of a corrosion inhibitor is not necessary.

Before use, submit the coating system for tendon corrosion protection in a bonded system for approval.

Protect bar tendons from corrosion at the job site by spraying with a rust preventative and by use of an approved protective covering over the bars.

(c) Anchorages and Bearing Devices. Use permanent-type anchorages to secure prestressing steel at the ends. Steel distribution plates or assemblies may be omitted if large enough anchorages are used in conjunction with a steel grill embedded in the concrete to effectively distribute the compressive stresses to the concrete.

For all systems of post-tensioning, set each anchorage device in all directions perpendicular to the prestressing steel axis. At both tendon ends, make accurate measurements of anchorage loss due to slippage or other causes. Compare these losses with the assumed losses shown in the post-tensioning schedule on the shop drawings. If necessary, make adjustments or corrections in the operation to reduce loss or slippage.

For special anchorage devices, test according to AASHTO LRFD Bridge Construction Specifications, Section 10.3.2.3.

(d) Installation of Sheathing Ducts. Form and place sheathing and secure it to prevent movement when concrete is placed. Make splices grout-tight.

After installation, blow the ducts clear using oil-free, compressed air for at least 5 seconds each. Plug the duct ends to prevent the entry of water or debris.

Make all splices, joints, couplings and connections to the duct and anchorages with devices or methods (mechanical couplers, plastic sleeves, heat-shrink sleeve) producing a smooth interior alignment with no lips or kinks. Use plastic welded connections on plastic sleeves and splices or use heat-shrink sleeves at the connections to seal seams. Connections must be sealed to prevent leakage.

Provide ducts or anchorage assemblies with pipes or connections for grout injection. Install 1/2 inch or larger in size pipe vents near the high points of each duct. Make vents grout-tight and provide means for grout injection, and heat-shrink wrap as necessary. Remove vent ends 1 inch below the member surface, after grouting has been completed.

For tendons made up of single prestressing bar or strand, make the inside diameter at least 1/4 inch greater than the diameter of the prestressing bar or strand. For tendons consisting of several prestressing strands, make the duct's cross-sectional area at least 2.5 times the net area of prestressing steel.

Locate ducts within the specified tolerances. For curved members, place the ducts on, or symmetrically about, the member axis parallel to the curvature direction.

Provide concrete cover a minimum of 1 1/2 inches for sheathing up to 2 inches O.D., and a minimum of 2 inches of cover for larger sheathing. Provide a minimum of 1 1/2-inch clear spacing between the sheathing at the beam ends, or provide 1 1/2 times the maximum aggregate size, whichever is greater.

After the prestressing steel has been installed, do not weld or use as a ground for welding equipment on steel in the member. Do not flame cut, unless the ducts and tendons are effectively shielded.

(e) Prestressing. Tension prestressing steel using hydraulic jacks, so the force in the prestressing steel is not less than the value indicated on the accepted shop drawings with appropriate allowance for all losses.

Within 20 days before stressing, calibrate all jacks and pressure gauge system and furnish certified copies of the load calibration curves to the Engineer except jack calibration for post-tensioning of box culverts and adjacent box beams. For post-tensioning of box culverts and adjacent box beams, accompany jack gauges with a current, certified calibration chart not older than 6 months. Equip each jack with a pressure gauge having an accurate reading dial at least 6 inches in diameter. Calibrate each jack and its gauge as a unit with the cylinder extension in four separate locations based on the final jacking force. Calibrate the jack and its gauge in the approximate 1/4 stroke, 1/2 stroke, 3/4 stroke, and final stroke position. Recalibrate stressing equipment at 6-month intervals, after mechanical failure, and if the accuracy of the stressing equipment is called into question by the Representative. Do not interchange jacks and gauges without recalibration. Check the certified calibration chart for hydraulic jacks and pressure gauges used for tensioning prestressing steel, both before and during tensioning operations.

Do not stress tendons until the concrete has attained its 28-day strength, unless partial stressing is allowed at a lower strength.

Apply an initial load of 10% of the full load to the tendon to take up slack and to provide a starting point for measurement of elongations. Apply the final load, including any overload. Apply the load at a rate consistent with procedures recommended by the manufacturer of the system.

Unless otherwise indicated, in simple span members, stress by jacking from one end only, with one-half of the prestressing steel in each member tensioned from one end and the other one-half tensioned from the opposite end.

If the same tendons are jacked from two ends, both jacking operations may be done simultaneously, provided uniform tensioning forces are applied at each end. The stressing forces, measured by jacking pressures and elongation, are required to agree within 5%. If the measurements cannot be reconciled within this range, halt the stressing, examine the procedure, and determine the sources of error so the measured force can be verified within this limit. If sources of error cannot be determined or verified by the Professional Engineer in charge of post-tensioning operations, to the satisfaction of the Engineer, the post-tensioning of the member will be stopped and the member rejected.

In continuous members, tension by jacking at each tendon end, unless otherwise indicated. Jacking of both ends need not be done simultaneously, unless otherwise indicated.

(f) Bonding and Grouting. Start grouting promptly after tensioning.

1. Grout. Use grout consisting of Portland cement, water, and admixtures. Use a Class C, prepackaged grout. Alternate grouts consisting of Type I, II, or III Portland cement may be used if an approved Special Design Grout, Class D is provided by the Design Engineer and conforms to the requirements of the Post-Tensioning Institute (PTI) M55.1 Section 3.4. Class D grouts must use non-shrink admixture and anti-bleed admixture of the type recommended by the manufacturer of an accepted tendon. Do not use admixtures containing chlorides or nitrates, or that release free hydrogen.

Use enough grout plastic to pump and completely fill the ducts. No grout shrinkage is allowed while in the plastic state. Before post-tensioning, submit the Manufacturer's data sheet of the grout to be used. to the Structure Control Engineer. If using a Class D, Special Design Grout, submit the mix design to the DME/DMM a minimum of two weeks before grouting. Design the mix and verify it has a minimum compressive strength of 2,500 pounds per square inch at 7 days and has 4% to 10% expansion. Verify strength by testing according to ASTM C 109. Limit the water content of the grout to the minimum volume necessary to produce a mix that can be pumped, with a maximum of 5 gallons per bag of cement or grout according to manufacturer's recommendations, whichever is less.

Prepare test cylinders from each day's grouting.

Visually determine the grout's ability to be pumped.

Strength testing of grout for precast box culverts is not required.

1.a Quality Control Testing – perform the following tests for each pump used for each shift or if a change in pump operator occurs. Testing must re-occur if visual or apparent changes in the characteristics of the grout occurs.

- Fluidity Test – ASTM C 939, Modified – Once every 2 hours, at the inlet. Results must be within 5 seconds of values established for grout qualification.
- Schupack Pressure Bleed Test – ASTM 1741 – Once per day, per shift at the inlet.
- API Mud Balance Test – Two (2) per day, at both the inlet and outlet. Result shall be between the values for minimum and maximum water dosage
- Change in Volume Tests (if expansive agent is used) – ASTM 1090 – Once per day. 0.0% +/- 0.1% change in 24 hours max, +0.20% change at 28 days.
- Grout Strength – ASTM 942 – Once per day, per shift at the inlet.

2. Grouting Equipment. Use equipment capable of grouting at a pressure of at least 100 pounds per square inch. Furnish equipment with a pressure gauge that has a full-scale reading of not more than 300 pounds per square inch. Provide standby flushing equipment and compressed air equipment capable of developing a pumping pressure at 250 pounds per square inch and large enough to flush out partially grouted ducts. Provide working pressure meters s that show the grout pressure at the injector nozzle discharge end on the group pumps.

3. Grouting. Clear ducts of deleterious materials that would impair grout bonding or interfere with grouting procedures.

After curing, blow ducts free of water and keep them dry until grouting. Immediately before grouting, blow the ducts out with oil-free compressed air.

Mix the grout using a high-shear colloidal mixer that produces uniform and thoroughly mixed grout. Do not retemper grout. Agitate the grout continuously until it is pumped. Before entry into the pump, screen grout through 0.07-inch maximum, clear opening screen.

Grout the ducts after completion of the tensioning operation for each unit as specified in Section 1108.03(b), unless otherwise directed.

Equip grout injection pipes with positive, mechanical shutoff valves. Fit vents and ejection pipes with valves, caps, or other devices capable of withstanding the pumping pressures. Do not remove or open valves and caps until directed, generally after the grout has set.

Apply grout by pumping toward open vents. Pump continuously, approximately 15-50 ft per minute, using moderate pressure, not to exceed 145 pounds per square inch for plastic ducts or 245 pounds per square inch for steel ducts, at the entry point in the duct, until entrapped air is forced out the open vent or vents and until visible slugs of water or air are ejected. Close the outlet pipe only after sufficient grout, equivalent to the grout being injected at the

inlet, is ejected from the outlet. With the entire duct filled and discharge vents closed, raise the pressure to a minimum of 50 pounds per square inch and hold for a minimum of 1 minute, and then plug the injection point to prevent grout loss. Close the valve at the inlet while maintaining this pressure.

3.a For box culverts:

3.a.1. Close discharge vents while applying constant grouting pressure from the injection point.

3.a.2. Once all discharge vents are closed, close the valve at the injection point and disengage the pump. Do not apply an increase in pressure after all discharge vents are closed.

Using an abrasive, blast clean the concrete surfaces at anchorage assemblies, until clean aggregate is exposed, to ensure concrete bonding or grout encasement of assemblies.

Where the end of a post-tensioned assembly is not embedded in concrete, recess the anchorages so the prestressing steel ends and parts of the anchorages will be at least 2 inches inside of the member end surface, unless a greater embedment is indicated. Following post-tensioning, clean the recesses, fill with non-shrink mortar, and finish flush. After curing, paint surfaces with two coats of epoxy resin.

SECTION 1109—GUIDE RAIL AND METAL MEDIAN BARRIER

1109.01 RAILS—As shown on the Standard Drawings and as follows:

(a) Rail Elements. AASHTO M 180, Class A, Type II; mark to show the approximate radius of curved rails.

(b) Rubbing Rails. Fabricate from steel, ASTM A1011/A1011M, with mechanical properties conforming to AASHTO M 270 (ASTM A709), Grade 36.
Galvanize as specified in Section 1105.02(s) (AASHTO M 111).
Shop form, when required, on curves having a radius of less than 150 feet, as follows:

- Notch flanges to form a curve with a series of chords of equal lengths not exceeding 18 inches (for radii from 0 to 20 feet), 3 feet for radii from 20 feet to 100 feet, and 6 1/4 feet for radii from 100 feet to 150 feet; cut notches to the proper angle and weld.
- Form so the midpoint of the chord is tangent to the curve.
- Mark to show the approximate radius of curvature.

1109.02 TERMINAL SECTIONS—As shown on the Standard Drawings and as follows:

(a) Alternate Terminal Sections. AASHTO M 180, Class A, Type II.

(b) Terminal Section Bridge Connection. AASHTO M 180, Class B, Type II.

(c) Flared Terminal Section. AASHTO M 180, Class A, Type II.

1109.03 POSTS—

(a) Steel I-Beam Posts. AASHTO M 270 (ASTM A709), Grade 36 or ASTM A769/A769M.
Galvanize as specified in Section 1105.02(s) (AASHTO M 111).

(b) Steel C-Posts and Channel Posts. Fabricate from steel, ASTM A1011/A1011M, with mechanical properties conforming to AASHTO M 270 (ASTM A709), Grade 36.
Galvanize as specified in Section 1105.02(s) (AASHTO M 111).

(c) Wood Guide Rail Posts. AASHTO M 168. As shown on the Standard Drawings and as follows:
Label each wood item with lot or batch number, plant, place, and date of manufacture.
Manufacture from timber having a minimum grade of 1,200 pounds per square inch according to the current standard grading and dressing rules of the West Coast Lumber Inspection Bureau, the Southern Pine Inspection Bureau or other acceptable timber associations. Timber to be either rough sawn (unplanned) or surfaced four sides (s4s) to the dimensions indicated. Size in the direction parallel to the axis of bolt holes to be within a tolerance of± 1/4 inch. Use one type of surface finish for posts and offset blocks in a continuous run of guide rail.
Treat timber with a preservative according to AASHTO M 133, after end cuts are made and holes are drilled. Certify as specified in Section 106.03(b)3.

(d) Breakaway Terminal Wood Posts. Section 1109.03(c)

(e) Breakaway Terminal Foundation Wood Posts. Section 1109.03(c)

1109.04 OFFSET BRACKETS—

(a) General Requirements. Provide offset brackets from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

(b) Wood Offset Brackets. As shown on the Standard Drawings and/or the approved Shop Drawings manufactured from timber having a minimum grade of 1,200 pounds per square inch according to the standard grading and dressing rules of the West Coast Lumber Inspection Bureau, the Southern Pine Inspection Bureau, or other acceptable timber associations. Treat timber with a preservative according to AASHTO M 133, after cutting ends, drilling bolt holes and, if applicable, routing. Provide brackets with a ±1/4-inch dimension tolerance in the direction of the bolt hole.

1. **Non-Routed.** Use with wood posts.

2. **Routed.** Use with steel posts.

(c) Composite Offset Brackets. As shown on the Standard Drawings and/or the approved Shop Drawings and manufactured from a combination of either virgin or recycled wood, plastic, rubber, or other materials. Provide brackets with a ±1/4-inch dimension tolerance in the direction of the bolt hole.

1. **Non-Routed.** Use with wood posts.

2. **Routed.** Use with steel posts.

1109.05 MISCELLANEOUS MATERIAL—As shown on the Standard Drawings and as follows:

(a) Nuts, Bolts, and Washers. Section 1105.02(c)1.
Galvanize as specified in Section 1105.02(s) (ASTM A153, or ASTM B695 and B696).

(b) Base Plates, Post Plates, End Post Support Angles, and Hardware. AASHTO M 270 (ASTM A709), Grade 36.
Galvanize base plates and hardware after fabrication, as specified in Section 1105.02(s) (AASHTO M 111). Do not punch, drill, grind, cut, or weld after galvanizing. Repair minor abrasions of galvanized surfaces with two coats of galvanizing paint.

(c) Rotating Bracket. Fabricate from malleable cast iron, ASTM A47 or structural steel, AASHTO M 270 (ASTM A709), Grade 36.
Galvanize as specified in Section 1105.02(s) (AASHTO M 111).

(d) Steel Spacer Tube. ASTM A53, Type S, Grade B, plain end, Schedule 40 steel pipe.
Galvanize as specified in Section 1105.02(s).

1109.06 GALVANIZING—Galvanize metal parts as specified in Section 1105.02(s) (ASTM A153 unless otherwise specified) and conform to the requirements of AASHTO M 180, Section 9.

1109.07 GALVANIZING PAINT—ASTM A780 Section 4.2.2

1109.08 WELDING MATERIAL—Section 1105.02(t)

1109.09 CERTIFICATION—Section 106.03(b)3

SECTION 1110—RIGHT-OF-WAY FENCE

1110.01 WIRE FABRIC AND COMPONENTS—As shown on the Standard Drawings and as follows:

(a) Type 1 Right-of-Way Fence.

1. Fabric. AASHTO M 181, Type I, II, or IV, 0.148-inch (No. 9 gage) coated wire size with the same type of coating throughout the project. Galvanize Type I fabric with a Class D coating.

2. Fasteners.

- For attaching the fabric to line posts: 0.192-inch (No. 6 gage) aluminum wire or 0.148-inch (No. 9 gage) galvanized preformed clips.
- For attaching the fabric to tension wires: 0.135-inch (No. 10 gage) galvanized steel wire or aluminum hog rings of comparable size.

Galvanize at a minimum of 1.6 ounces per square foot of actual surface area.

3. Tension Wire. AASHTO M 181

(b) Type 2 and Type 5 Right-of-Way Fence.

1. Fabric. Galvanized, 0.148-inch (No. 9 gage) steel wire, 0.120-inch (No. 11 gage) aluminum coated steel wire conforming to ASTM A491, or galvanized 0.148-inch (No. 9 gage) steel wire top and bottom with galvanized 0.120-inch (No. 11 gage) steel intermediate wires.

Join vertical stays at each horizontal wire by electric arc welding or by a hinge-type method, consisting of not less than 1 1/4 tightly wrapped twists.

Galvanize at a minimum of 0.6 ounce per square foot of actual surface area, as specified in Section 1110.04.

2. Fasteners. For attaching the fabric to posts; aluminum or galvanized steel bands or clamps, galvanized staples set in the post flanges, or another acceptable method.

1110.02 END POSTS, CORNER AND PULL POSTS, LINE POSTS, BRACES, STRETCHER BARS, TRUSS RODS, FITTINGS, AND HARDWARE—As shown on the Standard Drawings and as follows:

- Straight posts true to section.
- Braces, fittings, and hardware of commercial-quality steel or malleable iron.
- Posts of commercial quality steel or malleable iron, or Aluminum Alloys 6063-T6, 6005-T5, or 6061-T6, according to ASTM B221; tubular and open type sections.
- Moisture-excluding caps, firmly and rigidly secured to the post top.

Galvanize or coat both the inside and outside of tubular and open-type sections, according to AASHTO M 111. Either of two alternate coating systems may be used, as follows:

- **Outside.** Hot-dipped zinc coating, according to ASTM B6, at a minimum of 1.0 ± 0.1 ounce per square foot of actual surface area; chromate conversion coating at 30 micrograms per square inch ± 15 micrograms per square inch of actual surface area; thermoplastic electrostatically applied acrylic coating, 0.5 mil ± 0.2 mil in thickness.

and

- **Inside.** Zinc base coating, 0.5 mil ± 0.2 mil thickness (0.3 ounce per square foot ± 0.05 ounce per square foot) with a minimum of 80% zinc powder by weight.

or

- **Outside and Inside.** Hot-dipped, pure, aluminum coating, commonly identified as Type 2, with a minimum weight of coating of 0.75 ounce per square foot of actual surface area, triple spot test, and 0.70 ounce per square foot of actual surface area, single spot test, as measured according to AASHTO T 213; a chromate conversion coating; and a thin acrylic resin film.

(a) Type 1 Right-of-Way Fence.

1. End Posts. Round, rectangular, or square tubular sections, conforming to the requirements of Table A; if acceptable, other posts sections, conforming to the requirements of Table A.

Table A
Minimum Bending Moment (in-lb)[A]

Fence Height (ft)	End, Corner, and Pull Post		Line Post*	
	Major Axis	Minor Axis	Major Axis	Test Load (lbs)[B]
4	13,700	5,000	12,000	1,600
5	17,000	7,700	15,000	2,000
6	20,600	11,100	18,000	2,400
7	24,000	15,100	21,000	2,800
8	27,400	19,800	24,000	3,200

A. Bending Moment (in-lb) = Yield Strength (psi) x Section Modulus (in^3)
B. Test a 36-inch section of line post for bending capacity about the major axis of its cross section. Apply the Test Load concentrated at span center with supports spaced at 24 inches. Ensure that the test section achieves the Test Load as indicated in Table A, within the elastic limit of the material.

2. Corner and Pull Posts. Section 1110.02(a)1., except finish brace clamps or attaching devices, adjustable to various horizontal and vertical angles.

3. Line Posts. Tubular, H-column, or I-beam sections, conforming to the requirements of Table A; if acceptable, other post sections, conforming to the requirements of Table A.

4. Braces, Stretcher Bars, and Truss Rods.

- Braces: 1.66-inch O.D. tubular steel section with a minimum Bending Moment of 7050 inch-pounds; 1 5/8 inches by 1 1/4 inches roll formed U-shaped steel section at nominal 1.35 pounds per linear foot or equal.

- Stretcher Bars (for attaching the fabric), at least 3/16-inch by 3/4-inch flat steel, or equal.

- Truss Rods, 3/8-inch nominal diameter, good quality steel, or equal, with a turnbuckle or other provision for adjustment.

(b) Type 2 and Type 5 Right-of-Way Fence.

1. End, Corner, and Pull Posts. Tubular, angle, or other acceptable section, conforming to the requirements of Table A.

2. Line Posts. Tubular, ribbed tee, U-shaped, angle, or other acceptable section, conforming to the requirements of Table A.

Attach an acceptable plate or other device to the posts to hold plumb and to keep properly aligned. Fasten the plate or device by welding or riveting (not less than two rivets), or by another acceptable method.

3. Braces. 1.66-inch O.D. tubular steel section with a minimum Bending Moment of 7050 inch-pounds; 2-inch by 2-inch by 1/4-inch angle or equal.

1110.03 GATES—As shown on the Standard Drawings and as follows:

- Swing-type gates, with latches, stops, keepers, hinges, and locks.
- Steel wire fabric of same type material as the fence.
- Hinges of adequate strength to support the gate, and that do not twist or turn under the gate's action.
- Plungebar-type latches that can be locked, full gate height, and located in a manner that engages the gate stop.

Forked latches may be allowed, for single gates less than 10 feet wide.

- Stops are to consist of a flush plate, anchored in concrete, to engage the plungebar of the latch.
- Other types of stops may be allowed, for single gates less than 10 feet wide.
- Substantial devices are necessary for securing and supporting the free end of the gate in an open position.

1110.04 GALVANIZING—Galvanize fabric, posts, post caps, braces, fittings, and hardware, by electrolytic, hop-dip, mechanical, or other acceptable methods as specified in Section 1105.02(s) and as follows:

For electrolytic method: ASTM B633

For hot-dip method:

- Posts, braces, and fittings—ASTM A123 or ASTM A53
- Fabric—ASTM A392
- Hardware—ASTM A153

For mechanical method (hardware only): ASTM B695

Test galvanizing by weight, according to ASTM A90.

1110.05 INSPECTION—Material will be inspected, if considered necessary, at the place of manufacture, before shipment. Provide facilities for the Department inspector to determine that the material is being furnished as indicated.

1110.06 CERTIFICATION—Section 106.03(b)3

1110.07 DRIVE ANCHOR—Anchors from a manufacturer listed in Bulletin 15.

SECTION 1111—HIGH LOAD MULTI-ROTATIONAL BEARINGS

1111.01 DESCRIPTION—This work is the fabrication of high load multi-rotational bearings, as indicated.

1111.02 MATERIAL—Use new material at all times, with no reclaimed material incorporated in the finished bearing.

(a) Steel. Conform to AASHTO M 270 (ASTM A709), Grade 36, 50, or 50W, except for steel for guide bars and shear restriction pins and sleeves. Furnish guide bars and shear restriction mechanisms as specified by the manufacturer and that are approved.

(b) Elastomeric Disc.

1. Pot Bearings. Provide Shore A 50 Durometer and conform to the following requirements:

Furnish only virgin, crystallization-resistant polychloroprene (neoprene) or virgin, natural polyisoprene (natural rubber) as the raw polymer for the elastomeric rotational element used in the construction of pot bearings. Use individually molded and one-piece elastomers. Provide neoprene and natural rubber used in these bearings with physical properties, which conform to the following ASTM or AASHTO requirements, with the modification noted:

Compound	ASTM Requirement	AASHTO Requirement
Neoprene	ASTM D2000, Line Call Out M2BC520A14B14	AASHTO M 251
Natural Rubber	ASTM D2000, Line Call Out M4AA520A13B33	AASHTO M 251

Modification: 1) Samples for compression set tests shall be prepared using a type 2 die.
2) Shore A durometer hardness = 50 ± 10 Points

2. Disc Bearings. Provide polyether urethane conforming to the following requirements:

Physical Property	ASTM Test Method	Requirements			
		Compound A		Compound B	
		Min.	Max.	Min.	Max.
Hardness, Type D Durometer	D2240	46	50	60	64
Tensile Stress, psi	D412				
At 100% elongation		1,500	—	2,000	—
At 200% elongation		2,800	—	3,700	—
Tensile Strength, psi	D412	4,000	—	5,000	—
Ultimate Elongation, %	D412	350	—	220	—
Compression Set, 22 h @ 158F, %	D395 Method B	—	40	—	40

(c) Sliding Surfaces.

1. General. Provide polytetrafluoroethylene (PTFE) resin sheets, PTFE fabric, interlocked bronze and PTFE structures, PTFE-perforated metal composite, back-up materials and all other parts of fixed or expansion bearings containing PTFE materials having the friction, mechanical, physical, and weathering properties specified in 1111.02(c) or indicated.

2. PTFE Resin. Furnish virgin PTFE resin (not reprocessed) conforming to the requirements of ASTM D4894. Provide resin with specific gravity of 2.13 to 2.19 and Second Melting Peak Temperature of 621F ± 18F.

3. Filler Material. When filler material is used, furnish milled glass fibers (15% maximum filler percent by weight), carbon (25% maximum filler percent by weight) or fabric containing PTFE fibers, or other approved inert

filler materials.

4. Adhesive Material. Use heat cured, high temperature epoxy capable of withstanding temperatures of 385F to 500F when bonding the PTFE to its steel substrate. Provide adhesive material in epoxy resin conforming to the requirements of Federal Specification MMM-A-134 FEP film or approved equal.

5. Unfilled PTFE Sheet. Make finished unfilled PTFE sheet from virgin PTFE resin.
Ensure that finished unfilled PTFE sheet conforms to the following requirements:

Tensile Strength (minimum)	ASTM D638	2,800 psi
Elongation (minimum)	ASTM D638	200%

6. Filled PTFE Sheet. Make filled PTFE sheet from virgin PTFE resin uniformly blended with inert material.
Ensure that finished filled PTFE sheets containing glass fiber or carbon conform to the following requirements:

Requirement	ASTM Method	15% Glass Fibers	25% Carbon
Mechanical			
Tensile Strength (minimum)	D638	2,000 psi	1,300 psi
Elongation (minimum)	D638	150%	75%
Physical			
Specific Gravity	D792	2.20 ± 0.03	2.10 ± 0.03
Melting Point	D4894, D4895	621F ± 18F	621F ± 18F

7. Fabric Containing PTFE Fibers. Use manufactured fabric produced from oriented, multifilament, PTFE, fluorocarbon fibers and other fibers as required by proprietary designs. Use PTFE fibers with the following typical physical properties:

Physical Requirement	ASTM Method	PTFE Fibers
Tensile Strength (minimum)	D2256	2,400 psi
Elongation (minimum)	D2256	35%

8. Interlocked Bronze and Filled PTFE Structures. Supply interlocking bronze and filled PTFE structures consisting of a phosphor bronze plate with a 0.010-inch thick porous bronze surface layer into which is impregnated a lead/PTFE compound. Provide an overlay of compounded PTFE not less than 0.001 inch thick. Ensure that the phosphor bronze back plate conforms to ASTM B100 and the porous bronze layer conforms to ASTM B103/B103M.

9. PTFE Metal Composite. Supply PTFE metal composite consisting of virgin PTFE molded on each side and completely through a 1.32-inch perforated stainless steel ASTM A240, Type 304 sheet.

10. Surface Treatment. Where PTFE sheets are to be epoxy bonded, have an approved manufacturer factory treat one side of the PTFE sheet using the sodium naphthalene or sodium ammonia process.

11. Stainless Steel Mating Surface. Furnish stainless steel sliding surfaces conforming to ASTM A240, Type 304 with an ANSI 0.02 mil surface finish or less. Attach a stainless steel sheet by an approved welding procedure, which keeps the sheet in contact with the substrate, or weld a stainless steel overlay using Type 309L electrodes. Use 0.05-inch minimum thickness stainless steel.

12. Manufacturing Requirements. Manufacture the expansion bearing to the dimensions of and to conform to the requirements of the method of fastening to the structure as indicated.

12.a Attachment of PTFE Material. Factory-bond, mechanically connect, or recess into the back-up material PTFE material as indicated.

12.a.1 Bonding. Perform the bonding at the factory of the manufacturer of the fixed or expansion bearings under controlled conditions and according to the written instructions of the manufacturer of the approved adhesive system. Ensure that after completion of the bonding operation, the PTFE surface is smooth and free from bubbles.

Then polish filled PTFE surfaces.

12.a.2 Mechanically Fastened. If mechanically fastened, fasten PTFE sheet as indicated with the size, type, and number of fasteners required, taking care to have full bearing of the fastener used in the PTFE sheet and back-up material.

12.a.3 Fabric Containing PTFE Fibers. Bond or mechanically attach the fabric to a rigid substrate. Supply fabric capable of carrying unit loads of 10,000 pounds per square inch without cold flow. Provide a fabric-substrate bond capable of withstanding a shear force equal to 10% of the perpendicular or normal application loading without delamination in addition to the shear force developed as a result of the natural bearing friction shear force.

(d) Sealing Rings.

1. Rings with Rectangular Cross Sections. Furnish brass sealing rings conforming to ASTM B36/B36M.

2. Rings with Circular Cross Sections. Furnish round cross section metal sealing rings conforming to ASTM B16, Temper H02, half hard.

(e) Bronze Elements. Ensure that bronze bearing and expansion plates conform to the specification for Bronze Castings for Bridges and Turntables, ASTM B22. Furnish alloy C91100 unless otherwise specified.

Cast bronze plates according to the indicated details. Plane sliding surfaces parallel to the movement of the spans and polish them unless otherwise indicated.

(f) Lubricant. Furnish solid lubricant consisting of a combination of solids having non-deteriorating characteristics as well as lubricating qualities and capable of withstanding long term atmospheric exposure, de-icing materials, and water. Do not use molybdenum disulfide and other ingredients, which promote electrolytic or chemical action between the bearing elements. Do not use shellac, tars and asphalts, or petroleum solvents as binders.

1111.03 FABRICATION—

(a) Rotational Elements. Furnish elements conforming to the following requirements:

1. Pot and Disc Bearings. Manufacture from a solid plate by machining or fabricate by welding a flame-cut shape to a plate. Test all welded areas by the magnetic particle method meeting AWS D1.5/D1.5M, Clause 6 requirements. Welding is as specified in Section 1105.03(m).

Machine inside diameter (ID) of pots to a tolerance of ±0.005 inch up to 20 inches ID and ±0.007 inch over 20 inches ID.

Pots machined parallel to the inside to Class “A” tolerance.

Machined surfaces to an ANSI 125 micro-inch rms finish or better.

Elastomeric discs with tolerances as follows:

- Diameters up to 20 inches, ±1/16 inch
- Diameters greater than 20 inches, ±3/32 inch
- Total thickness of all pieces, -0 inch, +1/8 inch
- Mold discs in one piece, do not layer elastomer.

Pistons with tolerances as follows:

- Diameters up to 20 inches, ±0.005 inch.
- Diameters greater than 20 inches, ±0.007 inch.

- Upper side, Class “A” tolerance. Lower side, Class “B” tolerance.

2. Disc Bearings. Provide discs with tolerances as follows:

- Diameters up to 20 inches, ±1/16 inch.
- Diameters greater than 20 inches, ±3/32 inch.
- Thickness, -0 inch, +1/8 inch.
- Mold discs in one piece, do not layer elastomer.

Furnish bearing plates for discs with tolerances as follows:

- Diameters up to 20 inches, ±0.005 inch.
- Diameters greater than 20 inches, ±0.007 inch.
- Inside surfaces facing disc Class “A” tolerance and minimum ANSI 125 micro-inch rms finish.
- Outside surfaces, Class “A” tolerance and minimum ANSI 125 micro-inch rms finish.

3. Spherical Bearings. Provide spherical bearings with tolerances as follows:

- Machined diameters, ±0.015 inch.
- Convex radius dimensions, +0.000 inch, -0.010 inch.
- Concave radius dimensions, +0.010 inch, -0.000 inch.
- Mating surfaces to be as indicated, external edges may be “as cast” or flame-cut.
- Lower surface of convex element Class ”C” tolerance.

(b) Non-Rotational Elements (All Bearings). Furnish elements conforming to the following requirements:

Furnish masonry and distribution plates with tolerances as follows:

- Plan dimensions up to 30 inches, -0 inch, +3/16 inch
- Plan dimensions over 30 inches, -0 inch, +1/4 inch
- Thickness tolerance, -0.030 inch, +0.060 inch
- Masonry plates used with pot, disc, or spherical bearings, Class “C” tolerance for the underside and Class “A” tolerance for the upper side.

Provide PTFE sliding surfaces with tolerances as follows:

- Plan dimensions “total design area,” +5%, -0%
- Substrate flatness: Class “A” tolerance for pot and disc bearings, Class “B” tolerance for spherical bearings.
- Thickness, -0 inch, +0.063 inch per AASHTO LRFD Construction Specifications Table 18.1.4.2-1

Seal weld the stainless steel sheet around the entire perimeter using techniques, which ensure it will remain in

contact with the backing plate.

Provide an ANSI 20 micro-inch rms finish or better. Flatness to Class "A" tolerance. Furnish sole plates with tolerances as follows:

- Plan dimensions up to 30 inches, -0 inch, +3/16 inch
- Plan dimensions over 30 inches, -0 inch, +1/4 inch
- Center line thickness, -1/32 inch, +1/8 inch
- Flatness of surface in contact with steel beams, Class "B" tolerance; in contact with fresh concrete, none; in contact with stainless steel sliding surface, Class "A" tolerance; in contact with another steel plate, Class "B" tolerance.
- Minimum edge thickness, 3/4 inch
- Machined bevels to an angular tolerance of ±0.002 radians (0.115 degrees)
- Flatness of beveled surfaces, Class "A" tolerance

Provide guide bar with tolerances as follows:

- Length, unless integral with plate, ±1/8 inch
- Section dimensions, ±1/16 inch
- Flatness where it bears on another plate, Class "A" tolerance
- Bar-to-bar, nominal dimension ±1/32 inch
- Not more than 1/32 inch out of parallel

Overall bearing height not more than 1/8 inch or less than 0 inch from nominal dimension. Chamfer all edges.

(c) Determination of Flatness and Tolerances. Furnish bearings with flatness determined by the following method:

Place a precision straightedge, longer than the nominal dimension to be measured, in contact with the surface to be measured or as parallel to it as possible.

Select a feeler gage having a tolerance of ±0.001 inch and attempt to insert it under the straightedge using the least number of blades.

Flatness is acceptable if the feeler gage does not pass under the straightedge.

Flatness tolerances are arranged in the following classes:

Class "A" = 0.0005 inch × "Nominal Dimension"
Class "B" = 0.001 inch × "Nominal Dimension"
Class "C" = 0.002 inch × "Nominal Dimension"

"Nominal Dimension" is defined as the actual dimension of the plate, in inches, under the straightedge.

In determining flatness, the straightedge may be located in any position on the surface being evaluated and not necessarily at 90 degrees to the edges.

Ignore a 1-inch wide border around the plate in determining flatness.

(d) Painting. Do not paint before completion of welding.

If the time of exposure before welding is to exceed 90 calendar days, provide metal surfaces with a protective coating of clear lacquer or other approved coating.

Paint all steel surfaces as indicated and according to recommendations of the coating manufacturer.

(e) Testing. Conduct the following tests before installation of the bearings, and in the presence of the Representative.

1. Sampling. Select one sample, for testing purposes, at random from each "lot" of completed bearings at the manufacturer's plant.

A "lot" consists of one of the following:

- No more than 25 fixed bearings of one "load category"
- No more than 25 expansion bearings of one "load category"

One "load category" may consist of bearings of differing vertical force capacity but the bearings may not exceed a range of capacity differing by more than 300 kips.

2. Friction Test. Test only those bearings actually fabricated for the project.

Test a sample from each lot of expansion bearings. For all guided and nonguided expansion type bearings, measure the sliding coefficient of friction at the bearing's design capacity as specified in Section 1111.03(e)2.a, and on the fifth and fiftieth cycles, at a sliding speed of 1 inch per minute.

Calculate the sliding coefficient of friction as the horizontal force necessary to maintain continuous sliding of one bearing, divided by the bearing's vertical design capacity.

The test results will be evaluated as follows:

- Measured sliding coefficients of friction not to exceed 3%.
- Visually examine the bearing both during and after the test. Any resultant visual defects, such as bond failure, physical destruction, cold flow of TFE to the point of debonding, or damaged components will cause rejection of the lot.

2.a Test Method. Obtain approval of the test method and equipment and comply with the following requirements:

- Arrange the test so that the coefficient of friction on the first movement of the manufactured bearing can be determined.
- Clean the bearing surface before testing.
- Conduct the test at maximum working stress for the TFE surface with the test load applied continuously for 12 hours before measuring friction.
- Determine the first movement static and dynamic coefficient of friction of the test bearing at a sliding speed of less than 1 inch per minute, which is not to exceed the coefficient of friction for design in Article 14.7.25 of the LRFD specification.
- Subject the bearing specimen to 100 movements of at least 1 inch of relative movement and, if the test facility allows, the full design movement at a speed of less than 1 foot per minute. Following this test, determine the static and kinetic coefficient of friction again, which is not to exceed the values specified in Section 1111.03(e)2.a, fourth bullet. Verify that the bearing or specimen shows no appreciable sign of bond failure or other defects.

Bearings represented by test specimens passing the above requirements will be approved for use in the structure subject to on-site inspection for visible defects.

Bearings not damaged during the testing of performance characteristics may be used in the work.

3. Proof Load Test. Test one bearing from each production "lot" of fixed and expansion bearings. Load a test bearing to 150% of the bearing's rated design capacity and simultaneously subject it to a rotational range of 0.02

radians (1.146 degrees) or design rotation, whichever is greater, for a period of 1 hour.

Visually examine the bearing both during the test and upon disassembly after the test. Any resultant visual defects, such as extruded or deformed elastomer, polyether urethane or TFE, damaged seals or limited or cracked steel, will cause rejection of the lot.

During the test, for pot bearings maintain continuous and uniform contact between the steel bearing plate and steel piston for the duration of the test. For disc bearings maintain continuous and uniform contact between the polyether urethane element and the bearing plates and between the sliding steel top plate and the upper bearing plate for the duration of the test. Any observed lift-off will cause rejection of the lot.

4. Material Tests. Submit one sample of elastomer and one sample of PTFE from each "lot of material" to LTS for material testing to ensure compliance with appropriate material specifications.

(f) Packing and Shipping.

1. Packaging and Handling. Ensure that the bearings are securely banded together as units by fabricator, shipped to the job site, and stored without relative movement of the bearing parts or disassembly at any time. Wrap bearings in moisture resistant and dust resistant material to protect against shipping and job site conditions. Match mark the bearings to indicate normal position of each bearing.

Take care to ensure that bearings are stored at the job site in a dry sheltered area free from dirt or dust until installation.

Inspect bearings within one week after arriving on the project. Do not disassemble unless the fabricator's representative is present. Following inspection, rewrap the bearings to keep them clean until installation.

Do not remove the sole and top plates of bearings for separate attachment to the structure except under the direct supervision of the fabricator.

Do not remove the sole and top plates of bearings for separate attachment to the structure except under the direct supervision of the fabricator.

With each shipment, enclose a copy of the materials, fabrication, and testing compliance certifications.

(g) Shop Drawings. Submit as specified in Section 105.02(d) and include the following information:

- The total quantity of each kind of bearing required (fixed, guided-expansion, or non-guided expansion), grouped first according to type (load range) and then by actual design capacity.
- Plan view and section elevation including all relative dimensions.
- Details of all components and sections showing all materials incorporated into the bearing.
- All ASTM, AASHTO, and other material designations.
- The maximum design coefficient of friction as indicated.
- Clearly describe and detail any welding process used in the bearing manufacture that does not conform to the approved processes of the AWS code.
- Vertical, horizontal, rotation, movement, and load capacity.
- A schedule of all bearing offsets, if required by the project.
- Alignment plans.
- Paint or coating requirements.
- Installation scheme.
- Complete design calculations verifying conformance with the provisions of this specification. Stress analysis and the mechanics of standard bearing details are not required.

- Anchorage details.
- Bearing pre-set details.
- Location of the fabrication plant.
- The manufacturer's name and the name of its representative responsible for coordinating production, sampling, and testing.

(h) Certification. Ensure that the fabricator provides a certification package as specified in Section 106.03(b)3 and containing the following:

- Material test reports for all steels used except AISI C1018 and C1020 for which a mill conformance certificate is acceptable.
- Certificate of Compliance for all non-ferrous metals.
- Material test reports for any elastomeric components.
- Certificate of Compliance for PTFE and any adhesive used.
- A Certificate of Compliance for the bearings, executed by an officer of the manufacturing company.
- Certificate of Compliance for any dowels or bolts supplied.
- Test reports for the performance tests.

SECTION 1112—GLUED LAMINATED HARDWOOD TIMBER MEMBERS

1112.01 GENERAL REQUIREMENTS—

(a) Description. This work is the fabrication, treatment, delivery, and storage of hardwood glued laminated timber for structural members.

(b) Definitions.

1. Glued Laminated Hardwood Timber. An engineered, stress-rated product of a timber laminating plant, comprising assemblies of suitably selected and prepared laminations bonded together with adhesives.

2. Lamination. The separate lamination thickness shall not exceed 2 inches or be less than 3/4 inch. They may be comprised of pieces jointed to form any specific lamination length.

Laminations formed in combination using narrower pieces are not acceptable for bridge stringers.

Laminations bent and glued to curve form are accepted for use.

3. Exterior Use Adhesives. Use adhesives that perform satisfactorily for all moisture conditions, including exposure to weather, marine use, and where approved preservative pressure treatments are used after gluing. Accepted exterior use adhesives conform to current ANSI/AITC A190.1 requirements.

(c) Prequalification. Unless otherwise specified, timber fabricators will be required to prequalify to perform work for the Department by establishing proof of their competency in fabricating members conforming to the current ANSI/AITC A190.1.

Certification of the plant/shop will be performed by the LTS, and submission of a valid certificate to the Structural Materials Engineer, at 81 Lab Lane, Harrisburg, PA 17110, is required by the Department. An annual endorsed copy is required for continued qualification.

(d) Shop Drawings. Section 105.02 and as follows:

Design bridge members in lengths, depths, and widths that can be transported from fabrication source to the project.

Provide design computations prepared by a Professional Engineer registered in the State for Department approval.

It is the Department's prerogative to accept or reject the changes by the Contractor.

(e) Inspection.

1. General. The LTS will supervise fabrication and treatment inspection. Provide at least 14 calendar days notice of the beginning of work to the Department so that arrangements can be made for inspection.

The Department may waive fabrication or treatment shop inspection and make a complete inspection at a later stage of the construction sequence.

Provide material certification, in duplicate, ensuring that the components used in fabrication were in conformance with material specifications.

2. Facilities for Inspection. Furnish necessary supplies for the inspection of materials and workmanship. Allow Inspectors unrestricted access to the premises during plant working hours. Necessary facilities for inspection include a Type C field office as specified in Section 609.

3. Plant Inspector's Authority. Plant inspectors have the authority to reject any material or work that does not conform to the requirements of these Specifications.

In case of dispute, the Contractor may appeal to the Representative, whose decision will be final.

4. Rejections. Material, workmanship, or finished members accepted by the inspector at the fabricator's plant and treatment plant may be rejected later if they do not conform to the specifications.

5. Testing. Perform all certification tests when required according to the provisions of the current AITC 200 Inspection Manual or another trade association that certifies glued laminated timber under ANSI/AITC A190.1. Perform all preservative testing according to AWPA Standards.

6. Mill Orders and Shipping Statements. Furnish copies of mill orders and shipping statements, as directed. Ensure that the fabricator presents a copy of the shipping invoice to be stamped for verification of inspection and approval of timber items before shipment to the Department's shop inspector. Forward the stamped copy with the shipment for the project file.

(f) Storage of Materials. Section 106.05 and as follows:

Store fabricated glued laminated materials above ground upon suitable platforms, skids, or other supports.

Keep material free from dirt or other foreign materials and properly protected from moisture. Store glued laminated materials to avoid water or high humidity exposure.

1112.02 MATERIAL—

(a) Lumber.

1. General. Ensure that lumber conforms to the manufacturer's requirements under the American Softwood Lumber Standard PS 20-70. Use only Red Maple, Northern Red Oak, or Yellow Poplar.

2. Grading. Grade the lumber according to appropriate grading agency or inspection bureau rules. Grade red maple and northern red oak according to Northeast Lumber Manufacturer's Association (NELMA) rules.

Grade yellow poplar according to Northern Softwood Lumber Bureau (NSLB) rules.

Certify as specified in Section 106.03(b)3.

3. Moisture Content. Maintain average moisture content of hardwood lumber at 12% to 15%.

Any deviations from these lumber moisture content conditions must be approved.

(b) Adhesives.

1. General. Use any fully exterior adhesive for face joint bonding of laminations provided that adhesives have been qualified under appropriate sections of ANSI/AITC A190.1.

Acceptable face bonding includes either a 100% resorcinolic adhesive or in formulation with phenolic base adhesives.

End-joint connections must be bonded with a similar fully exterior adhesive or a 100% melamine base adhesive.

2. Exterior Adhesives. Examples of adhesive formulations shown acceptable for face lamination are:

Cascophen RS-254 (Resorcinol Adhesive)
Penacolite G1131 (Resorcinol Adhesive)
Cascophen LT-75 (Phenol with Resorcinol Adhesive)
Cascophen LT-5210 (Phenol with Resorcinol Adhesive)
Penacolite G1260 (Phenol with Resorcinol Adhesive)

Acceptable performance with use of these exterior adhesives is species dependent and is maintained through strict lamination procedures to achieve optimum bond development.

(c) Marking.

1. Mark all glued laminated hardwood timber bending members for orientation of end-use application. Mark straight or slightly cambered members with identification to denote proper top versus bottom beam orientation.

2. Include the word "TOP" by permanently labelling with routed letters approximately (2 inches high with identifications.

Members intended for axial load application or of symmetric construction suited for either up or down installation need not be labelled.

Appropriately stamp members with a quality mark or other documentation indicating conformance with ANSI/AITC A190.1. Certify as specified in Section 106.03(b)3.

(d) Treatment Chemicals. Treat northern Red Oak, Red Maple, and Yellow Poplar glued laminated members with an AWPA accepted oil base preservative. For creosote or creosote solution treat to a minimum 11.5 pounds per cubic foot assay retention. Other oil base treatments must meet minimum retentions conforming to AWPA C14.

Conduct retention and penetration assay according to AWPA C28.

Sample Northern Red Oak and Red Maple for soil contact as required for Southern Pine (refer to AWPA C28, Table 1).

Sample Yellow Poplar for soil contact as required for Pacific Coast Douglas-Fir (refer to AWPA C28, Table 1).

1112.03 FABRICATION—

(a) Required Standards. Fabricate structural glued laminated hardwood timber according to the requirements put forth in the current ANSI/AITC A190.1 and AITC 119.

Treat all structural glued laminated bridge members to minimum retention and penetration requirements.

(b) Lumber Preparation.

1. Moisture Content. Maintain moisture content for lumber received, at the Laminator's shop/plant, between 12% and 15%.

2. Surfacing Tolerances. Current ANSI/AITC A190.1.

3. End Joints. Current ANSI/AITC A190.1.

(c) Laminating Requirements. Current ANSI/AITC A190.1. Conduct red maple and yellow poplar lamination fabrication according to the general requirements for a 24F-E4 or 24F-E1 southern pine glued laminated timber (refer to AITC 117, Table 1) with special lumber stiffness and edge knot restrictions as follows:

Outer Tension Zone	10% 2.0-1/6 E-rated
Inner Tension Zone	15% 1.8-1/3 E-rated
Core	50% No. 2 VSR (NELMA, NSLB)
Inner Compression Zone	15% 1.8-1/3 E-rated
Outer Compression Zone	10% 2.0-1/3 E-rated

Conduct Northern Red Oak lamination according to the AITC 119 for the fabrication of Combination A glued-laminated timbers.

For applications other than girders no special laminating requirements apply other than minimum No. 2 lumber grade.

Provide hardwood glued laminated timbers at the treatment facility conforming to these requirements with a minimum 12% and maximum 19% moisture content.

Accept only hardwood glued laminated timbers that conform to these requirements. Certify as specified in Section 106.03(b)3.

(d) Surfacing of Laminated Members. Surface according to AITC 110. Provide industrial appearance hardwood glued-laminated members.

(e) Holes and Countersinks for Bolts, Dowels, Rods, Nails, and Screws.

1. Preservative Treatment. Section 1031.3(b)1

2. Location Tolerances. Section 1031.3(b)1 and 1031.3(b)2

3. Temporary Attachments. Section 1031.3(e)

4. Diameter. Size holes for driftpins, machine bolts, rods, and lag screws to allow in-service shrinkage and swelling of the wood. For dowels, drifts, pins and rods, match the hole diameter with the connection shank. For lag screws, refer to National Design Specifications (NDS), NDS Section 9.1.2. For machine bolts, refer to NDS Section 8.1.2 for size.

(f) Shop Assembly. Ensure that all fabricated members assemble together according to the shop and design drawings before shipping components to the job site.

1112.04 TREATMENT—

(a) General. Treat all glued laminated hardwood timber surfaces with an approved oil-borne preservative conforming to AWPA C1.

(b) Treatment Facilities. All treatment facilities must be prequalified by the Department by establishing proof of their competency and efficacy of their treating operation with theLTS.

(c) Creosote Treating Cycle. An empty cell cycle shall be used for creosote treatment of northern red oak, red maple and yellow poplar glued laminated timber bridge members. Provide initial air pressure between 140 kPa and 20 pounds per square inch and 30 pounds per square inch. Creosote solutions shall be introduced into the chamber and pressurized to 150 pounds per square inch to 200 pounds per square inch. The actual pressure will depend upon hardwood species being treated. Treatment temperature shall be between 190F and 210F. Continue treatment pressure and temperature until 12 pounds per cubic foot gauge retention is achieved. Gauge retention is confirmed by assay measurement to ensure a minimum 11.5 pounds per cubic foot creosote retention.

Following the pressure cycle, the pressure shall be released in a slow step down manner over a 1-hour period. An expansion bath during the “slow pressure release” shall be used with an increase in temperature in the treating chamber of 43F following the pressure release. The creosote solution is removed from the cylinder and a minimum vacuum of 11 pounds per square inch shall be applied for 2 hours. At this time the vacuum is released to atmospheric pressure and, if possible, the surface is steamed for 1 hour. A final minimum vacuum of 11 pounds per square inch is applied to the treated members for 2 hours.

This treating cycle will ensure a minimum amount of exudate during the service life of the member. It is the Department's prerogative to accept or reject treated hardwood glued laminated members, after pressure treatment that do not minimize exudate.

(d) Field Treatment. Field treat any preservative treated hardwood according to AWPA M4.

(e) Finish. Oil-borne preservative treated hardwood glued laminated members do not require a finish or sealer treatment. Do not use treated hardwood glued laminated railings where prolonged exposure to direct human contact is likely without application of a finish sealer.

Provide a two-coat sealer application for finish treatment for treated railings where prolonged exposure is likely. Acceptable sealers include latex epoxy, urethane, shellac, or other finishes that are effective coating agents that adhere to treated rails.

(f) Shipping, Field Storage, and Field Handling.

1. Storage and Handling. Section 1031.3(a)

2. Cuts and Abrasions. Section 1031.3(e)

3. Temporary Attachments. Section 1031.3(e)

SECTION 1113—PLAIN AND LAMINATED NEOPRENE BEARING PADS

1113.01 GENERAL REQUIREMENTS—

(a) Description. This work is the fabrication, furnishing, transportation, and delivery of plain and laminated neoprene bearing pads.

(b) General Requirements. Furnish bearing pads with the dimensions, material properties, elastomer grades, and laminate types indicated.

(c) Definition of Terms.

1. **Unreinforced Bearing Pads.** Elastomeric bearing pads consisting of elastomer only.

2. **Reinforced Bearing Pads.** Elastomeric bearing pads reinforced with steel or fabric laminates.

1113.02 MATERIAL—

(a) Elastomer. Furnish virgin Neoprene (polychloroprene) elastomer. Provide low temperature grade 0, 2, 3, 4, or 5 elastomer compound. Elastomer compound grades are defined by the testing requirements in Table A. Substitution of a higher grade of elastomer for a lower one is permissible.

Provide elastomer compound conforming to Table A unless otherwise directed. Interpolate test requirements for any intermediate specified hardness. If the material is specified by its shear modulus, furnish material with a measured shear modulus that is within 15% of the specified value. For the purpose of defining limits for the tests in Table A, supply material with a consistent value of hardness. If the material is specified by its hardness, furnish material with a measured shear modulus that conforms to Table 14.7.5.2-1 of the LRFD Specification. When test specimens are cut from the finished product, the physical properties are allowed to vary from those specified in Table A by 10%. Conduct all material tests at 73F ± 4F unless otherwise noted. Conduct shear modulus tests according to Annex A of ASTM D4014.

(b) Steel Laminates. Fabricate steel laminates used for reinforcement from rolled mild steel conforming to A 36/A36M, ASTM A1011, or equivalent, unless otherwise directed. Furnish laminates with a minimum nominal thickness of 16 gage. Do not make holes in plates for manufacturing purposes unless indicated.

(c) Fabric Reinforcement. Weave fabric reinforcement from 100% glass fibers of “E” type yarn with continuous fibers. Provide a minimum thread count in either direction of ten threads per 25 threads per inch. Furnish fabric having either a crowfoot or an 8 Hardness Satin weave. Ensure each ply of fabric has a minimum breaking strength of 800 pounds per inch in each thread direction. Holes in the fabric are not allowed.

(d) Bond. Provide a vulcanized bond between the fabric reinforcement and elastomer with a minimum peel strength of 30 pounds per inch. Supply steel laminated bearing pads that develop a minimum peel strength of 40 pounds per inch. Perform peel strength tests according to ASTM D429, Method B.

1113.03 FABRICATION—

(a) General. Ensure that the bearing pads conform to the requirements for flash tolerance, finish, and appearance included in the latest edition of The ARPM Rubber Handbook for Molded, Extruded, Lathe Cut and Cellular Products, MO-1, published by the Association for Rubber Products Manufacturers; RMA F3 AND T.063 for molded bearing pads and RMA F2 for extruded bearing pads.

(b) Laminated Bearing Pads with Steel Reinforcement. Cast laminated bearing pads with steel reinforcement as a unit in a mold. Bond and vulcanize bearing pads under heat and pressure. Ensure that the mold finish conforms to standard shop practice. Sand blast and clean the internal steel laminates to remove all surface coatings, rust, mill scale, and dirt before bonding, and ensure that the internal steel laminates are free of sharp edges and burrs. For bearing

pads that are designed to act as a single unit with a given shape factor, manufacture the bearing pads as single units. Repair all cavities left in the edges of the bearing pad from the manufacturing process by in-plant vulcanizing with neoprene material from the same lot as the bearing pad.

(c) Laminated Bearing Pads with Fabric Reinforcement. Vulcanize fabric-reinforced bearing pads in large sheets and cut to size. Perform cutting in such a way to avoid heating the materials and to produce a smooth finish with no separation of the fabric from the elastomer. Furnish at least single ply fabric reinforcement for the top and bottom reinforcement layers and double ply for internal reinforcement layers. Place fabric parallel to the top and bottom surfaces. Ensure that the fabric is free of folds and ripples.

(d) Plain Bearing Pads. Mold, extrude, or vulcanize plain bearing pads in large sheets and cut to size. Ensure that cutting does not heat the material, but produces a smooth finish.

(e) Marking and Certification. Provide the manufacturer's certification that each bearing pad satisfies the requirements of the plans and these Specifications. Provide a certified copy of the material test results. Mark each bearing pad (both reinforced and plain) in indelible ink or flexible paint. Include the orientation, the order number, lot number, bearing identification number, and elastomer type and grade number in the marking. Unless otherwise specified in the contract documents, place the markings on the face that is visible after erection of the bridge.

(f) Testing. Sample the completed bearing pads according to PTM No. 312.

1. Scope. Test materials for elastomeric bearing pads and finished bearing pads according to Table A and as specified below.

TABLE A
Neoprene Quality Control Tests

Property		Test Method	Minimum Requirements		
			Type 50	**Type 60**	**Type 70**
Physical Properties	• Hardness (Shore A Durometer) • Tensile Strength, Min. psi • Ultimate Elongation, min. %	ASTM D2240 ASTM D412	50 ± 5 2,250 400	60 ± 5 2,250 350	70 ± 5 2,250 300
Heat Resistance	• Change in Durometer Hardness, max. points • Change in Tensile Strength, max. % • Change in Ultimate Elongation, max. %	ASTM D573 70 h @ 212F	15 -15 -40	15 -15 -40	15 -15 -40
Compression Set	• 22 h @ 212 F, max. %	ASTM D395 Method B	35	35	35
Ozone	• 100 pphm Ozone in Air by Volume, 20% Strain 100F ± 2F 100 h	ASTM D1149 Method B, Procedure B1	No Cracks	No Cracks	No Cracks
Low Temperature Brittleness	• Grades 0 & 2 • Grade 3 Tested @ -40F • Grade 4 Tested @ -55F • Grade 5 Tested @ -70F	No test required ASTM D746 Procedure B	 No Failure No Failure No Failure	 No Failure No Failure No Failure	 No Failure No Failure No Failure
Instantaneous Thermal Stiffening	• Grades 0 & 2 @ -25F • Grade 3 Tested @ -40F • Grade 4 Tested @ -50F • Grade 5 Tested @ -65F	ASTM D1043	Stiffness(1) at test temperature not to exceed 4 times the stiffness measured at 73F.		
Low Temperature Crystallation	• Grade 0 • Grade 2, 7 days @ 0F	No test required			

	• Grade 3, 14 days @ -15F • Grade 4, 21 days @ -35F • Grade 5, 28 days @ -35F	Quad Shear Test as described(2)	Stiffness(1) at test time and temperature not to exceed 4 times the stiffness at 73F with no time delay.

(1) Note in Table A that ASTM D1043 refers to "modulus of rigidity", while ASTM D4014, referenced in the text, refers to "shear modulus stiffness". The word "stiffness" is used in Table A to cover both terms.

(2) Measure the stiffness with a quad shear rig in an enclosed freezer unit. Take test specimens from a randomly selected bearing pad. Use a 25% strain cycle and apply a complete cycle of strain with a period of 100 seconds. Discard the first 3/4 cycle of strain and determine the stiffness by the slope of the force deflection curve for the next 1/2 cycle of loading.

2. Frequency of Testing. Conduct ambient temperature tests as specified in Section 1113.03(f)3 for each lot of bearing pads. Provide test certificates from the supplier for each lot of steel or fabric reinforcement.

Conduct low temperature tests as specified in Section 1113.03(f)4 for each lot of bearing pads.

Visually inspect every finished bearing pad as specified in Section 1113.03(f)5.

Conduct short-duration compression tests as specified in Section 1113.03(f)6 on every steel reinforced bearing pad.

If required, conduct shear stiffness tests on material from a random sample of the finished bearings as specified in Section 1113.03(f)8.

3. Ambient Temperature Tests on the Elastomer. Use elastomer conforming to Table A for durometer hardness, tensile strength, ultimate elongation, heat resistance, compression set, and ozone resistance. Ensure that the bond to the reinforcement conforms to the requirements specified in Section 1113.02(d).

Test the shear modulus of the material at 73F according to Annex A of ASTM D4014. Ensure that the measured shear modulus is within 15% of the specified value. If no shear modulus is specified, ensure that the hardness falls within the range given in Article 14.7.5.2 and Article 14.7.6.2 of the LRFD Specification. Instead of performing a shear modulus test for each batch of material, the manufacturer may, if permitted, provide certificates from tests performed on identical formulations within the preceding year.

4. Low Temperature Tests on the Elastomer. Conduct low temperature brittleness tests (ASTM D746), instantaneous low temperature stiffness tests (ASTM D1043), and low temperature crystallization tests (ASTM D4014) on grades 3, 4, and 5 elastomers. For grade 3 elastomers, instead of conducting low temperature crystallization tests, the manufacturer may provide certificates from low temperature crystallization tests performed on identical material within the last year, unless the tests are required.

Conduct instantaneous low temperature stiffness tests (ASTM D1043) on grades 0 and 2 elastomers. If required, conduct low temperature brittleness tests (ASTM D746) and low temperature crystallization tests (ASTM D4014) on grades 0 and 2 elastomers.

Perform all tests according to Table A and ensure the compound satisfies all limits for its grade.

5. Visual Inspection of the Finished Bearing Pad. Inspect every finished bearing pad for compliance with dimensional tolerances and for overall quality of manufacture. In steel reinforced bearing pads, protect the edges of the steel everywhere from corrosion.

6. Short-Duration Compression Tests on Bearing Pads. Load the bearing pad in compression to 1.5 times its maximum design load. Hold the load constant for 5 minutes, remove, and reapply for another 5 minutes. Visually examine the bearing pad while under the second loading. If the bulging pattern suggests laminate parallelism or a layer thickness that is outside the specified tolerances, or poor laminate bond, reject the bearing pad. If there are three or more separate surface cracks that are greater than 0.08 inch wide and 0.08 inch deep, reject the bearing pad.

7. Long-Duration Compression Tests on Bearing Pads. Load the bearing pad in compression to 1.5 times its maximum design load for a minimum period of 15 hours. If during the test the load falls below 1.3 times the maximum design load, increase the test duration by the period of time for which the load is below this limit. Visually examine the bearing pad at the end of the test while it is still under load. If the bulging pattern suggests laminate parallelism or a layer thickness that is outside the specified tolerances, or poor laminate bond, reject the bearing pad. If there are three or more separate surface cracks that are greater than 0.08 inch wide and 0.08 inch deep, reject the bearing pad.

8. Shear Modulus Tests on Material from Bearing Pads. Cut a specimen from the finished bearing and test the shear modulus of the material according to Annex A of ASTM D4014, or, if acceptable, conduct a comparable nondestructive stiffness test on a pair of finished bearing pads. Ensure that the measured shear modulus is within 15% of the specified value. If no shear modulus is specified, ensure that the hardness falls within the range given in Article 14.7.5.2and Article 14.7.6.2 of the LRFD Specification. If the test is conducted on finished bearing pads, compute the material shear modulus from the measured shear stiffness of the bearing pad, taking due account of the influence on shear stiffness of bearing pad geometry and compressive load.

(g) Tolerances. Measure Overall Height and Overall Horizontal Dimensions of bearing pads according to ASTM D3767, modified as follows: Measure dimensions 4 inches or less according to ASTM D3767 Procedure B. Measure dimensions greater than 4 inches according to ASTM D3767 Procedure C. Provide finished bearing pads within the following tolerances:

• Overall Height	
Design Thickness 1 1/4 inches or less	+1/8 inch
Design Thickness over 1 1/4 inches	+1/4 inch
• Overall Horizontal Dimensions	
3 feet or less	+1/4 inch
Over 3 feet	+1/2 inch
• Thickness of Individual Layers of Elastomer (Laminated Bearing Pads Only) At any point within the bearing pads	±20% of design value but no more than ±1/8 inch
• Parallelism with Opposite Face	
Top and bottom	0.005 rad
Sides	0.02 rad
• Position of Exposed Connection Members Hole, slots or inserts	±1/8 inch
• Edge Cover Embedded laminates or connection members	+1/8 inch
• Thickness Top and bottom cover layer (if required)	-0, the smaller of 1/16 inch and +20% of the nominal cover layer thickness
• Size Holes, slots, or inserts	±1/8 inch

(h) Bedding Material for Bridge Shoes. Manufacture material from elastomeric material reinforced with organic fiber as filler material. The fiber may be oriented or random (Type I), or in the form of fabric (single or multiple laminations, Type II). Certify as specified in Section 106.03(b)3. Furnish finished bedding material conforming to the following requirements:

	Type I	**Type II**
1. **Tensile Strength.** ASTM D378, Die A, min.	500 psi	1,500 psi
2. **Oven Aging.** 7 days at 158F, change in actual tensile strength not to exceed	±40%	±40%

3. Compressibility. ASTM F36, Procedure H., without high temperature preconditioning	min. max.	10% 20%	0% 20%
4. Compressive Strength. 4-inch by 4-inch specimen, compressed to rupture between flat plates		5,000 psi	8,000 psi
5. Water Absorption. 24-hour immersion	max.	3.5%	0%

SECTION 1119—THRIE BEAM GUIDE RAIL

1119.01 RAILS—As shown on the Standard Drawings and as follows:

(a) Rail Elements. AASHTO M 180, Class A, Type II; mark to show the approximate radius of curved rails.

(b) Transition Section. AASHTO M 180, Class B, Type II; mark to show the approximate radius of curved rails.

1119.02 TERMINAL SECTIONS—As shown on the Standard Drawings and as follows:

(a) Terminal Section Bridge Connection. AASHTO M 180, Class B, Type II

1119.03 POSTS—As shown on the Standard Drawings and as follows:

(a) Steel I-Beam Posts. AASHTO M 270 (ASTM A709), Grade 36 or ASTM A769

(b) Galvanize as specified in Section 1105.02(s) (AASHTO M 111)

1119.04 OFFSET BRACKETS—Section 1109.04

1119.05 MISCELLANEOUS MATERIAL—As shown on the Standard Drawings and as follows:

(a) Nuts, Bolts, and Washers. Section 1105.02(c)1. Galvanize as specified in Section 1105.02(s) (ASTM A153 or ASTM B695 and B696).

(b) Miscellaneous Hardware. AASHTO M 270/M 270M (ASTM A709), Grade 36.
Galvanize hardware after fabrication, as specified in Section 1105.02(s) (AASHTO M 111). Do not punch, drill, grind, cut, or weld after galvanizing. Repair minor abrasions of galvanized surfaces with two coats of galvanizing paint.

1119.06 GALVANIZING— Galvanize metal parts as specified in Section 1105.02(s) (ASTM A153 unless otherwise specified) and conform to the requirements of AASHTO M 180, Section 9.

1119.07 GALVANIZING PAINT—ASTM A780 Section 4.2.2

1119.08 WELDING MATERIAL—Section 1105.02(t)

1119.09 CERTIFICATION—Section 106.03(b)3

SECTION 1124—TEMPORARY TRAFFIC CONTROL SIGNALS

1124.01 GENERAL REQUIREMENTS—Provide, install, maintain, relocate, reset, and remove portable traffic control signal systems for stationary operations. Document training or proficiency regarding the operation of the devices.

Provide Bulletin 15 approved products as indicated in Section 1104.01. Submit a completed temporary traffic signal permit application as indicated in Publication 213 and obtain Department approval prior to installation. The contractor owns, maintains, and operates the temporary traffic control signal and shall correct all signal failures or malfunctions in a timely manner.

Comply with Publication 213 and Part 4 of the Manual on Uniform Traffic Control Devices (MUTCD). Certify as specified in Section 106.03(b)3.

1124.02 TEMPORARY TRAFFIC CONTROL SIGNALS ON FIXED SUPPORTS—

(a) Design. Provide temporary signal system on fixed supports. Furnish, install, maintain, and remove all items required to provide a temporary signal system as indicated on the approved plans.

(b) Signs. In accordance with Sections 931.2, 935.2, 936.2, and 1103 and as follows:

Install additional signs and devices as required in Publications 149, 213, and 236, the approved traffic control plan, and as required based on actual site conditions and as directed by the Representative.

(c) Pavement Markings. In accordance with Section 961.2

(d) Controller Assembly. In accordance with Sections 952.2, 1104.01, and 1104.03 and as follows:

Provide a controller with minimum 3-cycle operation, auto-manual switch and a manual control button with flexible cord.

(e) Electrical Distribution. In accordance with Sections 910.2, 954.2, 1104.01, and 1104.05 and as follows:

Establish an electrical service agreement with the appropriate power company to furnish and install electrical service to the signal. Follow all power company procedures and specifications for obtaining the agreement and providing power to the system. Provide any additional materials required to provide electrical service at no additional cost. All agreement fees, installation, maintenance, removal, and energy supply costs are incidental to this item.

(f) Signal Heads. Sections 955.2, 1104.01, and 1104.06

(g) Detection. Sections 956.2, 1104.01, and 1104.07 or otherwise indicated on the approved plans.

(h) Support Poles. Section 952.2, 1104.01, and 1104.02 and as follows:

Use signal poles of wood, galvanized steel, or painted steel. Steel poles may be used in lieu of wood poles at no additional cost in order to eliminate encroachments on adjacent properties. Provide certification that the signal poles are designed to withstand the anticipated loading. Install the poles to provide transverse and vertical clearance as specified on the approved plans and in accordance with the Standard Drawings. All temporary signal equipment, especially poles and guy wires, must be within public Right-of-Way (Department or Municipal). If guy wires cannot be located on public Right-of-Way, written permission from adjacent property owners is required.

(i) System Testing. Notify the Representative and the appropriate Traffic Signals Section a minimum of 7 calendar days before a turn-on and a new construction phase. For locations that are currently unsignalized, flash signals for 3 to 7 consecutive calendar days before normal operation unless otherwise authorized by the appropriate District Traffic Engineer. Refer to Section 1104.01for additional details.

Make any timing adjustments as directed by the Representative and document accordingly on the approved plans. Any modifications will require Representative authorization and the approved plans to be updated accordingly.

Submit any proposed signal timing changes to the Representative for approval prior to implementation. Timing adjustments and/or other approved plan modifications will be considered incidental to this item.

1124.03 TEMPORARY TRAFFIC CONTROL SIGNALS ON PEDESTAL-MOUNTED PORTABLE TRAFFIC CONTROL SIGNAL SYSTEMS—

(a) System Configuration and Application. Furnish each pedestal-mounted portable traffic control signal system consisting of a minimum of two pedestal-mounted signal head units per approach or as directed by the approved plans.

Use trailer- or pedestal-mounted portable traffic signals only for single-lane, alternating one-way traffic, short-term, stationary applications as directed in Publication 213, which includes: daylight work zones; emergency nighttime work where work is in active progress and authorized by the District Traffic Engineer; or work which begins during the daylight and continues in active progress during hours of darkness with authorization from the District Traffic Engineer.

(b) Pedestal Units.

1. Structural Adequacy. Provide a structurally adequate unit to support all pedestal-mounted equipment. Furnish units with adequate structural integrity to enable lifting and placing them as required.

2. Stability. Provide units with acceptable stability and a suitable means for ballasting.

3. Assembly Mechanisms. Equip each unit with tires and retractable handles to facilitate deployment, relocation, and removal. Mount signal heads on a retractable vertical upright equipped with a manual hand crank. Provide assembly mechanisms for simplicity and quick operation to keep set up and take down time to a minimum and to enable operation by one person.

4. Labels. Mark the manufacturer, serial number, and emergency phone number permanently on each using a decal, metal plate, or other means suitable to the Department.

(c) Signal Displays.

1. Vertical Clearance. Mount the bottom of the housing of a signal at least 8 feet but not more than 15 feet above the sidewalk. If there is no sidewalk, measure the mounting height above the pavement grade at the center of the roadway.

2. Size and Orientation. Mount each signal head vertically with indications 12 inches in diameter.

3. Signal Head Design. Furnish yellow signal head housings as specified in Section 1104.06(a)1. Provide signal heads with visors having a minimum depth of 9-1/2 inches. Equip all signal heads with backplates as specified in Section 1104.06(a)3.

4. Approved Material Types. Furnish all signal heads with light emitting diode (LED) modules. Provide all LED modules and signal housings from a Bulletin 15 manufacturer.

5. Supplemental Signal Indicator Lamps. Provide these lamps on the back side of each unit for a visual status of the signal indications. The lamp should display red to indicate oncoming traffic is provided with a green indication and the indication should remain off if oncoming traffic is provided with a red indication.

(d) Environmental Requirements. Provide a portable traffic control signal system capable of operating acceptably over an ambient temperature range of -30F to 165F, and a relative humidity range of 0 to 95 percent.

(e) Power Supply. Provide a battery-powered, portable traffic control signal system. Furnish a power supply with sufficient capacity to power each unit for 7 days at 72F without charging. Equip each unit with batteries and a battery charger for use with a 110 V power source. Furnish a visual display of the battery charge status. Enclose the batteries and battery charger in a lockable, weatherproof compartment. Key all locks alike for each unit in a system. Provide a system capable of running via existing commercial power.

(f) Communication. Interconnect all portable traffic control signal systems used for operations via wireless radio link or overhead hardwire to ensure fail-safe operation and proper functioning. Interconnect the units to function as a master/slave system. Ensure radio communications conform to applicable FCC requirements.

(g) Modes of Operation.

1. Required Modes. Provide each system to operate via manually-controlled, fixed-time, traffic-actuated, and flashing modes.

2. Manually-Controlled Operation. Furnish manual control with wireless remote. Provide a manual control mode prohibiting the operator to interrupt any preprogrammed all-red and/or all-yellow clearance time in a manner that would create a conflict.

3. Fixed-Time Operation. Provide a system capable of accommodating a minimum of five timing patterns per 24-hour period.

4. Traffic-Actuated Operation. Use detection systems from a Bulletin 15 manufacturer.

5. Flashing Operation. Provide a system capable of both flashing red and flashing yellow operations in programmed flash and cabinet flash modes.

6. Emergency Preemption. As an option, provide a Bulletin 15 approved system capable of accommodating an optical, radio, or sound-based preemption system to provide a green indication for a properly-equipped, approaching emergency vehicle.

7. Railroad Preemption. Due to the complexity and variation involved with railroad crossings, this operation will require a special provision.

(h) Timing Parameters.

1. Programmable Timing Patterns. Allow users of the system to program coordinated signal timings for green periods and cycle lengths to the nearest 1 second, over a range of values from 3 seconds to 250 seconds. Phase timings, including minimum green, green extension, yellow clearance, and red clearance must be programmable to the nearest 1 second. Minimum green times must be programmable over a range of 0 to 25 seconds. Green extension times must be programmable over a range of 0 to 10 seconds. Maximum green times must be programmable for each phase to the nearest second, and must be programmable over a range of 3 to 250 seconds.

2. Minimum Number of Phases. Furnish system capable of a minimum of six-phase traffic signal operations.

3. Manual Programming. Allow users of the system the ability to program pre-selected timing patterns.

4. Timing Algorithms. If the system has software to automatically determine timing patterns based on certain input data, submit a complete description from the manufacturer of the logic behind the timing algorithm for the Representatives review and approval.

(i) Conflict Monitoring. Provide a system capable of preventing or detecting the display of conflicting signal indications according to the conflict monitoring provisions of the NEMA Standards. If a conflicting display is detected, provide a system causing a transfer of the signals to flashing red.

(j) Training and Documentation. Have the manufacturer provide training and documentation to users of the portable traffic control signal system. Submit documentation to the Representative showing that the trained personnel are knowledgeable of the signal system's operation and function.

1124.04 TEMPORARY TRAFFIC CONTROL SIGNALS ON TRAILER-MOUNTED PORTABLE TRAFFIC CONTROL SIGNAL SYSTEMS—

(a) Trailer.

1. General. Provide trailer capable of accommodating a vertical upright and a horizontal mast arm.

2. Structural Adequacy. Provide trailer with welded steel construction and with structural adequacy to support all trailer-mounted equipment, and adequate structural integrity to enable lifting and placing vertical upright and horizontal mast arm as required.

3. Stabilizers. Equip trailer with at least four leveling jacks, pads, or feet, one at each comer of the trailer, for maintaining the trailer in a level, stabilized position and capable of locking in position.

4. Licensing. Equip trailer with all required lighting and other features to legally transport on the public highway system. Provide trailer and all its components with sufficient strength and rating to operate safely upon the public highway system at legal speeds without bending, cracking, bottoming, premature wear, or other damage.

5. Lifting and Assembly Mechanisms. Provide all lifting and other assembly mechanisms for simplicity and quick operation to keep set up and take down time to a minimum and to enable operation by one person. Equip lifting mechanism with a locking device to secure the assembly in a raised position; with a horizontal, lowered position for transport; and with a raised, vertical position, facing rearwards from the trailer, for operation.

6. Vandal-Resistant Features. Furnish trailer and its components to help ensure continued proper placement and to forestall vandalism. Provide trailer with adequate vandal-proof housings for all equipment. Provide removable trailer tires and hitch. Provide lockable battery enclosures, crank mechanisms for horizontal arms, and other mechanisms for adjusting placement or operation to eliminate tampering by unauthorized personnel. Key all lockable items alike. Equip the trailer drawbar with a swing-away, screw-type jack.

7. Reflective Markings. Place reflective tape or reflectors at each corner on the front, rear, and sides of the trailer.

8. Labels. Mark the manufacturer, serial number, and emergency phone number permanently on each trailer using a decal, metal plate, or other means suitable to the Department.

(b) Signal Displays.

1. Number and Location. Furnish each trailer with a minimum of two signal heads or as directed on the approved temporary traffic signal permit. Mount at least one signal head overhead on the mast arm, except when the approved temporary traffic signal permit requires two overhead. Provide horizontal mast arm capable of extending a minimum distance of 9 feet from the edge of the trailer. Locate signal faces apart a minimum horizontal distance of 8 feet measured between centers of signal faces along a line perpendicular to the centerline of the approach.

2. Vertical Clearance. Suspend the bottom of the housing of a signal face over the roadway a minimum of 15 feet, but not more than 19 feet, above the pavement. Mount the bottom of the housing of a signal face not over the roadway at least 8 feet, but not more than 15 feet, above the sidewalk. If there is no sidewalk, measure the mounting height above the pavement grade at the center of the roadway.

3. Size and Orientation. Mount each signal head vertically with indications 12 inches in diameter and capable of rotating 180 degrees horizontally. Provide reversible mountings to allow for placing a trailer on both sides of the roadway.

4. Signal Head Design. Section 1124.03(c)3

5. Approved Material Types. Section 1124.03(c)4

6. Supplemental Signal Indicator Lamps. Section 1124.03(c)5

(c) Environmental Requirements. Section 1124.03(d)

(d) Power Supply. Section 1124.03(e)

(e) Communication. Section 1124.03(f)

(f) Modes of Operation. Section 1124.03(g)

(g) Timing Parameters. Section 1124.03(h)

(h) Conflict Monitoring. Section 1124.03(i)

(i) Training and Documentation. Section 1124.03(j)

SECTION 1200
INTELLIGENT TRANSPORTATION SYSTEM (ITS) DEVICES

SECTION 1201—ITS DEVICES - GENERAL

1201.1 DESCRIPTION—This work is the furnishing and installing fully functional and operational Intelligent Transportation System (ITS) devices. Provide furnished items to be new and utilize the most current technology. Provide subsystems that minimize the possibility that failure of any one component or module causes total subsystem failure. Failure of one component or module must not damage any other component or module. Provide device subsystems that proceed automatically to full-functional mode at the device location and at the TMC/RTMC or remote control location, without the need for human intervention, if related electrical power supply is turned on or restored.

Comply with the following standards and codes as indicated and where applicable: NEMA, NTCIP, ASTM, IEC, UL, EIA, NEC, and AASHTO. Furnish ITS devices conforming to and compatible with structures contained in Publication 647 and the Standard Drawings.

1201.2 MATERIAL—

(a) Materials Acceptance. Section 106 and as follows.

For all ITS devices submit for approval, at no additional cost to the Department, catalog cuts, drawings, sources of supply, and additional submissions as follows before purchasing equipment.

1. ITS Enclosure. For enclosure heating and cooling subsystems, submit heat-load calculation sheets, accompanied by related manufacturer's data sheets, as support materials for justifying the heating/cooling sizing choices. Use worst-case heat-load data of the energized devices for the calculations. Submit power usage calculations to support power distribution type and size.

2. Uninterrupted Power Supply (UPS). Submit calculation sheets, accompanied by manufacturer's data sheet listing the power requirement of critical components, as support materials for justifying the UPS sizing choices. Use worst-case power-load data for the calculations.

(b) ITS Enclosure. Utilize enclosure for ground-mounted, pole-mounted, or other structurally mounted enclosure installations as shown on the Standard Drawings and as indicated.

House all ITS device electronics in the ITS enclosures according to Publication 647 and as indicated in the contract documents. For pole-mounted and ground-mounted enclosures, provide all material, including mounting equipment, and a concrete pad or elevated pedestal, to meet the requirements contained in Publication 647.

1. NEMA 3R Enclosure. House device electronics in a locking, weather resistant NEMA 3R, UL50E listed aluminum enclosure. Furnish enclosure to provide protection from rain, sleet, snow, dripping water and corrosion. Construct complete enclosure from 0.125 inch thick aluminum alloy type 5052-H32 to provide strong and rigid construction. Provide enclosure with minimal dimensions of height, depth, and width necessary to accommodate all electrical equipment and wiring, plus a minimum additional 20% of excess empty space for future equipment and maintenance access. Adhere to the minimum requirements on clearances around all components and bending radii for all cables as specified by the manufacturers. Utilize weld nuts for mounting all enclosure inner panels.

Provide enclosure seams that are continuous and ground smooth, solid welds made by the Heliarc or stitch welding method. Provide enclosure welds that are neatly formed and free from cracks, blowholes, and other irregularities. Where enclosures are not ground-mounted, provide welded brackets or brackets bolted to the back of the enclosure for enclosure mounting. Where bolted bracket is used, bolt the bracket to an interior reinforcing plate fabricated of the same material as the enclosure. Fabricate mounting plates of a minimum 0.125 inch thick aluminum. Add body stiffeners where required to prevent the enclosures from sagging or bowing.

Equip enclosure with means for locking with pad lock. Furnish door handles which provide for positive latching of the door at three points as viewed if facing the door - top, bottom, and left side. Provide a pin tumbler type lock which serves to secure the door handles, thereby locking the cabinet doors. Provide two door keys with the cabinet.

Coordinate key type with the Representative.

Furnish door hinges and pins of 304 stainless steel conforming to ASTM A276. Provide continuous hinge mechanism along the entire side. Equip door with an adjustable doorstop to hold the door open at the angles of 90 degrees, 135 degrees, and 180 degrees with the front of the enclosure. Provide gasketing on all door openings that is permanently bonded to the metal. Cover mating surface of the gasketing with a silicone lubricant to prevent sticking to the mating surface. Provide bonding on the door and a grounding stud in the enclosure.

Provide shut-offs and panels with identification labels and appropriate warning labels. Place identification nameplate on the outside of the enclosure. Provide nameplate that does not deteriorate over time due to weather. Indelibly identify all devices, components, cables and wires on permanently attached labels for use in the intended environment using labels approved by the Representative, and inscribed according to the approved schematic shop drawing showing the component layout. Label all internal connectors and wire terminations with sufficient information to locate its connection point. Insert a block diagram of all components illustrating all connectors and connections used to interconnect the components, wiring diagrams and schematic drawings of all circuits in a resealable weather-resistant pocket that is permanently mounted on the inside of an accessible door in the controller enclosure. Inscribe the component name and model number using a permanent label or laminated name plate in a position adjacent to the location of each major or replaceable component on the inside of the enclosure.

Provide racks and shelves to mount equipment as needed, including communications, power and UPS equipment. Do not stack equipment on top of other equipment. Equipment may be set on shelves, installed on 19 inch rack rails, or attached to panels mounted to the rear or side walls of the enclosure. Provide a laptop shelf within the enclosure to accommodate for laptops/other devices during commission, testing, and maintenance. For all enclosures utilizing leased-line communications connections, provide for each lease-line connection mounting space for an additional 8 inches wide by 12 inches high by 2 inches thick Channel Service Unit (CSU) or other communication module (supplied by the telephone/cable company). Provide an additional fused or breaker protected, UPS-powered receptacle for related power requirement.

Furnish fluorescent lighting fixture complete with lens or shield and Type T-4 16 Watt fluorescent lamp with rapid start. Provide lighting fixture that activates upon opening enclosure door, and deactivates upon closing enclosure door. Position lamp assembly to provide light to all of the equipment within the enclosure. Shield lamp assembly to prevent light from shining directly in the eyes of servicing personnel.

Provide sufficient shelve space within the enclosures for shelf-mounted equipment. If plans indicate, provide an enclosure with a transparent anti-graffiti coating over the entire outer surface of the enclosure.

Provide the Statewide Device Identification Number on the enclosure so it is visible to maintenance and Department personnel approaching the device. Provide fabricated plaques of aluminum, plastic, or fiberglass of sufficient thickness to provide the necessary stiffness and to resist vandalism, or stencil directly onto the enclosure with weather-resistant paint. Indicate the complete Statewide Device Identification Number with 3 inch high letters with a contrasting color background. Caulking and weather proofing is required if attached by hardware that will penetrate the enclosure.

2. Power Distribution Subsystem. Provide full power distribution subsystem to all electronic components within the enclosure and the related ITS device. Furnish power distribution panel to distribute power to all equipment within the enclosure and ITS devices served by the enclosure. Provide circuit breakers sized to meet or exceed the NEC requirements for the loads supported, with a minimum of 10 A trips. Size the circuit breaker based on the loads of the ITS device(s) utilizing the enclosure. Provide circuit breakers on an electrical panel in a NEMA 1 enclosure, or DIN rail mounted with appropriately rated junction blocks and buses. Provide a power distribution panel that is fed directly by the main circuit breaker at the electrical point of service, or solar installation, where applicable. Provide interface and connection to UPS. Provide connection to grounding system.

If DIN rail components are utilized, provide black, white, and green DIN rail terminal blocks for 120VAC Hot, Neutral, and Ground, respectively. Provide differently colored terminal blocks for low voltage power and signals. Provide end stops, dividers, and appurtenances as required.

Provide a neutral bus of solid metallic strip rigidly mounted on the power panel which is isolated from enclosure ground. Provide all neutral conductors terminated on the neutral bus. Bond the control enclosure, the main disconnect, the power distribution panel, the service ground wire and the branch circuit ground wires to the ground bus. Bond the ground bus to the enclosure grounding system with AWG No. 4 Ground Wire.

3. Wiring and Cabling. Section 1101.08. Provide layout to minimize the flexure of cabling. Where wire is required to flex often, use high strand wire.

4. Heating and Ventilation Subsystem. Provide insulation, thermostat-controlled heating, heat dispersion and

ventilation to maintain internal temperature between 32F and 104F, with all installed components operating continuously at full capacity. Provide for other measures to allow the enclosure and internal component, as a single entity, to operate reliably in the ambient temperature between -40F and 140F, relative humidity between 20% to 95%, non-condensing. Where ventilation fan is used, provide thermostatically controlled enclosure ventilation fan that supplies a minimum airflow of 100 cubic feet per minute. Utilize enclosure openings to ensure continuous air circulation. Position the openings so short circuiting of air circulation is avoided, and the effect of removal of heat from inside the enclosure is maximized. Utilize louvers or other means to limit openings to 1/4 inches or smaller. Screen the fan to prevent the entrance of dust, small animals, and foreign matter. Screen all enclosure openings and vents besides the door opening with a filter that prevents small foreign objects from entering through these openings.

5. Duplex Outlet. Provide one duplex NEMA 5-15R, ground-fault circuit interrupting, GFCI receptacle, with 120 VAC power, for use as a convenience outlet inside the enclosure. Provide two duplex, NEMA 5-15R, receptacles, with 120 VAC power, marked for "Equipment Use Only" inside the enclosure. Ground the outlets through the enclosure grounding system. Furnish UL-listed receptacles.

6. Transient Voltage Surge Suppression (TVSS). Provide transient voltage surge suppressor (TVSS) for each copper cable entering/leaving the cabinet. The AC powerline TVSS is to be UL 1449 Third Edition listed as Type 1 or Type 2. Low voltage and signal circuit TVSS are to be UL 749 listed. TVSS protection is not required for fiber optic cables.

7. Ground Rod. Section 1101.11(j) and as follows:
If the enclosure and a device are mounted on the same support structure, provide a common grounding electrode system for both.

8. Enclosure Foundation. For ground-mounted enclosures.

- Class A Cement Concrete. Section 704
- Caulking Compound. Section 705.8(b)

9. Maintainer Pad. For pole or structure-mounted enclosures.

- Class A Cement Concrete. Section 704.
- Reinforcement Bars. Galvanized or epoxy coated steel wire fabric Section 709.3.
- No. 57 Coarse Aggregate. Section 703.2.

(c) Managed Network Switch. Provide an environmentally hardened managed network switch with a minimum of four (4), RJ45 ports for local connections, in addition to two (2) SFP gigabit transceivers to accept the communication media to the enclosure used for wide area network connection as indicated on the project plans. Configure it to limit the access for viewing, issuing instruction, and performing configuration to authorized users only. Provide cabling and connectors to connect network switch to all electronic devices in the enclosure which require LAN connectivity. Provide a managed network switch that meets the following requirements:

1. Physical Ports:

- 4 Gbps Ports: 4 × 10/100/1000Base-TX, 2 SFP Combo Ports: 2 × 10/100/1000Base-TX/100/1000Base-FX. Serial Console Port: RS-232 in RJ-45 with DB adaptor or console cable.

2. Security Features:

- Enable/disable ports, MAC based port security.
- Port based network access control (802.1x).
- VLAN (802.1Q) to segregate and secure network traffic.
- Radius centralized password management.
- SNMP v1/v2c/v3 encrypted authentication and access security.

3. Ethernet Standards:

- IEEE 802.3 for 10Base-T
- IEEE 802.3u for 100Base-TX and 100Base-FX
- IEEE 802.3z for 1000Base-X
- IEEE 802.3ab for 1000Base-T(X)
- IEEE 802.3x for Flow control
- IEEE 802.3ad for LACP (Link Aggregation Control Protocol)
- IEEE 802.1D for STP (Spanning Tree Protocol)
- IEEE 802.1p for COS (Class of Service)
- IEEE 802.1Q for VLAN Tagging
- IEEE 802.1w for RSTP (Rapid Spanning Tree Protocol)
- IEEE 802.1s for MSTP (Multiple Spanning Tree Protocol)
- IEEE 802.1x for Authentication
- IEEE 802.1AB for LLDP (Link Layer Discovery Protocol)

4. Regulatory Compliance:

- EMI: FCC Part 15, CISPR (EN55022) class A, EN50155 (EN50121-3-2, EN55011, EN50121-4)
- EMS: EN61000-4-2 (ESD), EN61000-4-3 (RS), EN61000-4-4 (EFT), EN61000-4-5 (Surge), EN61000-4-6 (CS), EN61000-4-8, EN61000-4-9, EN61000-4-11
- Shock: IEC60068-2-27, EN61373
- Free Fall: IEC60068-2-32
- Vibration: IEC60068-2-6, EN61373
- Safety: EN60950-1

5. Power:

- Input Power: Redundant +/–12~48VDC on terminal block, one 12 ~ 45VDC on power jack
- Power Consumption 10 Watts (Typ.)
- Overload Current Protection
- Reverse Polarity Protection

6. Mechanical:

- Size: (W × D × H) No larger than 3.00 × 5.00 × 6.00 in.
- Weight: <2.0 lbs.
- Installation DIN Rail and Wall Mount Design

7. Environmental:

- Storage Temperature –40 to 185ºF
- Operating Temperature –40 to 167ºF
- Operating Humidity 5% to 95% Non-condensing

(d) Power Supply 24 VDC. Provide an industrial grade, field-hardened 24 VDC output power supply to power ITS communications, network management and PSE devices(s). The power supply shall be DIN rail mounted and operate from an input voltage range of 100 VAC -240 VAC with an operating temperature no less than -30F to +167F. The power supply shall be sized to satisfy the amperage requirements for all ITS devices identified in the project plan documents with 20% spare capacity. The power supply shall be individually circuit protected at the Power Distribution Subsystem.

(e) UPS Subsystems. Furnish UPS subsystem inside the enclosure. Provide UPS subsystem that maintains a continuous supply of electric power to connected equipment by supplying power from a battery-backed power source when electric power from the regular source is not available. Furnish UPS of the double-conversion type, where the output to the connected load is only generated from the back-up battery (battery set), and the power from external source is only used to charge the backup battery (battery set). Furnish the battery subsystem to provide backup power

to all critical enclosure equipment, all operating at 100% capacity for minimum 1/2 hour duration. Critical enclosure components, by default, include power modules/subsystems required for operating all communication devices, controllers, low-power radio broadcast of 10 W transmission power or lower, all sensing ITS devices (cameras, vehicle detectors, environmental detectors, etc.).

Provide a true, separately derived power source as defined by NEC Article 250-5d with output neutral bonded to ground. Do not provide direct connection between input and output and less than 2 pF of effective input to output capacitance. Regulate UPS output to within the CBEMA and ANSI C84.1 point of utilization range of 104 to 127 VAC over the full dynamic range from no load to full load, low line VAC to high line VAC, and low battery voltage to high battery voltage.

Provide continuous, no break power during a power outage or momentary interruption. Standby power subsystems which have any measurable transfer time and interruption of the output wave form are unacceptable. Provide computer-grade sine-wave power with 5 percent or less total harmonic distortion capability. Meet or exceed CSA standard 22 Part 2-107 for harmonic distortion. Provide UPS that passes lightning testing standard as per ANSI/IEEE C62.41 category A test (6000 V spike and 3000 A) and C62.45 test procedures. Reduce the input spike to no less than 3 V on the output, for 2000 to 1 spike attenuation. Provide capacity in volt amperes (VA) while loaded with typical computer-grade switch-mode power supplies having a power factor of 0.5 to 0.7 and crest factor of 2.7 to 3.5. Install UPS batteries, or UPS with integral battery at construction.

Provide a UPS with secure monitoring and control via web browser, command line interface or SNMP. Configure the monitoring to notify the TMC/RTMC through the existing ATMS when the UPS is operating on battery power.

(f) IP Controlled Remote Power Switch. Provide a Remote Power Switch that allows the operator to securely monitor, identify abnormal conditions and reboot critical ITS devices. Provide an ethernet controlled remote power switch capable of individually controlling up to eight (8) circuits that meets the following requirements:

- Input Power: 89-135 VAC, 60± 3Hz.
- Rated Current: 12A.
- Overload Current Protection: 15A.
- Outlet Switching: minimum of six (6) switched circuits on individual 5-15R receptacles.
- Internal Surge Protection.
- Operating Temperature: -30º to 170ºF.
- Ethernet Interface: RJ-45 10/100 Base-T.
- Software Controls: Individual outlets on/off, all on/off, network settings, Web UI
- Panel mount or rack mount options
- Compliance: UL/CSA/FCC

(g) High PoE (Power over Ethernet) Midspan Injector. Provide a High PoE, midspan injector for each camera in the CCTV, DMS or Wireless Radio ITS enclosure, or as indicated on the design drawings. The midspan injector shall be industrial grade, field-hardened for long-term freeway deployment meeting the following requirements:

- Basic Function: PSE (Power Sourcing Equipment) Midspan, compliant with IEEE 802.3af, 802.3at
- Extended supply voltage range of 18 VDC to 57 VDC or 100-240 VAC.
- Output Nominal Voltage: 54 VDC (PoE).
- Output Power: Sized as required by the powered device (PD), 60W-90W typical.
- Serial Transmission Speed: 10/100/1000 Mbps.
- Pin Assignment: 1:1.
- Transmission Length: 100 m.
- Input Interface: Ethernet, RJ45.
- Output Interface: Ethernet, RJ45.
- Connection Method: CAT5e
- Circuit Protection: Reverse Polarity Protection
- Operating temperature range no less than -30F to +167F.
- DIN rail mounted

(h) Electrical Service. Furnish all conduit, elbows and expansion fittings, wire, connections, wooden poles, service disconnects, and related equipment to establish electrical service at the ITS device location according to Publication

647. Include all materials necessary to establish electrical connection between the device location, the device enclosure, and the electrical point of service.

1. **Electrical Cable.** Section 1101.08

2. **Conduit. S**ection 1101.09

3. **Junction Boxes.** Section 1101.10

4. **Power Supply.** Section 1101.11

(i) Documentation. Provide documentation pertaining to each ITS device subsystem. At a minimum provide one hard copy and one electronic copy of the operations manuals for each device and all its subsystems to the TMC/RTMC Representative. Submit an electronic and a hard copy of the wiring diagrams that display the connections between each of the subsystems. Coordinate with the Representative for relevant existing system information and desired formatting for the diagrams. At a minimum, provide the following diagrams:

- **Communications Subsystem.** Provide a comprehensive network architecture drawing documenting all subsystems and components, including port assignments and IP addresses, device model numbers and serial numbers, and network path to the TMC details. Provide detailed fiber optic cable documentation requirements, such as strand assignments, spare strands, splicing details, ODTR results, etc.

- **TMC/RTMC.** Including connections to and from the TMC/RTMC, ITS devices, network servers, and other related communications equipment. Include all new physical connections established within the TMC, including to and from existing or new work stations.

- **ITS Enclosure.** Provide three copies of the enclosure wiring diagram for each ITS enclosure assembly. Place a clear protective envelope in the controller assembly cabinet that contains one copy of the manufacturer's instruction manual for each component contained in the enclosure.

- **As-Built Drawings and Details.** Prepare As-Built drawings according to Publication 10, Design Manual, Parts 1 and 1A. Submit As-built Plans at the completion of the 60-Day Test. The 60-Day Test will not end until the As-Built drawings have been submitted and approved. Submit As-Built drawings for all device locations, electrical, communications details and structures. Provide As-Built plans and details formatted for 22" x 34" paper size in PDF format. Include all As-Built plans, wiring diagrams, installation plans, cabinet diagrams. As-built documentation is also required to include GPS coordinates for all ITS and communications equipment locations. Provide one complete set of As-Built drawings on 11" x 17" paper. Provide one set of As-Built drawings on 11" x 17' paper inside each ITS enclosure.

(j) Certification. Section 106.03(b)3 and as follows: Certify all structural attachments satisfy the Department's criteria and are adequate to support the loads indicated. As required by the Representative, this certification may include the signature and seal of a Professional Engineer registered in Pennsylvania. Certify the structural adequacy of all sign and device mounting brackets.

1201.3 CONSTRUCTION—As shown on the Standard Drawings, as indicated, and as follows:

(a) ITS Enclosure. Install an ITS enclosure to house ITS device communication, power and other related equipment necessary for the operation of field ITS devices. Provide enclosure at each device location, and as directed in the contract documents. Determine ITS enclosure mounting location and type per recommendations provided in Publication 646.

1. **Component Mounting.** Fasten all internal components securely to the enclosure using explicit mechanical means such as clamps, bolt/nut sets and screws.

2. **Enclosure Height**. According to Publication 647 and as follows: For mounting on vertical support structure, unless otherwise specified, where practical, install the enclosure with related center line at a nominal height of 42

inches above adjacent finished grade/floor. For ground-mounted enclosure installation, apply Ultraviolet (UV)-resistant caulking material along the joints with the enclosure. For mounting under a camera lowering system, position the enclosure away from the space directly below the camera.

3. Enclosure Openings. Include sealing lock nuts on each side of the enclosure wall on all penetration arrangements through the enclosure walls to prevent ingress of water. Use a bushing on the end of the conduit inside the enclosures to prevent chaffing of the cables. Seal all penetrations to the enclosure with rubber silicone sealant to impede entry of water.

After installing all related cables, seal all conduits connected to the enclosure, including all spare conduits, with self-expanding insulation foam, electrical putty or an approved sealant as recommended by the cable manufacturer, and in a manner that does not damage the cable, to a depth of minimum 4 inches. Provide measures to protect cables from all sharp edges at the end of the conduits. Insert steel wool before the sealant, to prevent rodent infestation.

4. Wiring. Neatly bundle and label all wires/cables within the enclosure.

Terminate ground wire from all electric devices, including surge suppressors, directly to the dedicated grounding terminal in the enclosure. Provide a maximum separation possible between signal wiring and power wiring or control wiring, to avoid inductive pickup. The minimum separation between the signal wiring and power wiring or control wiring is 12 inches. If power wiring has to cross the signal wiring, orient crossing as close to a right angle as possible.

5. Grounding. Section 910.3(q) and according to Publication 647.

6. TVSS. Segregate TVSS devices by type and position the TVSS devices as close as practical to the main termination point for grounding.

7. Enclosure Foundation. For pad mounted enclosures, construct the foundation according to Publication 647 and as specified in Sections 951.3(a) and (b).

8. Maintainer Pad. Provide a ground-level, concrete maintainer pad in front of each enclosure door and in front of the hand hole that provides a solid, leveled standing platform in front of the enclosure opening. Furnish a pad with sufficient space for maintenance personnel to stand and perform maintenance at the enclosure. Provide pad according to Publication 647. The size of the maintainer pad may be reduced in tight geometric areas and on steep slopes as determined by the Department.

9. UPS Subsystem. Install UPS and all required batteries into the ITS Enclosure or separate UPS cabinet as specified in contract documents. Ensure all electrical connections are terminated according to the manufacturers specifications.

(b) ITS Device Testing. Complete all testing for the following ITS devices: CCTV, HAR Subsystem, DMS, and Vehicle Detector Subsystem. Testing of the related ITS subsystems may involve additional ITS-related items, including, but not limited to, ITS Communications, Portable DMS, and ITS Enclosure.

Testing procedures described in this Section are intended to test each subsystem element to make certain that the elements are properly integrated to achieve a fully functioning subsystem. Make provisions for up to two Department personnel or their representatives to attend all tests and demonstrations. Conduct the following tests, in the order indicated, on each ITS device and device subsystem:

- Factory Demonstration Tests (documented factory testing may be used instead of having personnel on site for this at the discretion of the Representative)
- On-Site Standalone Tests
- System Tests
- 60-Day Testing
- 180-Day Operational Support Period
- Warranty Period (the length of the manufacturer's standard warranty at the end of the 60-Day Test)

The acceptance of each stage of testing does not imply testing is complete at that stage. If problems are found at a later date or stage of testing, it may be necessary to return to an earlier stage of testing after repairs have been made to the system. If at a later stage of testing, a piece of equipment is replaced, repaired, or significantly modified, retest to the level necessary to isolate any problem and establish a course of action to remedy the situation.

Provide test documentation, including at a minimum, test procedures, checklist, test forms, and data summary sheets for each item. Tailor test documentation for each item being tested. Submit testing documentation before testing for the Representative's acceptance. After test documentation is approved, provide the Representative with advance notice, as specified for each test, so the Representative can observe each test.

Failure to conform to the indicated requirements of all tests will be considered defective and equipment will be subject to rejection by the Representative. In the event a defect is determined, identify whether it is limited to a specific unit or could be potential problems in all such units. Equipment rejected because of problems limited to the specific unit may be offered again for retest provided all issues of non-compliance have been corrected and re-tested, and evidence is submitted to the Representative.

In the event equipment malfunctions during the test period, the Representative may declare a subsystem defect and require replacement of all equipment at no additional cost to the Department. If a subsystem defect is declared, restart the test for that specific subsystem. Begin the test period when all similar equipment is replaced and retest has been successfully completed.

If a unit has been modified as a result of the equipment replacement, prepare a report and deliver it to the Representative for acceptance. Describe in the report the nature of the failure and the corrective action taken. If a failure pattern, as defined by the Representative, develops, the Representative may direct design and construction modifications be made to all similar units without additional cost to the Department. In the case of problems common to many units, modify all units without additional cost to the Department.

1. General. Test the equipment according to approved test procedures only. Record test results on data summary sheets for each piece of equipment tested. Provide certification of test results by a qualified Representative. Submit all test records, including photocopied duplicates, as required, to the Representative, within one day of the test.

Complete testing for each equipment unit in as few consecutive days as possible as determined by the Representative. Schedule testing with additional time allotted for the Representative to request certain portions of a test be repeated. The Representative has the right to witness or assign their designee to witness all tests.

At a minimum, all testing procedures must be signed by the following: The Representative, or the Representative’s designee, and the Contractor’s designee. The acceptance of test procedures and witness of such tests does not relieve the responsibility to provide a completely acceptable and operating subsystem that meets the indicated requirements.

2. Factory Demonstration Test. Conduct factory demonstration tests at manufacturer's facility or a remote site location, identified in the project documents, before shipping the equipment, to verify each subsystem meets the contract requirements. If required by the Representative, provide personnel to observe the factory demonstration test in person before shipping the equipment. Include NTCIP testing as part of factory demonstration test. Utilize testing procedures to validate the latest version of NTCIP requirements. Prepare factory demonstration test documentation. Conduct factory demonstration tests at the manufacturer's facility for every ITS device provided for this project.

3. On-Site Standalone Tests. Conduct on-site standalone tests at each field location to verify each individual field device satisfies the indicated requirements. Conduct these tests before interconnection to the TMC/RTMC.

Following the installation of equipment in the field, conduct field tests on each piece of equipment, at each installation site to verify components, modules or subsystem of equipment operate properly in their intended application to the extent possible before connection to the TMC/RTMC and to other devices. Provide the required testing equipment, including a portable computer, and test software to perform local subsystem operations and diagnostic test procedures.

Submit test procedures, checklist, and summary sheets for the Representative's acceptance before performing tests. Provide Representative with a testing schedule indicating the date, time, and location of each test. Provide at least 5 working days’ notice before all tests so the Representative can observe each test. At a minimum submit the following testing data:

3.a Telecommunication Utility Coordination: Coordinate with the Utility provider(s) and the Department IT staff to setup new communication services at each proposed ITS site. Communications include Private IP (PIP) network and Frame Relay (MPLS). All communications are to be IP addressable and complaint with all applicable NTCIP standards. Configuration will allow the Department IT personnel to monitor the ITS sites simultaneously.

- T1 Line, Multiprotocol Label Switching (MPLS) Connections: Connections from the District facilities to the PIP network will be procured by the District IT staff. The contractor must supply GPS coordinates and a 911 address for each location.

Install, connect and configure equipment in ITS enclosures or node cabinets if applicable, and the RTMC as indicated on the Intelligent Transportation System Plans. Install MPLS equipment according to the manufacturer's recommendations. Coordinate with PennDOT IT Department and follow the Department's policies concerning but not limited to; IP addressing schemes, management and security policies, etc.

Depending upon project specific requirements Telecommunication Utility Coordination and testing may include:

- Cellular: Verizon Wireless Cellular activations will be done by the District IT staff. Supply GPS coordinates and a 911 address for each location.

Coordinate with the Department for installation of the existing SIM card and existing cellular provider to provide service to the proposed Cellular modem. Orient antenna to achieve the best signal possible. This may require multiple attempts. Once connectivity has been established coordinate with the Department IT staff for the integration of the ITS Communications subsystem into the existing RTMC and test accordingly.

3.b ITS Communications Device Testing: test all telemetry equipment under normal operating conditions. The intent of this test is to demonstrate and certify the operational interaction of the ITS WAN/LAN via/through the wired and wireless telemetry equipment. Testing shall include, but not be limited to:

Installation Tests:

- Verify new Radio Telemetry Equipment is located and installed according to the design drawings.

- Verify new Radio Antenna Equipment is located and installed according to the design drawings.

Electrical Tests:

- Verify the Telemetry Equipment is provided with adequate and stable power and is functional according to the design drawings.

- Verify all the wiring connections to the Telemetry Equipment are secure (including power, data and if applicable, RF).

Functionality Tests:

- Verify there is a clear transmission path between the Master and each Remote Telemetry Equipment.

- Verify the Telemetry Equipment has been programmed properly (including the correct IP addresses).

- Verify all remote radios have a Received Signal Strength Indication (RSSI) of -80 dBm or better (less negative).

- Verify all telemetry antennas operate with a Standing Wave Ratio (SWR) of less than 2:1.

If a device fails to meet the requirements specified, rectify the device as required and repeat the tests until successful at no additional cost to the Department. If a subsystem component has been modified as a result of the test failure, prepare a detailed report on the modifications to subsystem or software and submit it to the Representative. Describe in the report the nature of the failure and corrective action(s) taken.

4. System Tests. Conduct system tests from the TMC/RTMC and field locations, as required, to verify the overall subsystem meets the indicated requirements. Conduct system tests following completion and acceptance of all on-site standalone tests.

Provide at least 10 working days' notice before all tests so the Representative can observe each test. Where central control software, hardware and network switches exist, utilize the existing equipment and control software to manage and control the ITS devices. Exercise all functions for the device subsystems to test control and monitoring functions of the devices remotely. Where new software, switching systems, or hardware are installed in the project, utilize this new equipment to test control and monitoring functions of the devices remotely.

Demonstrate the communications subsystem is fully functional. In the event of test failure, perform a partial or total re-test to demonstrate the subsystem is functioning as a whole.

Conduct system tests on all subsystems and components that are being furnished under this contract. Conduct tests from the TMC/RTMC as indicated, exercising functional and interface requirements as required.

5. 60-Day Test. Conduct a continuous, 24 hour operating test for no less than 60 consecutive calendar days, beginning the day after the subsystem completes the system tests and is accepted. Conduct the 60-day test simultaneously for each subsystem installed in this project (for example, CCTV, DMS, and HAR subsystems). Provide operational and maintenance support for all installed equipment including troubleshooting and diagnostics in the event a malfunction occurs.

In the case where equipment malfunctions during the 60-day test period, the Representative may declare a subsystem defect. Correct failures during the test period by repairing or replacing malfunctioning parts or equipment or faulty work, regardless of the cause, in less than 24 hours. Restart at day 1 of the 60-day test for that specific subsystem. The 60-day test period is to begin when all similar equipment is replaced and a system retest has been successfully completed.

If over 10% of subsystems fail their 60-day test period, that is considered a large failure of the system, and the 60-day test will be restarted for all subsystems following replacement of the malfunctioning parts or equipment or faulty work. If less than 10% of the subsystems fail their 60-day test period, that is considered a small failure, and only the subsystem test needs to be restarted.

Make available a systems technician who is fully knowledgeable and capable of operating all functions of the specified subsystem for technical support during the 60-day test period. Provide this systems technician on-site from 8:00 A.M. to 5:00 P.M. on the first day of the 60-day test and on-call basis thereafter. The systems technician must specialize in communications. Provide technician having a minimum of 5 years' experience in the installation, testing, troubleshooting, and fine tuning of communication subsystems. Submit the systems technician qualifications for acceptance at least 20 working days before the start of the 60-day test.

Notification of a malfunction will be provided by the Department personnel immediately following the occurrence of the equipment malfunction. Receipt of notification is defined as when the systems technician or the answering service receives the call. Maintain records of stoppages and resumptions of the 60-day test. Verify against the records maintained by the Representative for accuracy. Submit documentation for all activities performed during this support period.

Provide complete operations support as required during the 60-day test period to the Department personnel, who will be using the subsystem and performing operational tests on the complete subsystem on a day-to-day basis. The means of communications during this test period will be through a local telephone number or an answering service. Provide at least one local telephone number at which the contractor can be reached. Provide a response to each call within an hour of the call being placed. Provide a turnaround time of 8 hours for each call.

If one of the subsystems fails during the 60-day test, the completion of the test for the other subsystems will not be delayed. During the testing period, provide Department personnel training, in order to operate all normal functions of the subsystem.

After the completion of 60-day test, conduct complete subsystem diagnostics for field and TMC/RTMC equipment as follows: Equipment testing and adjustment of settings and parameters; Check component operations with respect to these specifications.

Following the completion of 60-day test, clear the inside of all ITS enclosures using brushes and vacuums, as appropriate, perform component cleaning and filter replacements at all enclosures installed in the project. During the 60-day test, power and communication costs associated with maintaining the operation of the ITS devices will be the responsibility of the Contractor. Ownership of the subsystem will be transferred to the Department upon successful completion of the 60-day test.

6. 90-Day Operational Support Period. Conduct a 90-day operational support period. Furnish a detailed operational support plan covering preventive and remedial maintenance of all equipment. Furnish all necessary labor,

materials, equipment, tools, transportation, supplies, maintenance and protection of traffic, and incidental items. The plan must include qualifications of the personnel assigned by the Contractor for each activity included. The plan must be approved by the Representative before the completion of the 60-day test. The Representative's review period will not exceed 21 calendar days from receipt of the operational plan.

Provide operational support for a period of 90 days. The operational support period will start on the calendar day after the 60-day test is completed. The Department will operate and own the subsystem during this period.

If adjustments are made to software, wiring, or equipment settings during the operational support period, provide this upgraded software at no additional cost to the Department. If adjustments are made to wiring or equipment settings during the operational support period, reflect the adjustments in the documentation.

Coordinate with the Department's Traffic and Maintenance Units for all field activities. Except for emergency service requested by the Department or if responding to a malfunction repair request by PennDOT, notify the Department 7 calendar days before scheduling activities. Furnish maintenance and protection of traffic plans as required by the Representative.

Conduct preventative and remedial maintenance activities during the 90-day operational support period.

6.a Preventive Maintenance. As specified in Section 1206.3(a), Section 1216.3(a), Section 1217.3(a), Section 1226.3(a), Section 1236.3(a), Section 1237.3(a), and Section 1246.3(a).

6.b On-call Maintenance. As specified in Section 1206.3(b), Section 1216.3(b), Section 1217.3(b), Section 1226.3(b), Section 1236.3(b), Section 1237.3(b), and Section 1246.3(b).

7. Warranty Period. Provide a manufacturer's warranty for each ITS device, component, subsystem, hardware, software and piece of equipment furnished in the project. Provide manufacturer warranties of durations equivalent to industry standards. Provide warranties of a one-year minimum duration. Manufacturer warranties in excess of one year will remain in full force and effect throughout the entire manufacturer's warranty period. The warranty period for all individual devices will begin upon conclusion and acceptance of the 60-day operational test.

Provide a warranty that will enable the full replacement of a piece of equipment in the event of equipment failure, at no additional cost to the Department.

8. ITS Grounding Testing. Section 910.3(q).

9. Camera Lowering Device (CLD) Testing. Standalone testing is required for all CLD systems. At a minimum, the CLD must meet the following criteria:

- Raise or lower the camera within 2 minutes if utilizing the motorized drill component of the lowering device.
- Lock and unlock the camera into position at the top of the structure at least 2 times to demonstrate functionality of the locking mechanism. Verify the camera fully re-starts without manual initiation.

(c) ITS Device Integration. Integrate ITS equipment into the existing ITS system at the related TMC/RTMC or remote control location as indicated or directed by the Representative. Provide ATMS integration as specified in Section 1202 Provide all connectors, cables, software configuration and labor necessary to furnish a fully functional ITS device subsystem. This includes all work, cable, data connections, and installation that allows for data transmission and control from the TMC/RTMC. Coordinate with the Representative to obtain all relevant network information to configure the devices to successfully operate. Work scheduled for the RTMC will only be scheduled during normal working hours, subject to approval by the TMC/RTMC manager or designee. Normal working hours for the RTMC are Monday through Friday, 7:30AM to 3:30PM.

Integrate to ensure additional device capabilities as follows:

Install all cables and connections to enable bi-directional pan-tilt-zoom control to the TMC/RTMC and other locations as specified in contract documents. Perform all coordination and work with PennDOT's IT Bureau of Infrastructure and Operations (BIO) to enable the CCTV feeds to be available through PennDOT's 511 System, existing video management system software and any other systems deemed appropriate by the Department. Provide the necessary device information and coordinate with District and District IT staff in contacting BIO for system testing and integration into PennDOT's 511 System and other systems.

1. **Vehicle Detector.** Integrate the detector subsystems into the existing Transportation Sensor System (TSS) in the TMC/RTMC ATMS software using the related Field-to-Center (F2C) communications subsystem as indicated.

(d) ITS Device Training. Provide device training to Department personnel as identified by the Representative. Submit training plan for approval. At a minimum, provide training for the maintenance of the installed devices. If a standard device is integrated into ATMS or a currently used make/model device is provided, operational training is not required. Train personnel to use all major functionalities of the subsystem, including device maintenance procedures, before the beginning of the 60-day test. Provide training manuals and handouts for future reference. Training includes a minimum of 1 personnel present at the TMC/RTMC or control facility for a minimum of 8 hours per subsystem, unless otherwise specified.

(e) Electrical Service. Section 910.3 and as follows: Install all conduit, service poles, conduit, junction boxes and related equipment to establish electrical service for the ITS device. Where electrical and communications service are collocated at the electrical point of service, install complete, separate communications connection between the communications point of service, the device enclosure and the ITS device. Establish connection independent of power connection. Utilize separate conduit and junction boxes for all underground connections.

1. **Trench and Backfill.** Section 910.3(c)

2. **RGS and PVC Conduit.** Section 910.3(g)

3. **Cable Installation.** Section 910.3(h)

4. **Power Supply System.** Section 910.3(s)

5. **Power Supply Service Pole.** Section 910.3(k)

6. **Junction Box (power and communications).** Section 910.3(p)

1201.4 MEASUREMENT AND PAYMENT—

(a) ITS Enclosure. Each
Includes all cables, connectors, mounting, mounting hardware, heating ventilation subsystem, TVSS, managed network switch, UPS, equipment, racks, maintainer pad, grounding rod and conductor, installation, documentation, and configuration.

(b) ITS Testing. Lump Sum

- **Factory Demonstration Test.**

- **On-Site Standalone Test.**

- **System Test.**

- **60-Day Test.**

- **180 Day Support Period.**
  Includes all maintenance, repairs, on-call responses, and documentation.

- **Warranty Period.**

(c) UPS Subsystem. Each
Includes UPS Controller, all necessary batteries, and enclosure (if specified) as well as all cabling to ensure a fully functional Supply.

(d) Electrical Service. As follows:

- **Trench and Backfill.** Section 910.4(n)
- **Rigid Galvanized Steel (RGS) and PVC Conduit.** Section 910.4(k)
- **Cable Installation.** Section 910.4(m)
- **Complete Power Supply System.** Section 910.4(o)
- **Junction Box (power and communications).** Section 910.4(a)

SECTION 1202—ATMS ITS DEVICE INTEGRATION

1202.1 DESCRIPTION—This work is the coordination and documentation activities required to facilitate integration of ITS Devices into the Advanced Traffic Management System (ATMS) and to furnish information regarding the characteristics of all relevant ITS devices installed within the project. The ATMS is the common platform used by the Department to monitor, control and utilize all functionalities of ITS devices installed within the Commonwealth.

Work to integrate the ITS device(s) must be a collaborative effort between the Contractor responsible for installation of the ITS device(s) and the ITS Integrator. The ITS Integrator, at no cost to the Contractor, will be responsible for performing the work to integrate the ITS device(s) into the ATMS. The Contractor is responsible for furnishing all information pertaining to the ITS device(s) relevant to integration, as described herein, and as required by the ITS Integrator.

1202.2 MATERIAL—

(a) Protocol Documentation. Furnish protocol documentation for all communication protocols used by the ITS device(s).

(b) Integration Kit. Furnish integration kit (SDK, API, Software), if applicable, that the ATMS vendor will need to integrate device(s). Furnish documentation for integration kit.

(c) Licenses. Furnish licenses, if applicable, to support the integration of the device(s) by the ATMS.

(d) ITS Device Configuration Information. Furnish all information required herein for the respective device(s) being installed. Information must be provided for each device being installed as part of the ITS project. Omission of any information required for integration will be considered incomplete. If information is incomplete at the time of integration activities as identified by the project schedule or plan, it will be considered a delay of the project.

All information must be provided in the format described herein, or as directed by the Representative. Provide information in matrices in Microsoft Excel or comparable format, subject to approval by the Representative. Furnish one matrix per type of device being installed as part of the project.

Transmit information to the Department through the Representative via electronic communications such as email, CD-ROM, or as directed by the Representative.

(e) Device Vendor Point of Contact. Furnish point of contact for each device vendor.

1202.3 CONSTRUCTION—

(a) General. Before the integration activities identified in the project schedule or plan, furnish the information contained herein to ensure the successful integration of the ITS device(s). A template matrix identifying the integration information fields may be available from the Representative. This information is required to be provided to the ITS Integrator as soon as it is available. Systems Acceptance Testing will not commence until all information contained herein has been provided. Failure to provide the information required herein will be considered a delay to the project and be subject to liquidated damages.

(b) ITS Devices. Supply all information as indicated. If information is not readily available, it is the Contractor's responsibility to seek out and obtain the missing information, including performing all necessary coordination with the device(s) manufacturer(s), and performing coordination with the Representative. For fields not applicable to the project, clearly indicate within the matrix the particular cell is not applicable by filling the field with the text "N/A." Provide all latitude and longitude information with accuracy to the nearest 5 feet.

1. **CCTV Cameras.** Furnish the following information:

Location Information	**General Characteristics**	**Communications**
Statewide Device ID	Manufacturer	PTZ Communication Type
Type (permanent vs. portable)	Model	Camera Address
District (Location)	Serial Number/ Manufacturer ID	PTZ Communications Protocol
District (Owner)	Power Type	PTZ Connection Type
Descriptive Location	Encoder Manufacturer (where applicable)	PTZ Connection Parameters (Serial Only)
Roadway		
Roadway Direction		Camera Firmware
Mile Marker (where applicable)		PTZ IP Address
State Route Number		PTZ IP Port Name
Latitude		NTCIP Protocols Supported
Longitude		NTCIP Community String (if NTCIP)
Exit Number (nearest)		Multicast or Unicast
County		Username/ Password (where applicable)
		Video Format
		Video Transport

2. **DMS.** Furnish the following information:

Location Information	**General Characteristics**	**Communications**
Statewide Device ID	Manufacturer	Communication Type
Type (permanent vs. portable vs. semi-permanent)	Model	Communications Protocol (include version if applicable)
Structure Type	Serial Number/ Manufacturer ID	Connection Type
District (Location)	Power Type	Connection Parameters (Serial Only)
District (Owner)	Number of Display Lines	Controller Address
Descriptive Location	Matrix Type (line or full)	Controller Firmware
Roadway	Number of Pages Possible	IP Address
Roadway Direction	Sign Height (by number of pixels)	IP Port Name
Mile Marker (where applicable)	Sign Width (by number of pixels)	NTCIP Protocols Supported
Next Downstream Exit Number	For all available Fonts: • Font Dimensions • Font Height • Font Width • Font Character Spacing • Font Line Spacing	NTCIP Community String (if NTCIP protocol)
State Route Number		Phone Number (if Dialup Communications)
Latitude		
Longitude		
Exit Number (nearest)		
County		

3. **HAR Transmitter.** Furnish the following information:

Location Information	General Characteristics	Communications
Statewide Device ID	Manufacturer	Communication Type
Type (permanent vs. portable vs. semi-permanent)	Model	Communications Protocol (include version)
District (Location)	Serial Number/ Manufacturer ID	Connection Type
District (Owner)	Power Type	Connection Parameters (Serial Only)
Descriptive Location	Broadcast Radius	Controller Address
Roadway	Vendor Control Software - Type and Version	Controller Firmware
Roadway Direction		IP Address
Mile Marker (where applicable)		IP Port Name
Exit Number (nearest)		NTCIP Protocols Supported
County		NTCIP Community String (if NTCIP)
State Route Number		Phone Number (if Dialup)
Latitude		
Longitude		

4. **HAR Beacon.** Furnish the following information:

Location Information	General Characteristics	Communications
Statewide Device ID	Manufacturer	Communication Type
Type (permanent vs. portable vs. semi-permanent)	Model	Communications Protocol (include version)
District (Location)	Serial Number/ Manufacturer ID	Connection Type
District (Owner)	Power Type	Connection Parameters (Serial Only)
Descriptive Location	Associated HAR Transmitter Statewide ID	Controller Address
Roadway		Controller Firmware
Roadway Direction		IP Address
Mile Marker (where applicable)		IP Port Name
Exit Number (nearest)		NTCIP Protocols Supported
County		NTCIP Community String (if NTCIP)
State Route Number		Phone Number (if Dialup)
Latitude		On Code (where applicable)
Longitude		Off Code (where applicable)

5. **Vehicle Detectors.** Furnish the following information for the respective detector types:

5.a Microwave/Radar Detectors, Inductive Loops, and Video Detection units.

Location Information	**General Characteristics**	**Communications**
Statewide Device ID	Detector Type	Communication Type
Type (permanent vs. portable vs. semi-permanent)	Manufacturer	Communications Protocol (include version)
District (Location)	Model	Connection Type
District (Owner)	Serial Number/ Manufacturer ID	Connection Parameters (Serial Only)
Roadway		
Descriptive Location	Power Type	Controller Address
Roadway Direction	Vehicle Classification Capable and # of classification bins to be configured and value	Controller Firmware
Mile Marker (where applicable)	Number of Zones/Lanes	IP Address
Exit Number (nearest)	For each Zone/Lane: • Lane Number • Lane Type • Direction	IP Port Name
County		NTCIP Protocols Supported
State Route Number		NTCIP Community String (if NTCIP)
Latitude		Phone Number (if Dialup)
Longitude		

5.b RFID Tag Readers. Applicable only for IAG/Mark 4 manufactured RFID tag readers based upon the E-ZPass electronic toll collection system.

Location Information	**General Characteristics**	**Communications**
Statewide Device ID	Detector Type	Communication Type
Type (permanent vs. portable vs. semi-permanent)	Manufacturer	Communications Protocol (include version)
District (Location)	Model	Connection Type
District (Owner)	Serial Number/ Manufacturer ID	Connection Parameters (Serial Only)
Descriptive Location	Power Type	Controller Address
Roadway		Controller Firmware
Roadway Direction		IP Address
Mile Marker (where applicable)		IP Port Name
Exit Number (nearest)		NTCIP Protocols Supported
County		NTCIP Community String (where applicable)
State Route Number		
Latitude		
Longitude		

5.c Bluetooth Readers.

Location Information	General Characteristics	Communications
Statewide Device ID	Detector Type	Communication Type
Type (permanent vs. portable vs. semi-permanent)	Manufacturer	Communications Protocol (include version)
District (Location)	Model	Connection Type
District (Owner)	Serial Number/ Manufacturer ID	Connection Parameters (Serial Only)
Roadway	Power Type	Controller Address
Descriptive Location		Controller Firmware
Roadway Direction		IP Address
Mile Marker (where applicable)		IP Port Name
Exit Number (nearest)		NTCIP Protocols Supported
County		NTCIP Community String (where applicable)
State Route Number		
Latitude		
Longitude		

6. NETWORK Switch. Furnish the following information:

Location Information	General Characteristics	Communications
Statewide Device ID	Manufacturer	WAN Communication Type
Type (permanent vs. portable vs. semi-permanent)	Model	LAN Communication Type
Enclosure ID	Serial Number/ Manufacturer ID	MAC Address
District (Location)	Port Types	Firmware Version
District (Owner)	Port Quantity	Default Gateway
Descriptive Location	Power Type	IP Address
Roadway		IP Port Names
Roadway Direction	.	Time Configuration
Mile Marker (where applicable)		Discovery Protocol
Next Downstream Exit Number		Logging Protocol
State Route Number		
Latitude		
Longitude		
Exit Number (nearest)		
County		

(c) Testing. Section 1201.3(b) and as follows:

1. General. Conduct the System Tests in conjunction with the ITS Integrator. Coordinate with the ITS Integrator to ensure the ITS device(s) installed within the project is(are) integrated into Next Gen ATMS. Furnish all information prescribed herein in addition to all additional information required by the ITS Integrator to perform the integration. The System Test will be considered complete upon completion of the following two tests:

2. System Test. Complete comprehensive test of the subsystem to demonstrate full functionality of the ITS device(s) and subsystem, and compliance with the project specifications. Conduct the test using vendor-provided device control software or other equivalent software installed on a Commonwealth-provided computer or workstation in the TMC with access to the ATMS and the PennDOT WAN. Demonstrate full functionality of the

subsystem including all components, such as the workstation and all communications to and from the field. The Contractor is responsible for demonstrating full compliance with project documents, and full functionality of the ITS device and subsystem from the TMC to the field.

Coordinate with the Department Integrator to demonstrate full ITS device control and functionality using the ATMS platform. The ITS Integrator is responsible for physical integration of the ITS device(s) into the ATMS. Ensure integration occurs within the project schedule and according to the project documents. Provide a minimum of 2 weeks advanced notice to the ITS Integrator before integration of ITS device(s) or subsystem(s). Coordinate integration so as many devices as practical are integrated simultaneously.

1202.4 MEASUREMENT AND PAYMENT—

(a) Integration. Lump Sum

- 100% paid upon completion of System Test

SECTION 1204—ITS COMMUNICATIONS

1204.1 DESCRIPTION—This work is the furnishing and installation of the system equipment for the control of ITS and the furnishing and installation of equipment necessary to provide communication between devices, controllers, assemblies, and other components in the field or RTMC/TMC or both that form a system as indicated on the approved plans.

1204.2 MATERIAL—

(a) Micro-Fiber Optic Cable. Provide a fiber optic cable meeting the following:

1. Fiber Optic Distribution Cable.

- Single-mode fiber.
- Mini Loose tubes.
- Dielectric central member.
- Outer Jacket, HDPE.
- Meets Bellcore TR-TSY-000020, REA PE-90 and ANSI/ICEA S-87-640 according to ANSI/TIA/EIA-568A Commercial Building Telecommunications Cabling Standard.
- Reverse oscillation buffer tube stranding.
- Footage markings printed every 2 feet along outer jacket.
- Attenuation at 1310/1550 nm: 0.35/0.25 dB/km (maximum attenuation for every fiber in cable across entire operating temperature range).
- Operating temperature range: -40°C to +70°C.
- Maximum Nominal Outside Diameter - 6.2 mm.

2. Fiber Optic Termination Cable.

- Single-mode fiber.
- Loose tube cable.
- Dielectric central member.
- Medium density polyethylene cable jacket.
- Meets Bellcore TR-TSY-000020, REA PE-90 and ANSI/ICEA S-87-640 according to ANSI/TIA/EIA-568A Commercial Building Telecommunications Cabling Standard.
- Reverse oscillation buffer tube stranding.
- Footage markings printed every 2 feet along outer jacket.
- Attenuation at 1310/1550 nm: 0.35/0.25 dB/km (maximum attenuation for every fiber in cable across entire operating temperature range).
- Operating temperature range: -40°C to +70°C.
- Maximum Nominal Outside Diameter - 10.5 mm.

(b) Standard Fiber Optic Cable. Provide a fiber optic cable meeting the following:

1. Fiber Optic Cable.

- Single-mode fiber.
- Loose tube cable.
- Dielectric central member.
- Medium density polyethylene cable jacket.
- Meets Bellcore TR-TSY 000020, REA PE-90 and ANSI/ICEA S-87-640 according to ANSI/TIA/EIA 568A Commercial Building Telecommunications Cabling Standard.
- Reverse oscillation buffer tube stranding.
- Footage markings printed every 2 feet along outer jacket.

- Attenuation at 1310/1550 nm: 0.35/0.25 dB/km (maximum attenuation for every fiber in cable across entire operating temperature range).
- Operating temperature range: -40°C to +70°C.

2. Tracer Wire. Provide a single 24 AWG (minimum) THHN copper cable. The tracer wire is only required for underground installations.

(c) 5 GHz Outdoor Wireless Radio. Provide an environmentally hardened, dual antenna, wireless ethernet radio operating in the license free 5GHz band meeting the following requirements:

1. Security and Encryption.

- 128 bit- AES keys
- WPA2
- TKIP

2. Antenna.

- Internal Dual Polarized Directional.
- Gain: 19 dBi.
- Azimuth: 17 degrees Horizontal/Vertical.
- Elevation: 17 degrees Horizontal/Vertical.

3. Radio Interface.

- EIRP: Up to +36dBm for point to multipoint deployments, +49 dBm for point to point deployments
- RF Output: +30dBm rated transmitter.
- Operating Frequency: 5180 MHz - 5825 MHz.
- Bandwidths: 10, 20, 40, and 80 MHz.
- Receive Sensitivity: Up to 500 Mbps.
- Distance: Up to 2 mile (FCC Class A, Part 15 compliant).
- Distance: Up to 4 mile with MAC lock enabled (FCC Class A, Part 15 compliant).

4. Network Interface.

- Addressing: Static IP, DHCP Client, DHCP Server
- Two RJ-45 10/100/1000 Ethernet ports with sealed cable gland connectors.
- Three layers of Ethernet surge suppression on PD port.
- IEEE 802.3, 802.3u compliant.
- CSMA/CD 10/100 autosense, full-duplex.
- Dynamic Frequency Selection (DFS).
- Transmit Power Control (TPC).
- Quality of Service (QoS 802.1p).
- Internal RF Spectrum Analysis.
- Internal Antenna Alignment.

5. Enclosure.

- Cast aluminum NEMA-4X/IP67 enclosure.
- Two weatherproof Ethernet connectors.
- System LEDs (Power-On, Ethernet Link, Signal Strength).
- Weight: 5.5 pounds (5.4 Kg) with bracket and sunshield.
- Dimensions: No Larger than 12 inch by 12 inch by 3 inch.
- Pole Mounting Assembly.

6. Power.

- Operating Power: 48-57 VDC @ 170 mA.
- Power Consumption: 8 W maximum with no PD load connected.
- Internal overcurrent protection.
- PD Power: IEEE 802.3af/at PD compliant.
- PSE Power: IEEE 802.3af/at PSE compliant.

7. Environmental Specifications.

- Operating temperature: -40 ºC to +70 ºC.
- Storage temperature: -40 ºC to +85 ºC.
- Relative humidity (non-condensing): 5% to 95%.

(d) 24 GHz Outdoor Wireless Radio. Provide an environmentally hardened, dual antenna, wireless ethernet radio operating in the license free 24 GHz band meeting the following requirements:

1. Security and Encryption.

- 128 bit- AES keys
- WPA2
- TKIP

2. Antenna.

- Polarity: Dual-Slant Polarization.
- TX Gain: 23 dBi.
- RX Gain: 23 dBi.
- Front to Back Ratio: 70 dB.
- Cross-Polarity Isolation: >28 dB.
- Azimuth: 20 degrees Horizontal/Vertical.
- Elevation: 20 degrees Horizontal/Vertical.

3. Radio Interface.

- EIRP: -50 dBm for point to multipoint deployments, +49 dBm for point to point deployments
- RF Output: +30dBm rated transmitter.
- Operating Frequency: 24.05 GHz, 24.25GHz.
- Bandwidths: 10, 20, 30, 40, and 50 MHz.
- Receive Sensitivity: 1.4+ Gbps.
- Distance: Up to 8 miles (FCC Class A, Part 15 compliant).

4. Network Interface.

- Addressing: Static IP, DHCP Client, DHCP Server
- Data Port: One, RJ-45, 10/100/1000 Ethernet port.
- Configuration Port: One, RJ-45, 10/100 Ethernet port.
- Alignment Port: One, RJ-12, alignment tone port.
- IEEE 802.3, 802.3u compliant.
- CSMA/CD 10/100 autosense, full-duplex.
- Dynamic Frequency Selection (DFS).
- Transmit Power Control (TPC).
- Quality of Service (QoS 802.1p).

- Network Services: Ping Watchdog, SNMP Agent, Web Server, SSH Server, Telnet Server, NTP Client, Dynamic DNS, System Log, Device Discovery
- Internal RF Spectrum Analysis.
- Internal Antenna Alignment.

5. Enclosure.

- Cast aluminum NEMA-4X/IP67 enclosure.
- Three weatherproof Ethernet connectors.
- System LEDs (Power-On, Ethernet Link, Signal Strength).
- Weight: 23.15 pounds (10.5 Kg) with mounting bracket.
- Dimensions: No Larger than 12 inch by 12 inch by 3 inch.
- Pole Mounting Assembly.

6. Power.

- Operating Power: 42-58 VDC.
- Power Method: 50V, 1.2A PoE.
- Power Consumption: 40 W maximum.

7. Environmental Specifications.

- Operating temperature: -40 ºC to +55 ºC.
- Relative humidity (non-condensing): 5% to 95%.

(e) Cellular Modem - Provide an Industrial grade 4G/LTE Private IP Cellular modem, necessary cabling, and required antenna and connectors to provide a fully functioning cellular data connection. Provide a modem that is compatible with existing District modems, existing SIM cards, spare parts, and District Inventory and meeting or exceeding the following requirements:

1. Security:

- IPsec VPN
- GRE Tunnel
- Friends List

2. Network Technology:

- HSUPA
- With fallback to: HSDPA, UMTS, EDGE, GPRS (MS-12)
- Tri-Band UMTS/HSDPA/HSUPA, 850/1900/2100 Mhz
- Quad-Band GPRS/EDGE, 850/900/1800/1900 MHz
- EV-DO Rev A or later with fallback to: CDMA 1x EV-DO Revision 0, CDMA 1xRTT, CDMA IS-95

3. Radio Interface:

- Operating Frequency: 700/800 Mhz Cellular, 1900 Mhz PCS
- FCC Approved
- PCS Type Certification Review Board (PTCRB)
- Carrier Specific Approvals.

3. Environmental Specifications.

- Operating temperature: -40°C to 70°C, -40F to 158F

- Storage Temperature: -40°C to 85°C, -40F to 185F
- Vibration/Shock: MIL-STD-810G
- ROHS Compliant

4. Electrical Specifications.

- Input Voltage: (9-28V DC)

5. Maximum Device Dimensions.

- Size: 5.6 in x 1.5 in x 4.0 in

6. Host Interfaces

- Ethernet: 10/100 Mbps RJ-45
- RS-232: DB9 DCE (300 – 230400 baud)
- Antenna Connection: Primary 50 Ohm SMA, Rx Diversity 50 Ohm SMA

7. Application Interfaces

- TCP/IP
- UDP/IP
- DHCP
- HTTP
- SNMP
- SMTP
- SMS
- MSCI
- Modbus
- Binary

8. LED Indicators

- Network
- Signal
- Activity
- Service

9. Provide OMNI Directional antenna as follows:

- Support a cellular frequency of 698-960 MHz and 1710-2170 MHz PCS frequency band as well as all 3G and 4G/LTE frequencies used in the United States.
- Max Impedance: 50 Ohms
- Gain: 6 dBd or greater
- Power: 50W
- Vertical Polarization
- Connector: N/Female

Provide necessary low loss N/Female to N/Female connectors. Utilize ultra-low loss coaxial cable for connection between antenna and modem. Provide cable with dB loss less than 1.9 dB and diameter of 7/16”. Provide cable length as required to eliminate any cable splicing and eliminate any excess cable to make the length as short as possible.

Provide necessary additional ancillary equipment, hardware and cabling to integrate new modem into the District’s communications network.

Modem shall be compatible with the use of an existing SIM card currently in use by the District. Modem shall auto configure based on the installed SIM. See contact information in the project documents for SIM card.

(f) Radio Communication Cables. Provide outdoor rated, industrial grade, shielded CAT 6 Ethernet cable and connectors, properly grounded through the PoE AC/DC ground as recommended by the manufacturer. Supply all cable between wireless radio and related communication's enclosure that are comprised of single continuous runs without splices. Make provisions to keep some slack in the vertical cable run within or around the wireless radio enclosure. Provide cable entrance enclosure fittings to maintain enclosure NEMA/IP rating and strain-relief mechanism to the cable.

(g) Managed Network Switch. Section 1201.2(c)

(h) Power Supply 24 VDC. Section 1201.2 (d)

(i) High PoE (Power over Ethernet) Midspan Injector. Section 1201.2 (g)

(j) Documentation. Section 1201.2 (f)

1204.3 CONSTRUCTION—As directed and as follows:

(a) Micro-Fiber Optic Cable. Install fiber optic cable in new conduit/inner duct as indicated. Use appropriate installation techniques so the optical and mechanical characteristics of the cable are not degraded. Unless otherwise approved, use only the equipment and procedures specified by the manufacturer of the fiber optic cable. Install the cable in such a way the manufacturer's minimum bending radius and force limitations are not violated before, during, or after installation.

Before any fiber optic cable installation is performed, provide the Representative with four copies of the cable manufacturer's recommended installation plan and equipment set up locations and maximum force limitations for each cable size and type. The installation system to be used is to be inspected and approved by the Representative. Provide a list of the minimum allowable cable bending radius and cable manufacturer's approved pulling lubricants and guidelines for their application. Only these lubricants are allowed.

Before installation, verify duct integrity to discover any missing sections, improper couplings, kinks or blockage in the ducts. Use air pressure to test duct connectivity. Use shuttle testing to verify duct path integrity. Use sponge testing to clean out water and debris. Repair, replace or clean duct to ensure cable installation meets or exceeds manufacturer's guidelines.

Establish adequate voice communications between the blower units and receiving end and all intermediate locations. Set up the cable reels on the same side of the junction box as the conduit section in which the cable is to be placed. Make the reel level and bring it into proper alignment with the conduit section so the cable will pass from the top of the reel in a long smooth bend into the duct without twisting. Do not pay off the cable from the bottom of the reel. Feed the cable by manually rotating the wheel.

Install the cable in the duct with a factory installed cable grip and swivel attached to the air carrier unit to prevent twisting during the installation. Use an approved cable feeder guide between the cable reel or storage stack and the face of the duct to protect the cable, and to guide the cable into the duct as it is payed off the reel or from the storage stack. The dimensions and set-up of the feeder guide are to be such that the cable does not bend at any location to a radius less than the cable's minimum allowable bending radius. Do not exceed this minimum-bending radius at any time during cable installation.

Keep cable ends sealed at all times during installation, using an approved cable end cap. Do not use tape to seal the cable end. Keep the cable end sealed until termination takes place. Provide a minimum of 50 feet of slack for cables that are not immediately terminated.

Ensure the blower tractor unit is not allowed to continue to operate if cable motion stops. As the cable reaches any intermediate locations, make sure it is routed properly. Ensure no sharp bends exist that are less than the cable's minimum bend radius. Apply lubricant as required. When the cable reaches the end point, stop the blower and blower tractor according to the blower manufacturer's recommendations. Break down blower units according to the manufacturer's recommendations.

Use an approved lubricant, if needed, in the amount recommended by the cable manufacturer, to facilitate pulling the cable. Lubricate the cable as it is payed off the cable reel or storage stack into the cable feeder. Place an approved

cable lubricator (funnel) around the cable just ahead of the cable feeder to facilitate proper lubrication of the cable. After the cable has been installed, wipe the exposed cable in a junction box or cabinet clean of cable lubricant with a cloth before leaving the junction box or cabinet.

Take every precaution to ensure the cable is not damaged during storage and installation. Do not allow workers to step on the cable or run it over with any vehicle or equipment. Do not pull the cable along the ground, over edges or corners, over or around obstructions, or through unnecessary curves or bends. Use approved cable guides, feeders, shoes, and bushings to prevent damage to the cable during installation. Replace and reinstall all damaged cables at no additional cost to the Department.

Cable runs are to be continuous between allowable termination points in equipment cabinets and multiplexer nodes. Carefully determine the length of cable necessary to reach from termination point to termination point. Do not splice fiber optic cable in conduit or junction boxes.

Cable may be furnished and installed through an intermediate junction box if approved. Intermediate junction boxes will be considered part of cable installation, and no separate payment will be made for this work

Install the necessary length of cable from one equipment cabinet or multiplexing node to the immediate next downstream equipment cabinet or multiplexing node. Carefully store the remaining length of cable to be installed in the next conduit in a manner that is not hazardous to pedestrian or vehicular traffic yet ensures no damage to the cable occurs. Store the cable in a manner that allows that length of cable to be safely pulled into the next conduit and is approved.

In junction boxes, store 50 feet of slack fiber optic cable for the distribution fiber and 20 feet of slack fiber for the termination fiber spur that passes through the junction box. In addition, provide 50 feet of slack fiber for all fiber types at a junction box adjacent to an equipment field device cabinet. Neatly store slack cable on the side walls of the junction box using racking hardware approved. Optical fibers must be placed inside loose buffer tubes. Each buffer tube must contain 12 fibers. The fibers must not adhere to the buffer tubes.

No separate payment will be made for equipment used to install, terminate and test the fiber optic cable. The unit price for fiber optic cable includes all cable ties, clamps, associated material, and labor required to install the cable.

The firm or subcontractor involved in the installation of the fiber optic cable must meet the requirements of Section 102.01.

1. Termination. Terminate fiber optic cable only in equipment cabinets, multiplexer nodes, splice cabinets, and at the TMC shown on the plans, unless directed otherwise. Splice through all fibers not used at a particular cabinet, and cap unused fibers that end in a cabinet. Provide and install patch cables at the TMC or Multiplexers where connection is to be made from an existing patch panel to a communications device.

At fiber optic termination points provide a fiber optic splice enclosure. Make all fiber terminations by splicing the fiber to factory connected pigtails using fusion splicing only. The pigtails are to be buffered, strengthened with aramid, and meet the requirements for fiber optic cable. All pigtail connectors are to be the ceramic ST type. Use the pigtails to connect the fiber optic cable to the equipment in the cabinet or at the multiplexers. Permanently label all fiber optic connectors, whether on pigtails or equipment, to preclude improper connection. The Representative will approve the labeling method(s) before use.

The cost of terminating, including the cost of splicing kits, pigtails, connectors, fiber optic cable caps, moisture sealants, and mounting hardware is considered incidental to furnishing and installing fiber optic cable, and will not be paid separately.

(b) Standard Fiber Optic Cable. Install fiber optic cable in new conduit as indicated. Use appropriate installation techniques so the optical and mechanical characteristics of the cable are not degraded. Unless otherwise approved, use only the equipment and procedures specified by the manufacturer of the fiber optic cable. Install the cable in such a way neither the minimum bending radius nor the maximum pulling tension are violated before, during, or after installation.

Before any fiber optic cable installation is performed, provide the Representative with four copies of the cable manufacturer's recommended and maximum pulling tensions for each cable size and type. These pulling tensions are to be specified for pulling from the cable's outer jacket. Also provide a list of the minimum allowable cable bending radius and the cable manufacturer's approved pulling lubricants and guidelines for their application. Only these lubricants are allowed.

The installation system to be used is to be inspected and approved by the Representative.

Establish adequate voice communications between the cable feeding location and the cable pulling equipment before starting any pulling operations. Set up the cable reels on the same side of the junction box as the conduit section in which the cable is to be placed. Make the reel level and bring it into proper alignment with the conduit section so

the cable will pass from the top of the reel in a long smooth bend into the duct without twisting. Do not pull the cable from the bottom of the reel. Feed the cable by manually rotating the wheel.

Pull the cable in the conduit with a cable grip designed to provide a firm hold on the exterior covering of the cable. Use an approved cable feeder guide between the cable reel or storage stack and the face of the duct to protect the cable, and to guide the cable into the duct as it is payed off the reel or from the storage stack. The dimensions and set-up of the feeder guide are to be such that the cable does not bend at any location to a radius less than the cable's minimum allowable bending radius. Do not exceed this minimum-bending radius at any time during cable installation.

Keep cable ends sealed at all times during installation, using an approved cable end cap. Do not use tape to seal the cable end. Keep the cable end sealed until termination takes place. Provide a minimum of 50 feet of slack for cables that are not immediately terminated.

At any time, the allowable pulling tension is to be 70% of the manufacturer's maximum pulling tension for pulling by the outer jacket. Ensure the allowable pulling tension is not exceeded at any time during cable installation by using one of the following methods, as approved:

- Pulling the cable by hand.
- Approved mechanical means.

If the cable is pulled by mechanical means, use a clutch device to ensure the allowable pulling tension is not exceeded. Also, attach a strain gauge to the pulling line at the cable exit location, and at a sufficient distance from the take-up device, so the strain gauge can be read throughout the entire cable pulling operation.

Use an approved lubricant if needed, in the amount recommended by the cable manufacturer, to facilitate pulling the cable. Lubricate the cable as it is payed off the cable reel or storage stack into the cable feeder. Place an approved cable lubricator (funnel) around the cable just ahead of the cable feeder to facilitate proper lubrication of the cable. After the cable has been installed, wipe the exposed cable in a junction box or cabinet clean of cable lubricant with a cloth before leaving the junction box or cabinet.

Take every precaution to ensure the cable is not damaged during storage and installation. Do not allow workers to step on the cable or run it over with any vehicle or equipment. Do not pull the cable along the ground, over edges or corners, over or around obstructions, or through unnecessary curves or bends. Use approved cable guides, feeders, shoes, and bushings to prevent damage to the cable during installation. Replace and reinstall all damaged cables at no additional cost to the Department.

Cable runs are to be continuous between allowable termination points in equipment cabinets and multiplexer nodes. Carefully determine the length of cable necessary to reach from termination point to termination point. Do not splice fiber optic cable in conduit or junction boxes.

Cable may be furnished, installed, and pulled through an intermediate junction box if approved. Intermediate junction boxes will be considered part of cable installation, and no separate payment will be made for this work

Pull the necessary length of cable to be installed from one equipment cabinet or multiplexing node to the immediate next downstream equipment cabinet or multiplexing node. Carefully store the remaining length of cable to be installed in the next conduit in a manner that is not hazardous to pedestrian or vehicular traffic yet ensures no damage to the cable occurs. Store the cable in a manner that allows that length of cable to be safely pulled into the next conduit and is approved.

In junction boxes, store 50 feet of slack fiber optic cable for the distribution fiber and 20 feet of slack fiber for the termination fiber spur that passes through the junction box. In addition, provide 50 feet of slack fiber for all fiber types at a junction box adjacent to an equipment field device cabinet. Neatly store slack cable on the side walls of the junction box using approved racking hardware.

No separate payment will be made for equipment used to install, terminate and test the fiber optic cable. The unit price for fiber optic cable includes all cable ties, clamps, associated material, and labor required to install the cable.

The firm or subcontractor involved in the installation of the fiber optic cable must meet the requirements of Section 102.01.

1. Termination. Terminate fiber optic cable only in equipment cabinets, multiplexer nodes, splice cabinets, and at the TMC shown on the plans, unless directed otherwise. Splice through all fibers not used at a particular cabinet, and cap unused fibers that end in a cabinet. Provide and install patch cables at the TMC or Multiplexers where connection is to be made from an existing patch panel to a communications device.

At fiber optic termination points provide a fiber optic splice enclosure. Make all fiber terminations by splicing the fiber to factory connected pigtails using fusion splicing only. The pigtails are to be buffered, strengthened with aramid, and meet the requirements for fiber optic cable. All pigtail connectors are to be the ceramic ST type. Use the

pigtails to connect the fiber optic cable to the equipment in the cabinet or at the multiplexers. Permanently label all fiber optic connectors, whether on pigtails or equipment, to preclude improper connection. The Representative will approve the labeling method(s) before use.

The cost of terminating, including the cost of splicing kits, pigtails, connectors, fiber optic cable caps, moisture sealants, and mounting hardware is considered incidental to furnishing and installing fiber optic cable, and will not be paid separately.

(c) Outdoor Wireless Radio. Conduct a wireless line of sight analysis measuring existing Radio Spectrum, Received Signal Strength Indicator (RSSI), Link Quality and Performance for each wireless node as shown on the communications plan sheet. Submit results of the analysis to the Department for approval before any repeater pole installation. Any location not meeting the minimum RSSI level will require lateral adjustment to the location in order to achieve a minimum RSSI receive threshold reading as recommended by the manufacturer. Install the radios and panel antennas cable according to the manufacturer's guidelines. Adjust antenna alignment to achieve the maximum RSSI level reading. Configure wireless link radio according to the manufacturer's recommendations before deploying in the field.

(d) Cellular Modem: Install, connect and configure Cellular modem in ITS Device cabinet as shown in the Design Drawings. Install modem in accordance to the manufacturer's recommendations. Coordinate with the Department for installation of the existing SIM card and existing cellular provider to provide service to the proposed Cellular modem. Orient antenna to achieve the best signal possible. This may require multiple attempts. Once connectivity has been established coordinate with the District ITS staff for the integration of the ITS device into the existing RTMC and test accordingly.

(e) ITS Device Testing. As specified in Section 1201.3(b).

(f) ITS Device Integration. As specified in Section 1201.3(c).

(g) ITS Device Training. As specified in Section 1201.3(d).

1204.4 MEASUREMENT AND PAYMENT—

(a) Micro-Fiber Optic Cable. Linear Foot

Measured from junction box to junction box plus the slack cable required. Includes field splices and connectors necessary for the splices made at equipment locations.

Tracer wire installation is incidental to the installation of the Fiber Optic Cable

(b) Standard Fiber Optic Cable. Linear Foot

Measured from junction box to junction box plus the slack cable required. Includes field splices and connectors necessary for the splices made at equipment locations

Tracer wire installation is incidental to the installation of the Fiber Optic Cable

(c) Outdoor Wireless Radio. Each

Includes all material costs, wireless line of sight costs as well as construction costs associated with the installation of a fully functional Wireless Radio site.

- 25% of payment will be made upon installation of the Radio
- 55% of payment will be made upon integration into new or existing link
- 20% of payment will be made upon successful System Acceptance

(d) Cellular Modem. Each

Includes all material costs, cellular field study costs as well as construction costs associated with the installation of a fully functional Wireless Radio Repeater site.

- 25% of payment will be made upon installation of the Cellular Modem
- 55% of payment will be made upon integration into new or existing network

- 20% of payment will be made upon successful System Acceptance

SECTION 1206—MAINTENACE, ITS DEVICES - GENERAL

1206.1 DESCRIPTION—This work is to furnish, install, modify, repair, replace, and remove non-device specific ITS components and equipment essential to a fully functional and operational system.

1206.2 MATERIAL—Section 1201.2

1206.3 CONSTRUCTION—Section 1201.3 and as follows:

(a) Preventive Maintenance.

1. General. Perform Preventive Maintenance (PM) according to the manufacturer's recommendations, Publication 697, and the following:

Submit, for approval, an annual schedule of all PM activities within 2 weeks of receiving notice to proceed.

Comply with the following example submission schedule:

Preventative Maint. Report No.	Complete Field Inspection	Submit PM Report
1. Through November	November 28	December 15
2. Through December	December 28	January 15
3. Through January	January 28	February 15
4. Through February	February 28	March 15

PM is required before and after the winter season annually. Report all deficiencies on the PM checklist directly to the Department within 24 hours. Report all critical deficiencies directly to the Department immediately while on-site.

Submit one typed hard copy or electronic copy of the monthly status report showing all PM completed during each month. Include the following in the report:

- Detailed description of the PM performed.
- Copies of payroll records and work reports.
- PM Checklists; including test results.

2. Site. Check for proper clearance of tree branches or brush around power and communication lines associated with ITS devices. Provide required tree trimming and brush clearing work. Spray and place weed control measures around each device.

Remove snow and ice buildup around enclosure(s), maintenance area(s), and device(s). This also includes removing snow and ice from solar panels, camera housings, beacons, transmitters, detectors, and wireless communication devices.

3. Enclosures. Inspect all field enclosures, including camera control enclosures, backup or battery powered supply enclosures, hub enclosures, and junction and pull boxes, for damage, corrosion, water damage, and leaks. Verify absence of water from the inside bottom of enclosure. If water is present, ensure the means for drainage have not become obstructed. Remove obstructions, if present. Apply caulking, if required, to prevent water from entering enclosure.

Remove all objects or debris inconsistent with control enclosure materials such as nests made by rodents, birds, or flying insects, etc. Spray for insect prevention. Install or replace rodent control measures as necessary. Ensure conduit openings into the enclosure are sealed with metal meshing material to prevent animals from entering the enclosure. Inspect all connections, all cabling, and the physical appearance of the equipment within the enclosures.

Check gaskets, ground rod clamps, heaters, and all connections. Check anchor bolts for rust and tightness. Repair as necessary. Lubricate hinges, locks, and latches. Remove accumulated dust. Replace burned out light bulbs.

Clean semi-permanent filters during every PM inspection according to the manufacturer's recommendations. Replace semi-permanent filters if media integrity is ripped, torn, punctured, or contaminated beyond normal cleaning methods. Replace disposable filters twice annually with nylon-based filter media. Do not use paper filters.

Perform local diagnostics on all applicable equipment. Tighten loose connections. Service air conditioner, fans, and heater controls. Test ground rods for 25 ohms or less resistance utilizing fall of potential test. Test power, including battery backups, and communications line surge suppressors and replace as necessary. Inspect and test communications systems including transmission devices, modems, pagers, and cables.

If the device's Statewide Device Identification Number is not displayed on the enclosure or is faded, missing, or vandalized, provide the Statewide Device Identification Number as specified in Section 1201.2(b)1.

(b) On-call Maintenance.

1. General. Perform On-call Maintenance (OM) in accordance with the manufacturer's recommendations and Publication 697.

2. Responsiveness. Perform OM activities within the following timelines:

- **Notification:** The Department or the TMC notifies the On-call Responder of an issue.
- **Acknowledgment:** The On-call Responder is to acknowledge the notification within 30 minutes. Phone and email verification by the On-call Responder will be provided to the issuing TMC.
- **Diagnose:** The On-call Responder must arrive at the site and diagnose the issue within 4 hours from the notification by the Department or the TMC.
- **Performance:** The TMC issues a work directive to the On-call Responder, either written or verbal, and the On-call Responder is to complete the repairs within 72 hours from the issuance of work directive.
- **Log:** The On-call Responder is to log the activity within 2 business days after the completion of repairs.

1206.4 MEASUREMENT AND PAYMENT—

(a) PM, Other. Each

All labor, materials, and equipment required for routine preventive maintenance are incidental to this item including, but not limited to, the Statewide Device Identification Number, cleaning materials, caulk, metal meshing, lubricants, filters, lamps, paint, surge suppressors, fuses, circuit breakers, attachment hardware, insect prevention measures, rodent control measures, clearing and grubbing, selective tree trimming, snow and ice removal, and weed control measures. Mobilization is incidental to this item.

(b) On-call, Other Mobilization. Each

Mobilization will not be paid for procurement of parts. Travel to and from the site and district stockpile is incidental to this item.

(c) On-call, Other Repair. Hour

Repair time will not be paid for procurement of parts. Travel to and from the site and district stockpile is incidental to this item. Site specific snow and ice removal requested by the Department is included within this item.

(d) On-call, Other Parts. Dollar

Includes all cables, connectors, equipment racks, grounding rod(s), conductor(s), and other parts necessary for proper installation and configuration.

(e) Maintenance and Protection of Traffic. Section 901.4(a)

SECTION 1210—CLOSED CIRCUIT TELEVISION CAMERA

1210.1 DESCRIPTION—This work is to furnish and install a complete, fully functional Closed Circuit Television (CCTV) camera subsystem.

1210.2 MATERIAL—

(a) General. Furnish a CCTV camera subsystem including camera, midspan injectors, power supply, integrated camera housing, housing mounts, CCTV ITS enclosure, wires, connections, grounding system, Camera Lowering Device (CLD), Camera Lowering Tool, CCTV pole, and CCTV pole foundation. Utilize the newest and most current electronics.

(b) CCTV Camera. According to Publication 647, NTCIP, AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, MUTCD, NEMA, and NEC. Manufactured by an ISO-9001 certified facility.

(c) CCTV Camera Assembly. Provide a dome style CCTV camera assembly, positioner CCTV camera assembly, or both meeting the following requirements:

1. **Camera.**

- Sensor: 1/2.8” CMOS.
- HD Standard: SMPTE 274M-2008.
- Aspect Ratio: 16:9.
- Frame Rate: 30 fps.
- Electronic Image Stabilization (EIS) technology integral to the camera body.
- Automatic Day/Night Imaging with IR cut filter.
- Day/Night Modes: Monochrome, Color, Auto
- Minimum Shutter Speed Range – 1/2 to 1/10,000 second.
- Defog Mode, user selectable: Off/Auto/Manual.
- Gain Control, user selectable: AGC (Automatic Gain Control), Fixed
- Back Light Compensation (BLC) user selectable: On/Off/Enhanced or Intelligent Auto Exposure.
- Maximum signal-to-noise ratio of 50dB un-weighted.
- Through-the-lens auto white balancing with manual over-ride and white balance modes for Normal, Mercury and Sodium light sources.
- Provide OSD (On-Screen-Display) camera titles with configurable text colors to display options for text, preset, azimuth/elevation, compass, date/time and zoom for position control at a minimum.

2. **Optical.**

- Optical zoom power of minimum 30X.
- Digital zoom, minimum 12X, Off/On.
- Field of View (FOV) 2.3°-65°.
- Aperture F1.6-F4.6
- Iris control: Auto/Manual
- Focus control: Auto/Manual
- Generate video images that exhibit no geometric distortion and are free of blemishes as defined by EIA 330.

3. **Network Interface.**

- Network Format 802.3u 100Base-T, MDI-X.

- Support and comply with the following Network protocol and standards: Internet IPv4 with adjustable device IP address, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Internet Control Message Protocol (ICMP), Internet Group Management Protocol (IGMP), Address Resolution Protocol (ARP), Real-Time Transportation Protocol (RTP), , Dynamic Host Configuration Protocol (DHCP), Hypertext Transfer Protocol (HTTP), Simple Network Time Protocol (SNTP), and Simple Network Management Protocol (SNMPv2), National Transportation Communication for Intelligent Transportation System Protocol (NTCIP).
- Support and comply with the following camera control Protocols: NTCIP 1205, ONVIF-S.
- LAN Interface: Ethernet 10-Base T/100 Base-TX, Auto-Sensing, Half/Full Duplex, for connection to the video Local Area Network (LAN). Equip the camera with password protection against unauthorized access. Provide an RJ45 output interface.
- Data Rate: 9.6 kbps to 8Mbps.
- Video Compression: H.264 (ISO/IEC 14496-10), M-JPEG.
- Support NTSC 1080p, 720p, D1, 4CIF and CIF frame size at a frame rate of up to 30 FPS and provides adjustable frame size and frame rate.
- Provides at a minimum, two simultaneous H.264 compression streams, H.264 (MPEG4 part 10), format Baseline Profile or higher and the option of configuring one stream as M-JPEG CIF frame size and at a frame rate of up to 30 FPS.
- Support Real Time Streaming Protocol (RTSP, RFC 2326).
- Support the transmission of video via unicast or multicast.

4. Environmental.

- Environmentally sealed, camera housing which provides an Ingress Protection of IP66, NEMA 4X or better.
- Operate without degradation in performance under temperature range of -30F to +141F, and relative humidity of 100%, condensing, and a storage temperature range of -40F to +140F.
- Equipped with DC resistive heaters for operation down to specified operating temperatures identified above.

5. Mechanical.

- Capable of attachment to a Camera Lowering Device.
- Maximum Weight of 15 pounds.

6. Electrical.

- Provide and terminate two independent power sources for each camera. Provide input voltage of High PoE, midspan injector and power supply as primary or auxiliary or both power sources.
- Power Consumption without Heaters – 40W

Maximum Total Power Consumption – 75W Maximum

7. Pan/Tilt/Zoom (PTZ) Subsystem. Provide an integral PTZ subsystem capable of pan movement between 0 and 360 degrees at speeds between 0.1 and 80 degrees per second in normal operating mode. Also provide a camera which provides a tilt range between 0 and 180 degrees at tilt speeds between 0.1 and 40 degrees per second. Provide a PTZ subsystem capable of at least 64 preset positions, with a positioning accuracy of ± 1/2 degree. Include auto focus, auto iris, pan, tilt, and zoom functions in each preset position.

(d) Camera Housings and Mounts. Provide an environmentally sealed camera housing. Construct housing to be dust and water tight, and fully operational in 100% condensing humidity. Furnish housing to provide the environment needed for camera operation, and keep the viewing window free of fog, snow, and ice. Construct housing of aluminum, stainless steel, or steel with a corrosion-resistant finish. Construct viewing bubble of clear high-resolution acrylic or rugged polycarbonate, all materials optically correct. Provide each camera assembly with sunshield. Provide housing and mounting hardware that can withstand winds according to Publication 647, and to withstand vibration of up to 0.03 inch total excursion from 5 Hz to 30 Hz, and peak random vibrations of 5G's from 30 Hz to 1,000 Hz.

If camera is pole mounted, mount camera on support arm securely attached to the steel pole according to Publication 647.

(e) CCTV Camera Lowering Device (CLD). Provide all pulleys, cabling, suspension contact unit, cable guides, mounting fixtures, mounting arms, weights, cranks, connections and appurtenances necessary to provide a fully functional camera lowering system for a CCTV location. Provide CLD to enable a single maintenance personnel to access a CCTV by lowering the camera to the ground or enclosure-level without the need for a bucket truck or other lifting apparatus. Provide CLD as an integral component of the camera pole structure, where camera is pole-mounted.

Provide CLD capable of locking in place at any desired height, including at the ground level, and locked in position at the top of the pole or structure. When locked at the top of the pole or structure, release all weight from the CLD cables. Equip CLD with a manual crank that facilitates incremental lowering of the camera, lens, housing, PTZ mechanism, all heating/cooling/temperature devices, camera wiring and connections without causing damage or degradation of the camera functions and operations.

Comprise all components of corrosion resistant materials. Powder-coat, galvanize, or otherwise protect all external components from the environment by industry standard coatings to withstand exposure to a corrosive environment. Provide CLD that allows maximum play of ± 5 degrees if locked in raised position under sustained wind speeds of up to 130 miles per hour with a 30% gust factor, with camera housing presenting an effective wind loading surface of maximum 1 square foot.

Provide CLD assembly and connections in accordance with Publication 647, AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, 2001 (including 2002, 2003, and 2006 interims), fatigue design per Section 11: Fatigue Design, AASHTO Standard Specifications for Highway Bridges, 17th Edition (including interims), and Design Manual, Part 4, Structures, September 2007 Edition, (including Change Numbers).

Provide a heavy-duty suspension contact unit between the pole or structure and the camera apparatus that facilitates physical and electrical connections to the camera. Furnish contact unit that utilizes dual latching arms to connect the CCTV to the CLD. Provide unit with a load capacity of the dual latching arm apparatus of at least 2,400 pounds, including safety factor, and a locking mechanism between the fixed and moveable components of the CLD. Provide a locking mechanism which operates by alternately raising and lowering the assembly using the crank and lowering cable such that when latched, all weight is removed from the CLD cable. Provide the fixed unit with a heavy duty cast tracking guide and means to allow latching in the same position each time. Provide self-aligning contact units and receiver brackets that automatically align the centerline of the camera apparatus with the centerline of the camera pole or structure upon raising and locking into position.

Protect all electrical, video coaxial and other connections between the fixed and moveable portions of the contact block from weather by waterproof seal to prevent degradation of the electrical contacts. Fabricate electrical contacts of corrosion resistant material to prevent degradation of the connections. Provide a weatherproof CLD system housing with at replaceable neoprene gasket provided to seal the interior from dust and moisture without the use of pressurization. Furnish contact block of hypalon or other similar synthetic polymer in order to seal the internal contacts from weather, water, dust and degradation of the electrical contacts while in the raised and locked position.

Provide a connector block with the female and male socket contact halves modular and self-aligning. Provide internal and locking components that are made of stainless steel or aluminum or both. Provide internal connectors capable of supplying electric power of up to 5 A at up to 120 VAC through the connector without damage to the connector, while supplying full amperage draw of the camera assembly and operating with the heater and all electronics powered on. Provide electrical connections between the fixed and movable components to facilitate connection for the conductors typically required for the following signals: serial data signal involving up to eight conductors for camera PTZ control and response, 1-Volt peak to peak analog video signal, and eight-conductor (Cat6) signal for 10 Mbps Ethernet communication.

1. Equipment Connection Box. Provide a heavy-duty equipment connection box for connecting the CCTV or other ITS device to the lowering device. Furnish a 1.5 inch National Pipe Thread (NPT) pipe connection point in the equipment connection box for attaching a camera. Provide equipment connection box that has an ingress protection rating of no less than IP55. Provide CLD that includes a disconnect unit for electrically connecting the equipment installed on the CLD's equipment connection box to the power, data, and video cables (as applicable).

2. Lowering Tool. Provide a CLD that utilizes a portable, detachable lowering tool. Provide a tool consisting of a lightweight metal frame and a crank assembly with a cable as specified in 1210.2(e)3; a quick release cable connector, an adjustable safety clutch and a variable speed reversible industrial duty electric drill motor with maximum

rotations per minute per the manufacturer's recommendations. Provide a tool that is operable using 120V electric power, compatible with accessing the support cable through the hand hole of the pole and which will attach to the pole with one single bolt. If attached to the hand hole, the tool must support itself and the load, assuring lowering operations and providing a means to prevent freewheeling. Equip lowering tool with a positive breaking mechanism to secure the cable reel during raising and lowering operations and to prevent freewheeling.

Furnish a lowering tool which has a reduction gear to reduce the manual effort required to operate the lifting handle to raise and lower a capacity load. Provide the lowering tool with an adapter for operating the CLD by a portable drill with a clutch mechanism. Fabricate lowering tool made of durable and corrosion-resistant materials that are powder coated, galvanized, or otherwise protected from the environment by industry accepted coatings to withstand exposure to corrosive environment. Deliver lowering tool plus all additional tools required to the Representative upon project completion.

Provide all pulleys for the CLD and portable lowering tool with sealed, self-lubricated bearings, oil tight bronze bearings, or sintered bronze brushings. Provide weights and counterweights as necessary to ensure the alignment of pins and connectors are proper for the camera support to be raised into position without binding. Provide the CLD with sufficient weight to disengage the camera and its control components in order that it can be lowered properly.

3. Cabling. Provide lowering cable with a minimum of 0.125 inch diameter stainless steel type 316 aircraft cable with a minimum breaking strength of 1750 pounds with seven strands of 19-gauge wire each. Provide lift unit support subsystem with prefabricated components that preclude the lifting cable from contacting the power or video cabling.

Provide a CLD with only the stainless steel lowering cable permitted to move within the pole or externally-mounted conduit during lowering and raising operations. All other cables must remain stable and secure during lowering and raising operations. If the camera is mounted on a steel pole, contain the camera lowering cable on the inside of the pole. Install pulleys for the lowering device and portable lowering tool that have sealed, self-lubricated bearings, oil-tight bronze bearings, or sintered bronze bushings.

If cabling is contained inside a hollow pole, separate the cabling to prevent it from touching or interfering with other electrical and mechanical cabling within the pole. Make provisions to completely separate all CLD cables from electrical, communications and other cables.

(f) ITS Enclosure. Section 1201.2(b)

(g) Managed Network Switch. Section 1201.2(c)

(h) Low Voltage Power Supply. Section 1201.2(d)

(i) UPS Subsystems. Section 1201.2(e)

(j) IP Controlled Remote Power Switch. Section 1201.2(f)

(k) High PoE (Power over Ethernet) Midspan Injector. Section 1201.2(g)

(l) Electrical Service. Section 1201.2(h)

(m) Grounding Rod. Section 1101.11(j) and Publication 647

(n) CCTV Pole. Section 1101.01, 1101.02, 1101.04, 1101.05, and as follows. Furnish CCTV pole according to Publication 647. Aluminum poles are not allowed. Furnish poles of heights less than 50 feet according to the conventional lighting portion of Section 1101. Furnish poles of heights greater than 50 feet according to the high mast lighting portion of Section 1101.

Furnish baseplate of a minimum thickness of 3 inches unless otherwise specified. Provide bottom shaft sections with an 8 inch minimum thickness. Use joint penetration weld to connect the shaft to the baseplate according to AASHTO 2001 Sign Specifications in Table 11-2, Detail 11.

Provide hand holes as shown in the Standard Drawings of height to accommodate CLD.

(o) CCTV Pole Foundation.

1. Class A Cement Concrete. Section 704.

2. Grade 60 Reinforcement Bars. Section 709.1.

3. Conduit. Section 1101.09.

1210.3 CONSTRUCTION—As indicated, as shown on the Standard Drawings, and as follows:

(a) CCTV Subsystem. Configure camera with PTZ functions to return automatically to related "Home" viewing position. Configure the subtitle or sector for each camera view position and preset. Display subtitles with the associated video image. Include the road the camera is on, camera number, and all other information as directed by the Representative.

(b) CLD. Install CLD system as recommended by manufacturer. Install device in conjunction with the CCTV and camera pole structure.

1. Camera Support Arm Orientation. Where camera is pole mounted, orient support arm perpendicular to the adjacent roadway, with the camera positioned closer to the related roadway than the pole, unless otherwise specified.

(c) CCTV System Cables. Use only outdoor rated Cat5e/Cat6 cable for network cable. Utilize only outdoor rated cables for all communications, signal, and power cables. Supply all communications, signal, and power cables between a camera assembly and related communications enclosure that are comprised of single continuous runs without splices. For installation of camera cables through a hollow pole, make provisions to keep some slack in the vertical cable run within the pole. Provide strain-relief mechanism to the cable in vertical runs exceeding 60 feet, at minimum 60-foot interval.

(d) ITS Enclosure. Section 1201.3(a)

1. Midspan Injector. Section 1201.3(a)1. Install the midspan injector in the ITS enclosure, one per camera according to the manufacturer's recommendations. Install midspan injector in such a manner that it does not interfere with the operation of other equipment in the enclosure. Provide all wiring and cabling to connect the midspan injector to the CCTV communications subsystem. Clearly label, neatly bundle, and attach all wiring within the enclosure.

2. Low Voltage Power Supply. Section 1201.3(a)1. Install the Low Voltage power supply in the ITS enclosure, as required, and according to the manufacturer's recommendations. Install the Low Voltage power supply in such a manner that it does not interfere with the operation of other equipment in the enclosure. Provide all wiring and cabling to connect the Low Voltage power supply to the CCTV communications subsystem. Clearly label, neatly bundle, and attach all wiring within the enclosure.

(e) ITS Device Integration. Section 1201.3(c)

(f) Grounding. Section 910.3(q)

(g) ITS Device Testing. Section 1201.3(b)

(h) Training. Section 1201.3(d)

(i) Documentation. Section 1201.2(i)

(j) CCTV Pole. Section 910.3

(k) CCTV Pole Foundation. Section 910.3

1210.4 MEASUREMENT AND PAYMENT—

(a) Closed Circuit Television (CCTV) Camera Subsystem. Each
Includes camera, lens, midspan injectors, power supplies, wires, connectors, grounding rod and conductor, mounting, installation, training, integration work, and documentation for a complete subsystem.

- 50% of payment will be made upon complete installation of CCTV subsystem
- 30% of payment will be made upon completion of the standalone acceptance tests as specified in Section 1201.3(b).
- 20% of payment will be made upon completion of the 60-day test as specified in Section 1201.3(b).

Completion of tests includes completion of training, submission of all manuals and documentation as required, and completion of all final inspections as required by the Representative.

(b) CLD. Each
Includes cabling, connectors, installation, training, pulleys and all equipment.

- 50% to be paid upon complete installation of lowering device
- 30% to be paid upon completion of the standalone acceptance test as specified in Section 1201.3(b).
- 20% to be paid upon completion of the 60-day test as specified in Section 1201.3(b).

Completion of tests includes completion of training, submission of all manuals and documentation as specified in Section 1210, and in the Contract, and completion of all final inspections as required by the Representative.

(c) Camera Lowering Tool. Each
Includes winch and drill attachment mechanism.

(d) ITS Enclosure. Each
Includes enclosure, associated appurtenances, mounting hardware and complete installation of the CCTV ITS enclosure.

(e) CCTV Pole. Each
For the height indicated.
Includes pole, baseplate, anchor bolts, installation, and all work to level the pole.

(f) CCTV Pole Foundation. Each
For the type indicated.
The price includes excavation, concrete, anchor bolt assemblies, reinforcement bars, conduit, ground rod, ground rod clamp, grounding conductor, backfill, and satisfactory disposal of surplus material.

SECTION 1211—PORTABLE CLOSED CIRCUIT TELEVISION CAMERA

1211.1 DESCRIPTION—This work is to furnish and install a complete, fully functional Portable Closed Circuit Television (PCCTV) Camera subsystem with integrated IP.

1211.2 MATERIALS—

(a) General. Provide a PCCTV in trailer configuration, equipped with wheels for portability. Provide portable devices that meet the physical display and operational requirements of the MUTCD. Provide PCCTV consisting of camera assembly, integrated camera housing and mounts, wireless communications interface, a photovoltaic cell array, battery bank subsystem for powering the PCCTV, telescopic camera mast, enclosure, wires, connections, grounding system, and heavy duty trailer frame.

(b) CCTV Camera Assembly. 1210.2(c)

(c) High Power over Ethernet (PoE) Midspan Injector. 1210.2(e)

(d) Power Supply 24 VDC. 1210.2(f)

(e) Camera Housings and Mounts. 1210.2(d)

(f) Camera Communications. Provide local and remote control operation of the camera via a wireless communications interface that utilizes the ports specified and locally via a laptop computer. Local connections to a laptop computer must facilitate routine repairs, diagnostics and all other operational functions. In addition to the standard communication ports required for operation, provide, at a minimum, the following interfaces to the PCCTV: USB port, Ethernet port and serial port.

Provide a wireless communications interface, field-hardened for long-term freeway deployment where it is typically subject to wide daily and seasonal temperature swings, wind gusts and typical road vibrations with an extended operating temperature range from -30F to + 165F.

Coordinate wireless communications interface type and configuration with the Representative for network compatibility. The wireless carrier data account will be provided by the Department. Provide the wireless communications interface as a unit detachable from the PCCTV assembly to facilitate easy change out to other communications means.

(g) Power Supply. Equip PCCTV with solar array and battery bank to provide power to the CCTV assembly and communications equipment. Using solar array, supply the nominal operating voltage to the CCTV camera assembly and communications equipment. Provide solar array that consists of photovoltaic, single crystal silicon modules. Provide automatic recharging of power supply batteries to normal operating levels with meters showing charge.

Securely mount the solar array to the PCCTV for operation and transport. Provide mounting capable of swiveling, tilting, and reangling the cells to optimize exposure to solar rays. Include capability to lock the solar panels at any angle necessary to optimize solar exposure.

Provide AC/DC battery charger. Provide battery bank that at full charge can power the camera assembly at continuous use for 8 hours without recharging from the solar array. Equip battery bank with a battery controller to prevent overcharging and over-discharging. Provide battery controller with external battery level indicator. Protect the battery, controller, and power panel from the elements and vandalism. Provide battery subsystem with automatic recharging of power supply batteries. Equip battery subsystem with meter to indicate if batteries are being charged or used.

Provide battery bank consisting of low-maintenance, gel batteries. Contain the battery in a NEMA-rated compartment or enclosure that prevents water ingress during operation or transport. Fabricate the compartment to completely contain any spills from damaged or malfunctioning batteries. Provide battery enclosure that is separate from enclosure to house DMS controller.

1. Plug-In AC Power. Provide an AC-to-DC power converter and a power receptacle behind a lockable window at the main frame of the PCCTV, to allow the use of power feed from an alternate power source such as a generator

set on trailer, or road-side power outlet. Provide a selector switch inside the window that connects the internal loads of the PCCTV to the battery-powered subsystem, or the above AC-to-DC power converter. Include provision for the external AC power to charge the batteries when the PCCTV operates using the external AC power. Provide AC-to-DC power converter that converts 120 VAC power to DC power suitable for operating the PCCTV. Protect all data and electrical connections from the PCCTV using transient voltage surge suppression (TVSS) equipment. Provide window with a grommet-lined semi-circular notch at the bottom to allow passage of extension cord with the window closed. Provide twist locking type receptacle. Provide an extension cord with male plugs at both ends that is suitable for outdoor uses, oil resistant, minimum 50 feet long, and equipped with three 12 AWG conductors. Provide cord where one of the plugs is regular type and the other plug is suitable for use with twist locking type receptacle. Deliver cord to location identified by the Representative.

(h) Grounding Terminal. Provide means to connect a grounding conductor to the PCCTV assembly. Provide deliberate grounding connection from the trailer frame and the PCCTV controller frame, to this grounding terminal. Provide grounding terminal suitable for terminating a wire of up to 2 AWG. Provide painted signage next to the grounding terminal, with 1-inch tall black letters on white background, stating "PROVIDE GROUNDING TERMINATION HERE."

(i) Trailer. Provide a wheeled trailer fabricated of steel. Deburr and finish all metal with a corrosion resistant coating. Equip trailer with tie-down points to facilitate storage and transport by securing the trailer to a utility trailer or flatbed truck. Equip trailer with class-A tail lights, using a plug adaptor.

Furnish trailer that can be set up at the site with its own chassis and outriggers, without being hitched to a vehicle. Equip trailer with fenders over the tires that are made from heavy-duty material sufficient to allow a person to stand and operate or perform maintenance on the unit. Delineate the trailers on a permanent basis by affixing retroreflective material in a continuous line on the face of the trailer as seen by oncoming road users. Finish trailer with a glossy federal safety aliphatic acrylic urethane finish. Provide orange color to conform to the MUTCD requirements for portable changeable message signs (PCMS).

Provide a trailer mounting structure for the Camera housing, mounting bracket and peripherals (camera assembly). Provide accessible mechanism to easily raise and lower the assembly. Provide a locking device to lock the camera assembly in the raised or lowered position. Provide a single metal telescoping mast pole to mount the camera assembly that is an integral piece of the body of the trailer. Provide support capable of adjusting the height of the camera assembly, and allows the camera assembly to rotate 360 degrees around the vertical axis of the support beam, without requiring more than a single operator to perform height or angle adjustments. Provide capability to elevate the center-point of the camera assembly to a minimum height of 20 feet. The locking mechanisms must prevent the camera assembly from changing angles during windy conditions or vibrations.

Equip trailer with a hitch for connection to a towing vehicle. Provide hitch with a towing capacity of 5,000 pounds. All trailer hitch components must conform to SAE J684 Standards for Class II trailers. Equip hitch with a 1/4 inch safety chain for secure attachment to towing vehicle. Provide trailer with sealed, flush-mounted, combination stop, tail and turn lights, and front and rear sided marker lights. Provide a rear license plate display holder, and a rear center identification light bar for illuminating the trailer license plate. Provide a rear fender.

Provide four hydraulically or mechanically adjustable outrigger leveling pads permanently installed at each of the four corners of the sign trailer for leveling and support functions. Provide leveling pads with a minimum capacity of 2,000 pounds each. Provide leveling pads that are adjustable using a single operator, and without any special tools. The leveling pads must be capable of lifting the trailer so the tires do not touch the ground. Equip trailer with tires according to ST225/75R15 Load Range C. Provide 5-lug pattern wheel configuration. Affix the manufacturer's name and the trailer make and model to trailer. Provide an operator's manual within the control enclosure of each unit.

Equip the PCCTV trailer with a metallic enclosure to house the wireless communications interface. Provide a weatherproof and rust resistant enclosure securely fastened to the trailer structure. Equip the enclosure with a door with a key locking mechanism, and provisions for externally locking the door using a typical pad lock.

1211.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) PCCTV. Section 1210.3(a)

1. Camera Support Arm Orientation. Section 1210.3(b)1

2. Video Cables. Use only outdoor rated Cat5e/Cat6 cable for network cable. Supply all cable between a camera assembly and related communications enclosure that are comprised of single continuous runs without splices. Make provisions to keep some slack in the vertical cable run within or around the telescoping pole. Provide strain-relief mechanism to the cable.

3. Integration. Section 1201.3(c)

4. Grounding. Section 910.3(q)

5. Testing. Section 1201.3(b)

6. Training. Section 1201.3(d)

7. Documentation. Section 1201.2(f)

(b) Trailer Unit. Install trailer unit as specified in contract documents. Ensure the trailer is located in an area free of debris so a maintainer can access the unit and be protected from most vehicular traffic. Configure all outriggers to equally support the weight of the trailer and ensure the unit is completely level.

1211.4 MEASUREMENT AND PAYMENT—

(a) PCCTV Camera Subsystem. Each

Includes camera, lens, communications equipment, wires, connectors, grounding rod and conductor, trailer, mounting and installation, training, integration work, and documentation for a complete subsystem.

- 50% of payment will be made upon complete installation of PCCTV
- 30% of payment will be made upon completion of the standalone acceptance tests as specified in Section 1201.3(b).
- 20% of payment will be made upon completion of the 60-day test as specified in Section 1201.3(b).

Completion of tests includes completion of training, submission of all manuals and documentation as required, and completion of all final inspections as required by the Representative.

SECTION 1216—MAINTENANCE, CLOSED CIRCUIT TELEVISION (CCTV) CAMERA

1216.1 DESCRIPTION—This work is to furnish, install, modify, repair, replace, and remove components of a CCTV Camera subsystem.

1216.2 MATERIAL—Section 1210.2

1216.3 CONSTRUCTION—Section 1210.3 and as follows:

(a) Preventive Maintenance.

1. General. Section 1206.3(a)1

2. Site. Section 1206.3(a)2

3. Enclosures. Section 1206.3(a)3

4. Camera Poles and Structures. Inspect camera poles for wear, rust, cracks, and missing, damaged or bent sections. Inspect and test lowering device. Check bolts for rust and tightness. Install or replace screening at the base plate as necessary.

5. Pan/Tilt Drives and Housings. Inspect for wear, rust, cracks, missing, damaged, or bent parts, loose connections, frayed cables, lowering device, and general condition. Ensure proper ventilation. Check attachment hardware. Clean, repaint, and repair as necessary. Thoroughly clean solar panels that power the battery packs. Test communications system. Test power and communications line surge suppressors and replace as necessary. Test and verify communications system with TMC.

6. Portable Lowering Tool. Hoist inspections, maintenance, and repairs will be performed only by trained, experienced, and qualified hoist inspection, maintenance, and repair personnel. The hoist operator will not perform frequent and periodic inspections, maintenance, or repairs on a manually operated hoist, unless the operator has been trained to perform such inspections, maintenance, or repairs on a manually operated hoist and is designated by the hoist manufacturer to perform such inspections, maintenance, and repairs. For information on hoist inspection, maintenance and repairs, always refer to the manual furnished by the manufacturer of the hoist, or contact the manufacturer directly.

(b) On-call Maintenance.

1. General. Section 1206.3(b)1
After On-call Maintenance (OM) has been completed, perform Preventive Maintenance (PM) as specified in Section 1216.3(a).

2. Responsiveness. Section 1206.3(b)2

1216.4 MEASUREMENT AND PAYMENT—

(a) Preventive Maintenance, CCTV Camera Subsystem. Each
All labor, materials, and equipment required for routine preventive maintenance are incidental to this item including, but not limited to, the Statewide Device Identification Number, cleaning materials, caulk, metal meshing, lubricants, filters, lamps, paint, surge suppressors, fuses, circuit breakers, attachment hardware, insect prevention measures,

rodent control measures, clearing and grubbing, selective tree trimming, snow and ice removal, and weed control measures. Mobilization is incidental to this item.

(b) On-call, CCTV Camera Subsystem Mobilization. Each

Mobilization will not be paid for procurement of parts. Travel to and from the site and district stockpile is incidental to this item.

(c) On-call, CCTV Camera Subsystem Repair. Hour

Repair time will not be paid for procurement of parts. Travel to and from the site and district stockpile is incidental to this item. Site specific snow and ice removal requested by the Department is included within this item.

(d) On-call, CCTV Camera Subsystem Parts. Dollar

Includes all cables, connectors, equipment racks, conductor(s), and other parts necessary for proper installation and configuration of a CCTV Camera subsystem.

(e) Maintenance and Protection of Traffic. Section 901.4(a).

SECTION 1217—MAINTENANCE, PORTABLE CLOSED CIRCUIT TELEVISION (PCCTV) CAMERA

1217.1 DESCRIPTION—This work is to furnish, install, modify, repair, replace, and remove components of a Portable Closed Circuit Television (PCCTV) Camera subsystem.

1217.2 MATERIAL—Section 1211.2

1217.3 CONSTRUCTION—Section 1211.3 and as follows:

(a) Preventive Maintenance.

1. General. Section 1206.3(a)1

2. Site. Section 1206.3(a)2

3. Enclosures. Section 1206.3(a)3

4. Trailer and Mount Structure. Lubricate all hinges, jacks stands, mast, and trailer hitches. Inspect for wear, rust, cracks, missing, damaged or bent parts, loose connections, frayed cables and general condition. Check attachment hardware and tighten if necessary to the appropriate parameters. Clean, repaint and repair as necessary.

5. Pan/Tilt Drives and Housings. Inspect for wear, rust, cracks, missing, damaged, or bent parts, loose connections, frayed cables, lowering device, and general condition. Ensure proper ventilation. Check attachment hardware. Clean, repaint, and repair as necessary. Thoroughly clean solar panels that power the battery packs. Test communications system. Test power and communications line surge suppressors and replace as necessary.

(b) On-call Maintenance.

1. General. Section 1206.3(b)1.
After On-call Maintenance (OM) has been completed, perform Preventive Maintenance (PM) as specified in Section 1217.3(a).

2. Responsiveness. Section 1206.3(b)2

1217.4 MEASUREMENT AND PAYMENT—

(a) Preventive Maintenance, Portable Closed Circuit Television (PCCTV) Camera Subsystem. Each
All labor, materials, and equipment required for routine preventive maintenance are incidental to this item including, but not limited to, the Statewide Device Identification Number, cleaning materials, caulk, metal meshing, lubricants, filters, lamps, paint, surge suppressors, fuses, circuit breakers, attachment hardware, insect prevention measures, rodent control measures, clearing and grubbing, selective tree trimming, snow and ice removal, and weed control measures. Mobilization is incidental to this item.

(b) On-call, Portable Closed Circuit Television (PCCTV) Camera Subsystem Mobilization. Each
Mobilization will not be paid for procurement of parts. Travel to and from the site and/or district stockpile is incidental to this item.

(c) On-call, Portable Closed Circuit Television (PCCTV) Camera Subsystem Repair. Hour
Repair time will not be paid for procurement of parts. Travel to and from the site and/or district stockpile is incidental to this item. Site specific snow and ice removal requested by the Department is included within this item.

(d) On-call, Portable Closed Circuit Television (PCCTV) Camera Subsystem Parts. Dollar
Includes all cables, connectors, equipment racks, conductor(s), and other parts necessary for proper installation and configuration of a PCCTV Camera subsystem.

(e) Maintenance and Protection of Traffic. Section 901.4(a).

SECTION 1220—HIGHWAY ADVISORY RADIO SUBSYSTEM

1220.1 DESCRIPTION—This work is to furnish and install a Highway Advisory Radio (HAR) subsystem with the capability to locally store and broadcast audio messages to traveling motorists from the transmitter over a programmable amplitude modulated (AM) frequency, and to alert motorists of the message using flashing beacons and advisory sign.

1220.2 MATERIAL—

(a) General. Provide transmitter subsystem that includes AM transmitter, field enclosure, digital recorder/player, National Oceanic and Atmospheric Administration's (NOAA) weather receiver, digital recorder/playback module, digital communications controller, Global Positioning System (GPS) synchronization unit, an integrated AC/DC power supply, wood pole, mounting apparatuses, and all necessary cables, connectors and wiring to provide a fully functional HAR subsystem.

Provide HAR transmitter subsystem with the capability to communicate with flashing beacon sign subsystems that alert motorists to a message being broadcast. Transmitter must be fully compatible with HAR beacon subsystem specified in Section 1220.2(h). Provide HAR subsystem that includes software and hardware to configure, operate and monitor the HAR transmitter locally in the field using a portable laptop computer and remotely using a personal computer.

Furnish HAR transmitter subsystem compliant with CFR Title 47, Section 2.901 (Part 2, Subpart J); Section 68, Connection of Terminal Equipment to the Telephone Network; and Section 90.242, Travelers' Information Stations.

(b) Transmitter. Furnish field-hardened, high-efficiency Class D, AM broadcast band to meet the rigorous demands of HAR use. Provide an FCC approved and certified traveler information station transmitter that meets the following requirements:

- Operating frequency in accordance with the FCC license application and research (530-1700kHz inclusive)
- Class D common source amplifier
- Adjustable Radio Frequency (RF) output power up to 10 watts, nominal, using a 12-volt power supply
- Remotely adjustable output power level
- Frequency tolerance: 100 Hz or better
- Harmonic attenuation: Greater than FCC specification of 53 dB with approved antenna subsystem
- Operating Voltage Standing Wave Ratio (VSWR): 1.5 to 1 or less
- Modulator: 20 watt bridge amplifier with transformer coupling; capable of 100% modulation up to 15 watts RF output
- Audio distortion: Less than 1.5% from 200 Hz to 3.5 kHz
- Noise level: At least 70 dB below 80% modulation level
- Automatic modulation limiter on modulation peaks above 80% including a maximum limit of 100% modulation; 12 dB overload range
- Built-in FCC compliance audio filter (-3dB at 3kHz, 18 dB/octave roll off)
- Audio Inputs: Line input adjustable from +12dBm to -20dBm; telephone input adjustable from 0dBm to -20dBm; selector switch
- Power consumption: 1.5 A at 12 VDC
- Power operating range: 10 VDC to 14 VDC
- Temperature operating range: -40F to +165F
- Humidity operating range: 95% (non-condensing)
- Unbalanced RF output impedance of 50 ohms
- Transmitter power efficiency of 80% or greater

- Integrated Light Emitting Diode (LED) indicators on the front panel of the transmitter that displays power on/off, transmit on/off, and VSWR statuses
- Self-supporting and capable of withstanding wind gusts of up to 80 miles per hour and 1/2 inch of radial ice
- Buffered from transmitter through lightning protection circuitry
- Transmission Control Protocol (TCP)/IP capable

(c) Digital Recorder/Playback Module. Provide a digital recorder/player meeting the following requirements:

- FCC certified under Part 68 for dial-up operations
- Local and remote control of all functions
- Multiple modes of operation including: Playlist, Emergency, Auxiliary (Weather Radio), Go Live, and Off
- User-definable time period up to 1,440 minutes (1 day) for the "Auxiliary" Mode, after which it must revert to the previous HAR mode. Provide module with the capability to operate in "Auxiliary" Mode for an indefinite period
- User-definable time period for the "Go Live" mode up to 1,440 minutes (1 day), after which the subsystem must revert to the previous HAR mode. Provide module with the capability to operate in "Go Live" Mode for an indefinite period
- Simultaneous record/playback of messages
- 999 distinct, variable length messages, 25 playlists (each with up to 100 messages), and master schedule with up to 200 events
- Message retention subsystem that does not require a battery to retain messages in the event of main power loss. Stores messages indefinitely
- Use of an external time source with an accuracy of at least 50 nanoseconds
- Capability to simultaneously launch the audio broadcast such that the audio is synchronized to other adjacent HAR transmitters. Use of "master" and "slave" HAR transmitters, where one transmitter disseminates a message to adjacent transmitters, is not acceptable
- Programmable by day of the week, date and time
- Security code access
- 28 MIP 16-bit Digital Signal Processor (DSP) microprocessor
- Firmware programmable in the event new features are later added
- Memory to support 80 minutes of messaging at 5 kHz audio bandwidth
- Built-in voice prompts for ease of use
- Switch selectable inputs for telephone, local handset, line, and microphone; automatic reset to telephone after period of inactivity from other inputs; 4 expansion audio input channels
- RS-232 and parallel digital interfaces
- Broadcast of messages from the NOAA weather receiver at programmable times and intervals, or on command from the control software
- Built-in local microphone for field recording of messages
- TCP/IP capable
- Control Methods. Provide two methods of HAR control:
  - Dual Tone Multi-Frequency (DTMF) tones (via standard analog telephone line or digital cellular telephone)
  - Digital commands
- Download Methods. Provide two methods of downloading messages to the HAR transmitter:
  - Real time audio (e.g. voice or playing recorded audio)
  - Transfer of digitized audio files (.wav files)
- Closed Loop Control & System/Health Monitoring. Provide the following capabilities:
  - Verification that commands entered by the user have been successfully or unsuccessfully processed
  - Verification that the HAR Mode and playlist have not changed since the last connection with the HAR

- Verification of the current HAR mode (Off, Playlist, Emergency, Live, Auxiliary, Weather)
- When updated, the HAR subsystem records a time stamp indicating the last time the HAR was updated. Each time the HAR is accessed, the HAR subsystem verifies that this recorded time stamp has not changed unexpectedly to assure the user that the subsystem has remained intact and has not been accessed by an unknown user
- Seven analog instrument inputs for expansion options
- Audio Quality – 5 kHz bandwidth, less than 1% distortion, greater than 80 dB dynamic range
- Manual and automatic level control
- Audio Outputs – Transmitter, telephone, headphones, line, local
- Programming Controls – Local: handset; Remote; touch-tone keypad
- Instrumentation input lines with Transistor-transistor logic (TTL) Interfaces: 7 A/D channels, 8-bits, 0-2.5 volt levels, 16 digital
- Power consumption: 0.35 A at 12 VDC
- Temperature: -40F to +165F
- Humidity: 95% (non-condensing.
- The Following Operational Statuses:
  - Status of Battery voltage (if battery back-up system is used or if it is solar-powered system)
  - Status of AC Power vs. DC Power operation
  - Current HAR mode (Off, Playlist, Emergency, Live, Auxiliary)
  - Absence of Broadcast (from a silence sensor)
  - Audio Broadcast (demodulated broadcast available when remotely accessed by an operator or computer through an analog telephone line)
- Upon detection of a fault condition for any of the above parameters, the HAR must send notifications to the TMC/RTMC using the following methods:
  - To the Central Software Subsystem
  - By e-mail notification
  - By pager notification
  - By telephone notification (to landline or digital cellular telephones)

(d) Weather Receiver Module. Provide a weather receiver module that receives up-to-the-minute information directly from the National Weather Service (NWS). Include all seven selectable frequency bands, including split channels. Include a built-in speaker and headphone jack for monitoring weather information on site. Provide unit that works in conjunction with the digital recorder/player to automatically interrupt the current message being broadcast upon receipt of an emergency alert from the NWS. Provide Alert feature (on/off) as well as the feature to set the duration for broadcasting the alert that is selectable from within the digital recorder/player's voice prompts. Provide weather receiver with the following characteristics:

- Frequency: seven selectable frequencies; selectable through a series of dip switches; Internal speaker and headphone jack.
- Sensitivity: Better than 0.2µV; S/N better than 12 dB
- Selectivity: ±10 KHz at -6Db; ±20 KHz at -70 Db
- Weather Alert: Detects 1050 Hz tone; LED & TTL outputs
- Antenna: External 50Ω BNC connector
- Power Input: less than 0.4 A at 12 VDC
- Operating Temperature: -40F to +165F; Humidity 95% (non-condensing)
- TCP/IP capable

(e) Global Positioning System (GPS) Synchronization Unit. Furnish GPS synchronization unit to synchronize radio frequency signals broadcast by multiple HAR transmitter units. Provide unit to tune the operating frequency of the transmitter to a high precision using phase locking to timing signals received from GPS satellites.

Display power, GPS reception quality, satellite lock, and HAR transmitter frequency lock indicators on the front panel display of the unit. Size GPS unit to fit in the rack or chassis included in the ITS enclosure specified in Section 1201.2(b). Provide field hardened unit with ambient operating temperature range of -40F to +165F.

(f) Grounding Rod. Utilize manufacturer recommended grounding system at the transmitter location. Where no manufacturer recommendations exist, utilize Section 1101.11(j). Obtain Representative approval before installing grounding system.

(g) Transmitter Pole. Section 1101.11(a) and as follows: Size pole in accordance with HAR subsystem manufacturer's recommendations. Furnish minimum 30 foot pole height.

(h) HAR Flashing Beacon and Sign. Provide an HAR beacon subsystem consisting of HAR advisory sign equipped with dual flashing beacons that are activated upon the broadcast of a radio message from nearby HAR Transmitters. A HAR Beacon subsystem is comprised flashing beacon unit, reflective advisory sign, foundation, structure, breakaway system, complete power subsystem (via solar power or power point of service), flashing beacons, field enclosures, an integrated AC/DC power supply, battery backup subsystem, and all necessary cables, connectors and wiring to provide a fully functional HAR beacon subsystem.

Provide HAR beacon subsystem with flashing beacons that activate at preset flashing intervals when a message is broadcast from a nearby transmitter. Provide compatibility to fully control beacons with existing central control software used to control HAR transmitter. Where no software exists at the TMC/RTMC, provide software as specified herein.

1. Beacons. Furnish two 12-inch amber, LED single section heads with maximum power consumption per each signal head not exceeding 15 Watts. Provide LED rated for 100,000 hours of continuous operation, in the operating temperature range of -31F to +167F. Wire individual LEDs in at least six parallel groupings of equal quantity, such that the failure of a single LED will at most deactivate only its grouping. Arrange individual LED's in concentric circles, with denser packing towards the center, to more closely represent a typical incandescent signal. Provide ultraviolet (UV) stabilized polycarbonate signal heads to withstand direct sunlight exposure for a minimum of 5 years without exhibiting evidence of deterioration. Coordinate with the LED signal head manufacturer to select the wavelengths of the LED in order to maximize visibility of the LED signal heads.

Furnish one NEMA-Rated dual circuit flasher along with an additional seven position terminal strip, barrier type rated at 20 A, 600 V RMS minimum, to support wire connections to second signal head and to flasher control circuitry. Provide a similar three position terminal strip in the signal head. Provide interface to enable capability to activate, control, and monitor the HAR beacons via a communication method specified.

Furnish beacon mounting hardware constructed of stainless steel. Fabricate brackets of aluminum alloy ASTM B221, Alloy 6061-T6 or equal with a load concentrating boss of stainless steel ASTM A582, type 416 or equal. Fabricate coupling bolt of ASTM A325 galvanized in accordance with ASTM A153. Fabricate couplings of alloy steel AISI-4130H or 4340H and capable of withstanding a minimum tensile force of 47 KIPS. Provide adequate insulation between dissimilar metals to minimize the possibility of galvanic reactions.

Provide secure connections between the LED beacons and sign supports in accordance with the manufacturer's recommendations.

2. Type A Advisory Sign. Section 930.2

3. Type E Advisory Sign. Section 934.2

4. Advisory Sign Legend. Section 1103.02 and as follows: Provide sign with two-sections, a top and a bottom section, each with border and legend. Color background of top section high-intensity, reflectorized yellow, and color legend and border of non-reflectorized black. Provide the top section with legend that reads "TRAFFIC ADVISORY WHEN FLASHING." Color background of bottom section reflectorized blue, and legend and border of reflectorized white. Provide the bottom section (advisory sign frequency panel) with legend of "HIGHWAY INFO TUNE RADIO TO XXXX AM". Utilize AM frequency identified by Representative, and as approved by the FCC permit. Verify the station frequency and sign text before finalizing sign. Provide sign with 1 1/4 inch border with 6 inch corner radii. Use Series E letters and numbers for all legends.

Provide separate frequency panel sized only to display the licensed AM radio frequency. Fabricate frequency panel of the same material as the advisory sign.

5. Power Supply. Provide complete solar power supply to the HAR beacon sign, if indicated. Provide complete power management subsystem for the HAR flashing beacons in accordance with Section 1201.2(e).

5.a Solar Installations. For solar panel powered installations, provide photovoltaic, single crystal silicon solar panel modules and battery bank subsystem to operate the flashing beacons continuously at full power for a minimum of 8 consecutive hours without solar array exposure to sunlight. Provide solar panel array that is compliant with International Electrotechnical Commission's (IEC) 61215 standard. Provide subsystem with DC output power is nominal 13.6 V direct current at 5 A, with maximum 15 VDC and maximum 10 A. Provide maintenance-free 12 volt gel batteries that are rated at a minimum of 180 A-hours, and are deep cycle. Furnish trickle charger to charge batteries for use.

Furnish beacon and solar panel mounting hardware constructed of stainless steel. Fabricate brackets of aluminum alloy ASTM B221, Alloy 6061-T6 or equal with a load concentrating boss of stainless steel ASTM A582, type 416 or equal. Fabricate coupling bolt of ASTM A325 galvanized in accordance with ASTM A153. Fabricate couplings of alloy steel AISI-4130H or 4340H and capable of withstanding a minimum tensile force of 47 kips. Provide adequate insulation between dissimilar metals to minimize the possibility of galvanic reactions.

Provide NEMA 3R rated enclosure to house battery bank. Provide NEMA rated enclosure that prevents water ingress during operation. Utilize rigid galvanized steel conduit to house all wires between the solar array, battery bank and ITS enclosure. Furnish a NEMA enclosure that completely contains any spills from damaged or malfunctioning batteries.

5.**b Hard-Wire Installations.** Section 954.3(f),

6. Control Software. Section 1220.2(j)

7. Grounding Rod. Section 1101.11(j)

(i) ITS Enclosure. Section 1201.2(b)

(j) Control Software. Provide HAR transmitter and flashing beacon subsystem that is fully compatible with existing software utilized to remotely control the HAR subsystem. Provide integration of HAR subsystem and all components into existing software.

Provide full remote monitoring capabilities of HAR transmitters, including the operational status of all equipment as defined in Sections 1220.2(a) 1220.2(b) and 1220.2(c). Provide synchronization of broadcasted messages among multiple HAR transmitter stations as needed based on proximity to other HAR transmitters. Provide control, operation, and monitoring of all HAR beacons specified in Section 1220.2(h). Provide capability to associate individual HAR beacons with the HAR transmitter location within the software.

1220.3 CONSTRUCTION—

(a) General. Install HAR subsystem field equipment, including the field enclosure and HAR beacons, per the manufacturer's recommendations. Install control software or integrate into existing software on PCs, Laptop computers and network servers as identified by the Representative. Install software and hardware in the TMC/RTMC without disturbing TMC/RTMC operations. No down time will be allowed of any TMC/RTMC workstation, unless otherwise indicated by the Representative.

(b) HAR Flashing Beacon. Install HAR beacon, sign assembly and all field equipment per the manufacturer's recommendations. Integrate beacons into control software at the TMC/RTMC. Integrate into software on all PCs, laptop computers and network servers that already contain the central control software. Integrate beacons at the TMC/RTMC without disturbing TMC/RTMC operations.

Configure the two circuits in the dual circuit flasher to flash alternately, at intervals between 50 flashes per minute and 60 flashes per minute, upon activation.

1. Solar Panels. Mount solar panels at the top of the sign structure at the proper angle for optimum performance, in accordance with the recommendation of the solar panel manufacturer. Mount solar panels on steel

post that is farthest from trees and trim/remove trees in order to subject solar array direct sunlight for 75% of the day. Provide mounting capable of swiveling, tilting, and re-angling the cells in order to optimize exposure to solar rays. Include capability to lock the solar panels at any angle necessary to optimize solar exposure.

2. ITS Enclosure. Section 1201.3(a) and as follows: Mount ITS enclosure on HAR sign structure, on the support that is farthest from the roadway.

3. Conduit. Install conduit supports in accordance with NEC 347-8 and table 347-8.

(c) Type A Advisory Sign. Section 930.3

(d) Type E Advisory Sign. Section 934.3

(e) Advisory Sign Frequency Panel. Mount frequency panel to the advisory sign in the location that indicates the AM radio frequency. Fasten frequency panel to advisory sign in a manner such that it is easily removable and changeable.

(f) Transmitter Pole. Install HAR antenna and control enclosure on a minimum 30 foot wooden utility pole using secure connections.

(g) Permits and Licenses. Acquire FCC license, or adjust existing FCC license for the use of the HAR transmitter at each deployment site, at the frequency band specified or as directed by the Representative. These services include all preparations necessary to complete all required application forms, and coordination to make certain that all parts of the HAR subsystem comply with existing FCC rules. All related FCC fees are incidental to the cost of this item.

(h) Submissions. Section 1201.2(f)

(i) ITS Enclosure. Section 1201.3(a)

(j) Grounding. Install manufacturer recommended grounding system at the transmitter location. Where no manufacturer recommendations exist, utilize Section 910.3(q). Obtain Representative approval of grounding system before installation. Terminate the core conductor of the antenna cable at a transient voltage surge suppressor in the related enclosure, before further connections to the transmitter or any electronic device in the enclosure. Ground the surge suppressor to the adjacent grounding electrode system. Terminate the shield (metallic armor) of the antenna cable to the grounding electrode system of the antenna pole. Provide this grounding to the part of the antenna cable near the base of the related pole, outside the related transmitter enclosure.

(k) Testing. Section 1201.3(b)

(l) Integration. Section 1201.3(c)

(m) Training. Section 1201.3(d)

1220.4 MEASUREMENT AND PAYMENT—

(a) HAR Transmitter Subsystem. Each

Includes transmitter, weather receiver, digital recorder/playback module, wires, connectors, permit acquisition, grounding, installation, mounting, documentation, FCC permits and licenses, integration, training, and work for a complete HAR transmitter subsystem.

- 50% of payment will be made upon complete installation of HAR pole and transmitter equipment.
- 30% of payment will be made upon completion of the standalone acceptance tests as specified in Section 1201.3(b).
- 20% of payment will be made upon completion of the 60-day test as specified in Section 1201.3(b).

Completion of tests includes completion of training, submission of all manuals and documentation as required herein, and in the Contract, and completion of all final inspections, as required by the Representative.

(b) HAR Flashing Beacon Subsystem. Each

Includes beacons, connections, wiring, cabling, grounding, mounting, installation, integration, training, and related equipment to provide a fully functional subsystem.

- 50% of payment will be made upon complete installation of HAR beacon equipment,
- 30% of payment will be made upon completion of the standalone acceptance tests as described in Section 1201.3(b).
- 20% of payment will be made upon completion of the 60-day test as specified in Section 1201.3(b).

Completion of tests includes completion of training, submission of all manuals and documentation as required herein, and in the Contract, and final inspections as required by the Representative.

(c) GPS Synchronization Unit. Each

Includes wiring, cabling, installation and integration.

(d) Type A Advisory Sign. Section 930.4

(e) Type E Advisory Sign. Section 934.4

(f) Transmitter Pole. Each

For the type indicated. Includes mounting equipment used to mount transmitter and related transmitter cables and equipment.

SECTION 1226—MAINTENANCE, HIGHWAY ADVISORY RADIO (HAR) SUBSYSTEM

1226.1 DESCRIPTION—This work is to furnish, install, modify, repair, replace, and remove components of a Highway Advisory Radio (HAR) subsystem.

1226.2 MATERIAL—Section 1220.2

1226.3 CONSTRUCTION—Section 1220.3 and as follows:

(a) Preventive Maintenance.

1. General. Section 1206.3(a)1

2. Site. Section 1206.3(a)2

3. Enclosures. Section 1206.3(a)3

4. Transmitters. Inspect for wear, rust, cracks, missing, damaged or bent parts, loose connections, frayed cables, damage caused by lightning, leaning, car impacts, or vandalism, and general condition. Check batteries. Clean, repaint, and repair as necessary.

Verify the broadcast signal strength of the HAR transmitter via the dials located on the front panel. Verify that the HAR transmitter is clearly transmitting a signal by utilizing a car radio and turning the dial to the appropriate channel. Test communication system, including pager systems.

Test power and communications line surge suppressors and replace as necessary. Test all static signing flashing warning devices associated with the HAR systems, check batteries, clean controller enclosure and solar panels that power the battery packs.

5. Flashing Warning Beacons. .Verify the operation and inspect, clean, and repair the components of the system including, but not limited to: flashing LED yellow lights, supports, signage legend, aluminum sheet , foundation, connections, field enclosure, dual circuit flasher controller, modems, communications, programming, services, conduit, junction boxes, wiring, sign luminaries, solar panels, and battery back-up if applicable along with any other related system equipment.

(b) On-call Maintenance.

1. General. Section 1206.3(b)1.

After On-call Maintenance (OM) has been completed, perform Preventive Maintenance (PM) as described in Section 1226.3(a).

2. Responsiveness. Section 1206.3(b)2

1226.4 MEASUREMENT AND PAYMENT—

(a) Preventive Maintenance, HAR Subsystem Transmitter. Each

All labor, materials, and equipment required for routine preventive maintenance are incidental to this item including, but not limited to, the Statewide Device Identification Number, cleaning materials, caulk, metal meshing, lubricants, filters, lamps, paint, surge suppressors, fuses, circuit breakers, attachment hardware, insect prevention measures, rodent control measures, clearing and grubbing, selective tree trimming, snow and ice removal, and weed control measures. Mobilization is incidental to this item.

(b) Preventive Maintenance, HAR Subsystem Beacon. Each

All labor, materials, and equipment required for routine preventive maintenance are incidental to this item including, but not limited to, the Statewide Device Identification Number, cleaning materials, caulk, metal meshing, lubricants, filters, lamps, paint, surge suppressors, fuses, circuit breakers, attachment hardware, insect prevention measures, rodent control measures, clearing and grubbing, selective tree trimming, snow and ice removal, and weed control measures. Mobilization is incidental to this item.

(c) On-call, HAR Subsystem Transmitter Mobilization. Each

Mobilization will not be paid for procurement of parts. Travel to and from the site and/or district stockpile is incidental to this item.

(d) On-call, HAR Subsystem Beacon Mobilization. Each

Mobilization will not be paid for procurement of parts. Travel to and from the site and/or district stockpile is incidental to this item.

(e) On-call, HAR Subsystem Transmitter Repair. Hour

Repair time will not be paid for procurement of parts. Travel to and from the site and/or district stockpile is incidental to this item. Site specific snow and ice removal requested by the Department is included within this item.

(f) On-call, HAR Subsystem Beacon Repair. Hour

Repair time will not be paid for procurement of parts. Travel to and from the site and/or district stockpile is incidental to this item. Site specific snow and ice removal requested by the Department is included within this item.

(g) On-call, HAR Subsystem Transmitter Parts. Dollar

Includes all cables, connectors, equipment racks, conductor(s), and other parts necessary for proper installation and configuration of a HAR subsystem.

(h) On-call, HAR Subsystem Beacon Parts. Dollar

Includes all cables, connectors, equipment racks, conductor(s), and other parts necessary for proper installation and configuration of a HAR subsystem.

(i) Maintenance and Protection of Traffic. Section 901.4(a).

SECTION 1230—DYNAMIC MESSAGE SIGNS

1230.1 DESCRIPTION—This work is to furnish and install a light emitting diode (LED) based, full color, full matrix Dynamic Message Sign (DMS) subsystem. The DMS will be utilized to disseminate traveler information to motorists that may include, but is not limited to, road closure information, adverse weather and roadway conditions, detour routes, and travel times.

1230.2 MATERIAL—

(a) Shop Drawing Approval. Submit the following (as a minimum) to the Department before purchase of the DMS Subsystem:

- A letter from the manufacturer certifying the sign has been designed and furnished according to all AASHTO guidelines and requirements.
- Sign housing shop drawings.
- Certification verifying the ambient operating temperature range of the DMS.
- LED brightness and color bins that are used in each pixel. Provide a letter of certification from the LED manufacturer that demonstrates testing and binning according to the International Commission on Illumination (CIE) 127 (1997) standard.
- A list of the character fonts and samples of the fonts.

(b) General. Provide DMS with full-color, full-matrix, RGB LED displays, complete with a minimum cone of vision of 15 degrees around the vertical axis of any pixel on the sign. Provide DMS with front-panel or walk-in accessible to maintenance crews. Furnish a DMS subsystem complete with all individual units, components, software modules, cabling, connectors, etc. that are completely compatible with each other and the existing Advanced Traffic Management Software (ATMS) at the Traffic TMC/RTMC. Provide Ethernet (copper Cat.6) or fiber optic connection between the DMS Controller in the ITS Node Cabinet and the DMS enclosure communications interface electronics. Provide single mode (or multi-mode) fiber connections between the controller cabinet and the DMS cabinet according to the manufacturer's recommendations. Provide power conductors between the DMS cabinet and the controller cabinet, according to the manufacturer's recommendations in separate conduit. Provide two spare Ethernet(copper) ports, or combo fiber/copper ports at the communications interface. Provide a DMS subsystem where all exposed material on the DMS, enclosure, and other exposed appurtenances is corrosion-resistant. Prevent ambient magnetic and electronic fields, including fields generated by the DMS itself, from interfering with or disrupting subsystem performance. Prevent magnetic and electronic fields generated by the DMS subsystem from interfering with other electronic systems near the DMS.

Fabricate, weld, and inspect DMS according to ANSI/AWS. Seal or otherwise make indelible all identifications, including labels, markings, and engravings, on the sign and its components.

Furnish all equipment to allow maintenance access from the front panels or from the central corridor of a walk-in sign for ease of maintenance. Require no special tools to access the sign or its components. Enable all equipment to be accessible without disassembly for inspection and maintenance purposes. Orient all equipment indicator lights, LEDs, and user interfaces in a manner that is readily visible to maintenance or inspection crews accessing the sign. Provide readily accessible and clearly labeled test points for maintenance or inspection crews to test voltage at essential locations. Terminate all external connections using industry standard, safe, tamper resistant connectors. Key connectors to resist improper hookups.

Provide the capability to store at least 132 pre-programmed messages (100 permanent and 32 temporary) locally at the DMS or in the device TMC/RTMC software or both.

Furnish DMS meeting the criteria of the following codes and standards:

- NEC

- AASHTO - Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals (ITE publication No. LP-321), with current addendums.
- AWS D 1.2 Structural Welding Code – Aluminum and AWS A 5.1 & A 5.5 Structural Welding Code - Steel
- ASTM International
    - ASTM A 36 Steel
    - ASTM B 209 Aluminum and Aluminum Alloy Sheet and Plate
    - ASTM A 325 High Strength Bolts
    - ASTM B 686 Aluminum Alloy Castings, High Strength
- Electrical Testing Laboratories, Inc. (ETL)
- Electronic Institute of America (EIA). EIA/ TIA-232- E Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange; and EIA-422- A Electrical Characteristics Of Balanced Voltage Digital Interface Circuits
- MUTCD and Standard Alphabets for Highway Signs and Pavement Markings most current version adopted by the Department
- NEMA – TS4 Standard
- TS4-2005 Hardware Standards for Dynamic Message Signs with NTCIP requirements
- NTCIP Standards (most recent approved versions):
    - NTCIP 1101 - Signal Transportation Management Framework (STMF)
    - NTCIP 1102 - Base Standard: Octet Encoding Rules (OER)
    - NTCIP 1103 - Simple Transportation Management Protocol (STMP)
    - NTCIP 1201 - Global Object Definitions
    - NTCIP 1203 - Object Definitions for DMS – (Section 0 for full list of Functional Requirements for DMS) NTCIP 2001 - Class B Profile
    - NTCIP 2101 - Point to Multi-Point Protocol Using RS-232 Subnet Profile
    - NTCIP 2102 - Subnet Profile for PPP over FSK Modems
    - NTCIP 2103 - Subnet Profile for Point-to-Point Protocol using RS 232
    - NTCIP 2104 - Subnet Profile for Ethernet
    - NTCIP 2201 - Transportation Transport Profile
    - NTCIP 2202 - Internet (TCP/IP and UDP/IP) Transport Profile
    - NTCIP 2301 - Application Profile for Simple Transportation Management Framework (STMF)
    - NTCIP 2303 - Application Profile for File Transfer Protocol (FTP)
- Standards for Enclosures for Electrical Equipment (Publication No. 250)
- Standards for Wiring Devices - Dimensional Requirements (Publication No. WD6)
- NFPA-70
- OSHA
- UL
- ANSI
- IEEE
- International Standards Organization (ISO)

(c) Sign Housing. Furnish DMS Sign and housing rated for continuous usage of at least 20 years. Furnish DMS sign to withstand wind loads defined in Publication 647 without deformation, damage, or unreasonable fatigue.

Fabricate external skin of the sign housing of aluminum alloy 5052 H32, a minimum of 0.125 inches thick. Attach all external cables to the sign housing using clamps, or by other means as directed; adhesive attachment is not acceptable. Encase external cabling in rigid galvanized steel (RGS) conduit. Continuously weld all external seams, joints, excluding the sign face panels or display, using inert gas welding method. The maximum number of seams at the top of the sign housing is three. Stitch weld the external sign housing to the internal housing structure to form a single, unitized structure.

Fabricate all external sign mounting assembly components from aluminum alloy 6061-T6 extrusions, with minimum size of W6x15 according to Publication 647. Provide Z-Brackets according to Publication 647, each of a minimum thickness of 0.25-inch. Attach all structural members to the internal framework of the sign.

Provide a minimum of four drain holes on the bottom of the sign housing that are centered from the front to back edges of the bottom sign panel, and spaced evenly across the sign's full length. Screen all drain holes to prevent the

entrance of small insects and animals. Slope the bottom of the sign housing panel towards the drain holes in order to prevent the accumulation of water at the bottom of the sign.

On the top panel of the sign housing, provide multiple steel lifting eyebolts or other equivalent hoisting points to be used during transport and installation. Lifting bolts or hoisting points are to be connected directly to the sign housing internal structure. The hoist points must enable the sign to be lifted evenly during transport and installation. On the top panel of the sign housing, make provisions to prevent the pooling or collecting of water on the top of the sign housing.

1. External Sign Face Panels. Furnish weather-resistant sign face panels. Provide panels to prevent moisture, dirt, dust or other foreign objects to permeate the sign face at the seams or at the edges of pixel holes. Construct sign face panels of aluminum, and coat with a matte-black coating system according to or exceeding American Architectural Manufacturers Association (AAMA) Specification 2605. Provide sign face panels that do not limit the cone of vision of the individual LED pixels, or the sight distance of the sign as a whole.

2. Lens Panel Assembly. Incorporate lens panel assemblies with sign face panels. Furnish lens panels that are modular in design, and allow for ease of removal, and interchangeability.

2.a Lens Panel. Provide lens panel mask fabricated of aluminum. Finish mask with a matte-black coating system according to or exceeding AAMA Specification 2605. Perforate the panel to provide an aperture for each pixel on the display modules. Each aperture must be as small as possible, without blocking the LED light output at the required viewing angle.

Provide lens panel glazing that is 90% ultraviolet (UV) opaque polycarbonate, clear in color, and laminated to the inside surface of the lens panel aluminum mask to form lens panel assembly.

(d) Interior Structure.

1. Internal Structural Members. Construct internal structural members including the structural frame out of aluminum alloy 6061-T6 or 6063-T5. Provide internal structural members to accommodate all LED mounting and air distribution subsystems as applicable. Provide internal structural members to retain the display modules in a manner that facilitates ease of maintenance, including the rapid removal of individual display modules. Enable the removal of individual display modules without interfering with adjacent or surrounding modules.

2. Sign Housing Surface Finish. Finish sign face with a matte-black fluoropolymer coating system according to or exceeding AAMA Specification 2605. Provide certification from the licensed coating manufacturer for all aluminum face materials.

3. Sign Housing Access Door for Walk-In DMS. Where a walk-in sign is utilized, provide a sign housing door that is fabricated from aluminum. Equip sign with a minimum of two vertically hinged access doors located at the right and left sides (while facing the front of the sign) of the DMS housing. Mount doors to door frames that are integral to the sign housing. Provide stainless steel hinges to support the door, and enable the door to open outwards. Furnish access door to be a minimum of 2 feet wide and 80 inches high. Equip door with a handle-operated locking mechanism, closed-cell neoprene gasket, and stainless steel hinges. Locate door release levers so a person without keys and tools cannot become trapped inside the housing. Furnish doors with a hinge/stop mechanism that retains the door in a 90-degree open position.

Furnish a Grade 1 three-point center-case dead bolt locking mechanism that conforms to ANSI/Builders Hardware Manufacturers Association (BHMA) Standard A156.2 and utilizes a zinc finish. Provide a handle on both the inside and outside of the door. Furnish industrial-strength, corrosion-resistant handles. Equip door with electronic monitoring subsystem that provides an alert to TMC/RTMC personnel if the door is opened.

Equip DMS housing with an OSHA compliant anchor point at each entrance location for the connection of a personal fall arrest system. Provide anchorages strong enough to withstand a force of 5,000 pounds, as required by OSHA. Locate anchorages so they will not allow a person to free-fall more than 6 feet if a 6-foot lifeline is used. Locate anchorages just inside each access door within easy reach from the outside, and just outside the access door within easy reach from the doorway.

4. Sign Housing Access for Front Access Signs. For front access signs, provide unobstructed access that allows servicing of internal components. Access must not require specialized tools or excessive force.

5. Sign Housing Operating Environment. Provide sign housing that conforms to the operating environment requirements established in NEMA TS4. Provide sign housing that ensures functionality of all DMS equipment in the ambient operating temperature range of -29F to +165F, or as defined in the most recent version of NEMA TS4.

Where ventilation subsystem is utilized to ensure conformance to NEMA TS4, provide positive pressure, filtered, forced air sign housing ventilation subsystem that distributes air over all LEDs, power supplies, communications equipment and other electronic devices contained in the DMS housing. Evenly distribute circulation across display modules, in the cavity between each display module, across lens panels and the back of the display modules. Submit ventilation subsystem design calculations to the Representative for acceptance before sign installation.

Provide screened or filtered intake holes to feed ventilation subsystem. Provide holes large enough to accommodate the air intake necessary to provide ventilation to the entire sign housing.

Provide ventilation subsystem capable of being tested automatically once each day, and capable of being tested on command from remote and local control access locations. If a failure occurs, send an error message to the TMC/RTMC or a laptop computer through the DMS controller. Provide ventilation subsystem capable of operating without decrease in performance over an ambient operating temperature range of -29F to +165F as per NEMA TS 4, Subsection 2.1.5.1, with a maximum relative humidity of 100%.

Provide a fail-safe ventilation subsystem that includes a snap disk thermostat that is independent of the sign controller. Preset the thermostat at 130F. If the sign housing's interior reaches 130F, activate the thermostat to override the normal ventilation subsystem, bypassing the sign controller and turning on all sign ventilation fans. The fans will remain under the control of the thermostat until the internal sign housing temperature falls to 115F, at which time the fail-safe subsystem will return control of the ventilation subsystem to the sign controller.

Include a manual override timer switch located just inside the access door to manually activate the ventilation subsystem. The switch must be adjustable to run for up to 4 hours.

Furnish a sensor or a sensor assembly to monitor airflow volume to predict the need for a filter change and capable of being tested on command from remote and local control access locations. If a failure occurs, send an error message to the TMC/RTMC or a laptop computer through the DMS controller. The ventilation subsystem fans must possess a 100,000-hour L10 life rating.

Provide inlet and exhaust filters which are 1-inch thick, permanent, reusable, electrostatic filters that require no electrical attachment. Provide filters which are easily removable from within the sign housing without the use of tools.

Provide blower that is capable of providing a minimum of one sign housing volume change per minute. Position the blowers to provide a balanced airflow to the ventilation subsystem in the event of failure of any blower.

Make all ductwork that impedes access to any sign components to be easily removable, without tools, for servicing of these components. Fabricate all ductwork from minimum 0.040 inches aluminum. Furnish ducts that are extremely efficient with minimal pressure drop throughout the subsystem.

6. Sign Housing Temperature Sensor. Provide a temperature sensor in the sign housing that is controlled and monitored by the sign controller. Provide the capability for the sign to blank itself if a user-defined critical temperature threshold is exceeded. Provide the capability for the user defined critical temperature threshold to be monitored and changed remotely from the TMC/RTMC or other location, using the sign controller.

7. Sign Housing Humidity Sensor. Provide a humidity sensor that detects from 0% to 100% relative humidity in 1% or smaller increments. Provide interface between the sensor and the controller. Allow for the humidity to be monitored remotely from the TMC/RTMC. Provide a sensor with accuracy better than plus or minus 5% relative humidity. A humidistat is not acceptable.

8. Photoelectric Sensor Devices. Provide sensors with the capability to monitor ambient light levels. Furnish sensors that employ a sufficient number of photocells in the appropriate locations to measure ambient light conditions. Position photocells to measure light levels on both the front and rear of the sign, and light levels at the sign location.

Furnish sensor that provides the DMS controller with accurate ambient light conditions at the sign location and can be monitored remotely from the TMC/RTMC. Configure controller to react to the light conditions by brightening or dimming the sign LEDs. Reduce the brightness of the pixels in low ambient light, and increase in high ambient lighting. Avoid pixel blooming in low-light conditions. Automatically adjust LED brightness in small enough increments so the brightness of the sign changes smoothly, with no perceivable brightness change between adjacent levels. Make provision to prevent perceivable brightening of the sign due to stray headlights shining upon the photo sensors at night.

Provide brightness and color of each pixel that is uniform over the sign's entire face within a minimum 15-degree viewing angle in all lighting conditions. Non-uniformity of brightness or color over the sign's face is justification for rejection of the sign by the Representative.

9. Sign Housing Internal Lighting and Electrical Outlets for Walk-In DMS. Furnish a sign housing with a minimum of four internal light fixtures. Near the door, locate a 12-hour timer without hold feature for the lights. Make certain that all fixtures are spaced evenly above the walkway and fully enclosed in shatter-proof protective fixtures. Furnish emergency lighting that automatically illuminates the interior in the event of a power outage.

Prevent light produced from the internal lighting fixtures from being visible from outside the sign during nighttime or dark conditions, and prevent light from interfering with normal visible operation of the sign.

Equip sign housing with at least three 15 A, 120 volt rated ground fault interrupter (GFI) outlets that include protected duplex electrical receptacles. Locate one duplex receptacle at each end of the sign housing and one at the center of the sign housing. Space the duplex receptacles evenly on the rear wall of the housing at a height of between 1.5 feet and 3 feet above the walkway.

(e) Display Modules. Provide display modules manufactured by one source and fully interchangeable throughout the manufacturer's sign subsystem(s). Removal or replacement of a complete display module or LED board must be able to be accomplished without the use of special tools. Furnish display modules containing solid-state electronics to control pixel data and read pixel status.

1. Full Matrix Display Module. Assemble display modules to form a full color, full matrix configuration suitable for displaying three lines of characters. Provide a minimum of 18 characters per line, and a maximum of 24 characters per line, as indicated. Provide 12-inch or 18-inch-high display characters with a standard character size ratio of 5:7, width vs. height. Standard Font character spacing will follow MUTCD guidelines for inter-character and inter-line spacing.

2. LED and Pixel Specifications. Provide LEDs based on AllnGaP technology. Provide diodes with a minimum 15 degree viewing angle centered around the optical axis, or zero point, of the pixel, with an amber color and a peak wavelength of 590 nanometers. The peak wavelength must not vary by more than ± 2 nanometers. Provide pixels on the DMS and in the spare parts to have equal color and on-axis intensity.

Provide sign display to produce an overall luminous intensity of at least 7440 candelas per square meter when operating at maximum intensity. Measure brightness according to the International Commission on Illumination's (CIE) requirements as detailed in the Test Method A of the CIE 127 (1997) standard.

Provide capability to test pixel operational status remotely from the TMC/RTMC, or at the site using a laptop computer pixel test. Provide subsystem capable of producing a log file that includes the pixel status, module number, column number, and pixel number. Provide pixel status test to determine the functional status of the pixel as stuck-on or stuck-off and does not affect the displayed message for more than half a second.

Individually mount each LED directly on a printed circuit board (PCB). Provide LEDs that are individually removable and replaceable using conventional electronic repair methods. Prevent the failure of one pixel from affecting the functionality of any other LED on the PCB.

3. Optical, Electrical, and Mechanical Specifications for Display Modules. Provide display modules with connectors for power, controls, and data; contains display module control electronics and memory elements; and provides the signals to switch the LED pixels.

Furnish display modules that have identical vertical and horizontal center-to-center distances (i.e., pitch) between adjacent pixels ranging from 0.59 inches to 1.00 inches. Provide separation between the last column of one display module and the first column of the next module that is equal to the horizontal distance between the columns of a single display module.

Provide NEMA FR4-rated black LED PCB. Alternate LED PCB configurations are to be submitted to and accepted by the Representative before installation. Provide PCBs that allow components to be removed and replaced without damage to PCB, traces, or tracks. Finish all PCBs with a solder mask and a component-identifying silk screen.

Provide all PCBs, except for the power supply and the pixels on the front of the PCB, with a complete and uniform coating of silicone resin with a minimum thickness of 0.01 inch. Meet the material requirements of MIL-I-46058C Military Standard, United States Department of Defense (USDOD).

Mount all LEDs so the mechanical axis of the LED is ±1 degree to the sign's face to ensure uniformity of brightness over the sign's face. Ensure LEDs are secured perpendicular to the display module within 0.5 degrees.

Prevent devices used to secure LEDs from blocking air flow to the LED leads or blocking the LED light output at the required viewing angle. Provide all-black components on the LED side of PCBs.

Provide multiple power supplies to provide power to each display module. Power supplies must be redundant and rated so if one supply fails, the remaining supply will be able to operate 100% of the pixels in that display region at maximum brightness.

Furnish sign controller that continuously measures and monitors all LED module power supply voltages and provides power readings that indicate to the TMC/RTMC or a laptop computer if the power is sufficient or insufficient on command. Automatically generate an error message to be sent to the TMC/RTMC or a laptop computer if it polls the sign controller and voltages measured are outside nominal values.

Protect LEDs from external environmental conditions, including moisture, snow, ice, wind, dust, dirt, and UV rays. Do not use hoods, louvers, cylinders or visors that could impede the free flow of air over all surfaces of each individual LED. Do not use epoxy to encapsulate the LEDs.

(f) Character Displays. Provide signs capable of displaying American Standard Code for Information Interchange (ASCII) characters 32 through 126, including all uppercase and lowercase letters and digits 0 through 9, at any location in the message line.

Display uppercase alphanumeric characters over the complete height of the matrix. Provide characters legible under all light conditions within the minimum 15-degree cone of vision centered on the pixel's vertical and horizontal optical axes. In addition to the standard character size ratio of 5:7, width vs. height, provide sign capable of displaying compressed ratio (i.e., 4:7), expanded ratio (i.e., 6:7), or double-stroke ratio (i.e., 7:7) character fonts, and capable of changing the default spacing between characters. Provide spacing options to include 1-, 2-, or 3-pixel columns between the characters. Provide font that conforms to the local District's requirements, including height, style, boldness, and font type. If there is no District-required standard font, load the subsystem with a default font according to the Standard Font set described in NEMA TS4-2005 (section 5.6). Font types incompatible with existing District central control software or Advanced Traffic Management System (ATMS) software may be grounds for rejection of the sign. Configure subsystem to allow the assignment of font access privileges. Provide sign controller capable of a self-updating time or date display or both on the sign.

Provide sign capable of showing additional graphics or characters.

(g) Sign Controller. Provide a sign controller with operational firmware stored in non-volatile memory. Provide controller to receive sign control commands from TMC/RTMC and a local, on-site laptop. Program controller to transmit responses, as requested, to the TMC/RTMC, and to control sign operation, message displays, and maintenance polls and statuses. Provide sign controller to control the following operations:

- Message displays
- Sign blanking
- Logic or data error logging
- Error reporting to the TMC/RTMC and local laptop
- Providing operational status of the sign and all its components, including each individual pixel, to the TMC/RTMC and local laptop via polling, or real-time transmissions
- Provide all sensor readings including internal and external temperature, photocell, airflow, humidity, LED power supply, and sign door opening to the TMC/RTMC and local laptop
- Temperature thresholds to activate temperature control devices
- Specified as recommended by District TMC/RTMC Personnel per ECMS contracted project
- Provide Option, as determined by the Department, to provide three dry contact inputs that can be used for two Emergency Messages and one to put the unit into "local" if remote contacts are closed.

Transmit each sign function control to the TMC/RTMC using related communications media. Provide controller capable of being polled on command and on a user-definable schedule. Provide controller with the capability of storing a minimum of 100 logs locally in the event of communications failure.

Utilize ambient environmental conditions collected by the sensors in an algorithm that activates the temperature control devices within the sign, including the ventilation subsystem, fans, and heating devices, if the temperature exceeds or dips below the temperature thresholds set in the sign controller.

Furnish sign controller that consists of, at a minimum, local control panel status indicators, including power on/off, TMC/RTMC communications status, laptop computer communications status, communications status with the electronics in the walk-in housing (as applicable), and sign diagnostics and error status.

Provide sign controller that provides automatic power-up commands that blank-out the sign automatically when recovering from power off conditions, and automatically returns to standby conditions in the event power is removed then restored. During power-up procedures, the sign must return to a preprogrammed message, is blanked, or can display graphics or characters as desired by the TMC/RTMC. Provide a hardware watchdog circuit to provide automatic recovery from critical errors, and automatic shutdown in the event of critical hardware failure. Provide a DMS controller that blanks the display in user-definable situations including, but not limited to, pixel failure, extended communications failure, or extended power failure.

Provide a ground-level access point and an in-sign access point at the sign location that allows the sign to be programmed and controlled via a local laptop.

Prevent pedestrians from accessing the sign controller, or changing displayed messages without permissions. Protect access to sign controller using security authentication or login if accessing the sign locally via a laptop computer.

Provide a controller containing:

- Clearly Labeled Manual On/Off Switch
- Momentary contact switch that resets the sign controller

Provide electrical field connections by barrier type terminal connection blocks as defined in NEMA TS1. Identify all terminal block connections and locate so readily accessible for maintenance. Provide all wire and cable terminations made with insulated spade terminals as defined in NEMA TS1. Soldering of field terminal connections is not permitted.

Provide the latest version of the DMS client/server software on the DMS controller. Provide software that is compatible with the existing ATMS software and hardware at the TMC/RTMC. The software must, at a minimum, provide password protection to restrict access to the program and the sign control functions, and the ability to fully control all programmable functions of the DMS.

1. Display Subsystem Hardware. Provide data interface circuit to enable communications between the display modules and the sign controller. Contain the following display subsystem components in the sign housing or the field enclosure:

- DMS controller
- Display subsystem interface circuits
- Display modules
- Power supplies
- Local and remote control switches
- LED indicators
- Electronic Industries Alliance (EIA)-232 plug-in connection for laptop computers, EIA-232 null modem cables (minimum of 4 feet for connection of laptop and controller)
- Workspace and convenient outlet for a laptop computer
- Communications equipment for communications with the TMC/RTMC
- Transient voltage surge suppressors

2. Sign Controller Communications Interface. Furnish DMS controller that includes at least two 9-pin EIA 232 serial interfaces, and one Ethernet Local Area Network (LAN) RJ45 port. The interfaces must accommodate communications to the TMC/RTMC, the managed network switch, and to a local laptop. Provide serial interfaces to support:

- Data bits: 7 bit or 8 bit
- Parity: even, odd, none, mark, or spare
- Number stop bits: 1 bit or 2 bit

Terminate all cables for Ethernet connection over copper media according to EIA/TIA-568-C standard.

Configure one EIA-232 serial interface to drive asynchronous modems for full duplex communication with the TMC/RTMC over point-to-point dial-up lines or a multidrop fiber or copper network. Switching between dial-up, Ethernet, and multidrop operation must not require sign controller software or hardware modifications. Configure the second EIA-232 serial port for local communication with a laptop computer.

The charges acquired for installing and connecting communications cables and for all deployments involving cable services from outside service supplier are at no additional cost to the Department. Provide modems to be retained by the Department at each location. For dial-up operations, provide a user-selectable data transmission rate of up to 19.2 kbps.

Configure sign controller and software to display single-page and multi-page messages, with mixed fonts and spacing. Provide message page times and text flashing rates that are programmable between 0.5 seconds and 5 seconds in 0.1-second increments.

Provide subsystem to log and report errors and failures, including data transmission errors, receipt of invalid data, communication failure recoveries, alternating current power failures, power recoveries, pixel status reads, fan and filter airflow status where applicable, temperature status, power supply status, and information on the operational status of the temperature, photocell, airflow, humidity, sign door opening and LED power supply sensors. Report airflow and humidity sensor information using the objects from the dmsClimateCtrlStatusTable of the NTCIP 1203 V2 standard.

Fiber Optic modules or Fiber Optic Small Form Factor electronics, or fiber optic-to-copper (Cat.6) media converters, and their associated power supplies, shall be temperature hardened and meet the environmental operating requirements as specified in 1230.2(d)5.

3. Message Status and Monitoring. Provide DMS supporting two modes of operation:

- Master operation, where the TMC/RTMC commands and controls the sign and determines the appropriate message or test pattern.
- Local operation, where the sign controller or a laptop computer commands and controls the sign and determines the appropriate message or test pattern.

For walk-in signs, keep electronic components away from the access door to protect them from the elements. For front and rear-access signs, keep electronic components away from the access panels where possible to protect them from damage or corrosion due to exposure to the elements. Provide DMS capable of performing the following functions:

- Control Selection – Provide local/remote switch on the local control panel that functions in parallel with the local/remote switch located in the ground control box. Provide a LED indicator near the local/remote switch to indicate if either switch has selected the local mode. The operating mode is determined by the position of the mode switch on the local control panel. If the local control panel's switch is set to local, the operating mode is local. Otherwise, the operating mode is master.
- Message Selection – Use keypad to select a blank message or any one of the messages stored in the sign controller's nonvolatile memory if the control mode is set to local.
- Message Implementation – Activate the selected message.

Provide sign controller that transmits a return message to the TMC/RTMC whenever it receives a valid status request. Return messages must contain an Internet Protocol (IP) address for the sign controller, the actual message that is visibly displayed on the sign, the displayed message's transmission origin (i.e., the TMC/RTMC, laptop computer, manual entry, etc.), remote or local control status, error and failure reports, temperature readings, access alarms, power supply voltage levels, line voltage, and Uninterrupted Power Supply (UPS) status.

In the event of a sign controller failure, blank any displayed message. During power loss, provide capability to display a user-defined message, including a blank page.

Message additions, deletions, and sign controller changes must be made either remotely from the TMC/RTMC or a local laptop computer. Provide capability to activate messages with specified run-time duration. Upon expiration of a run-time duration, display a user-defined message, including a blank page. Prevent perceivable flicker or ghosting of the pixels during sign erasure and writing periods.

In the event of an AC power loss retain all non-volatile memory for a minimum of 30 calendar days. Provide controller that monitors messages downloaded from the TMC/RTMC or laptop computer to ensure the message will

fit in the display area of the sign. Provide internal time clock that is integral to the controller to provide for message deactivation at the correct time, even in the event of a communication loss. Maintain internal clock time during power outages and automatically display the proper message if power is restored.

4. Traffic Management Center Communications. Provide all communications equipment, cables, wires, interfaces, and appurtenances to establish a connection to the District TMC/RTMC using a specified communications method.

Provide DMS that complies with the NTCIP 1201 v01, 1203 v01, 2101 v01.19, 2102, 2103 v01.13, 2201 v01.14, 2202 v01.05, and 2301 v01.08 standards. Provide documentation NTCIP testing has been completed at the factory for each DMS provided by the manufacturer.

Furnish DMS meeting all mandatory requirements contained in NTCIP 1203 v02 Protocol Requirements List (PRL) contained in sections 3.3.8 and 3.3.9. Provide additional conformance to the following "Optional" User Needs (UN) and Functional Requirements (FR), as described in NTCIP 1203 v02:

UN	FR	Description
2.3.2.1.3.	N/A	DMS Type: Variable Message Sign (VMS)
2.3.2.2.2.	N/A	DMS Technology: LED
2.3.2.3.2.1.	N/A	DMS Display Matrix Configuration: Full Matrix
2.4.2.2.	All Mandatory Items	Logged Data Exchange
2.5.1.2.	All Mandatory Items	Determine the Sign Display Capabilities
	3.5.3.2.1	Monitor Information about the Currently Displayed Message
2.5.1.3.	All Mandatory Items	Manage Fonts
	3.5.1.3.5	Configure a Font
	3.5.1.3.6	Delete a Font
	3.5.1.3.7	Validate a Font
2.5.1.4.	All Mandatory Items	Manage Graphics
	3.5.1.4.5	Store a Graphic Definition
	3.5.1.4.6	Delete a Graphic
	3.5.1.4.7	Validate a Graphic
2.5.1.5.	All Mandatory Items	Manage Automatic Brightness
2.5.2.2.	All Mandatory Items	Remotely Reset the Sign Controller
2.5.2.3.3.	Mandatory	Define a Message
	3.5.1.2.4	Delete All Messages of a Message Type with One Command
	3.5.2.3.2.3	Configure Default Flash-On and Flash-Off Times
	3.5.2.3.2.4	Configure Default Font
	3.5.2.3.2.5	Configure Default Line Justification
	3.5.2.3.2.6	Configure Default Page Justification
	3.5.2.3.2.7	Configure Default Page On-Time and Page Off-Time
	3.5.2.3.2.8	Configure Default Character Set
	H.2.2.1.	Set Time
2.5.2.3.5.	All Mandatory Items	Schedule Messages for Display
2.5.3.1.1.	Mandatory	Determine Sign Error Conditions - High Level Diagnostics
	3.5.3.1.1.3	Execute Climate Control Equipment Testing
2.5.3.1.2.	Mandatory	Monitor System Subsystem Features - Mid-Level Diagnostics
	3.5.3.1.3.8	Monitor Humidity Warnings
2.5.3.1.3.	All Mandatory Items	Monitor Subsystem Failure Details - Low-Level Diagnostics
	3.5.3.1.4.8	Monitor Sign Housing Humidity
2.5.3.1.8.	All Mandatory Items	Monitor Door Status
2.5.3.1.9.	All Mandatory Items	Monitor Controller Software Operations
2.5.3.1.10.	All Mandatory Items	Monitor Automatic Blanking of Sign
	3.5.3.2.1.	Monitor Information about the Currently Displayed Message
2.5.3.1.11.	All Mandatory Items	Monitor Power Source
2.5.3.1.12.	All Mandatory Items	Monitor Power Voltage
2.5.3.2.	Mandatory	Monitor Current Message
	3.5.3.2.1.	Monitor Information about the Currently Displayed Message

Requirement ID	Specific Requirement ID	
	Mandatory	Supplemental Requirements for Message Definition
	3.6.6.2.1	Support Multi-Page Messages
	3.6.6.2.2	Support Page Justification
	3.6.6.2.2.1	Support for One Page Justification Within a Message
	3.6.6.2.2.2	Support for Multiple Page Justification Within a Message
	3.6.6.2.3	Support Multiple Line Messages
	3.6.6.2.4	Support Line Justification
	3.6.6.2.4.1	Support for a Single Line Justification within a Message
	3.6.6.2.4.2	Support Line Justification on a Page-by-Page Basis
	3.6.6.2.4.3	Support Line Justification on a Line-by-Line Basis
	3.6.6.2.6	Support Font Commands
	3.6.6.2.6.1	Support One Font within a Message
	3.6.6.2.6.2	Support One Font per Page within a Message
	3.6.6.2.10	Support Flashing
	3.6.6.2.10.3	Support Page-by-Page Flashing
3.6.6.	3.6.6.2.14	Support of Graphics
	All Mandatory Items	Supplemental Requirements for Line Justification
	3.6.13.1	Support Left Line Justification
	3.6.13.2	Support Center Line Justification
	3.6.13.3	Support Right Line Justification
3.6.13	3.6.13.4	Support Full Line Justification

(h) Control Enclosure. Section 1201.2(b) and as follows: Provide a one-door or two-door NEMA 3R control enclosure to house communications and power connections to the DMS. Mount enclosure on the DMS structure or on a concrete pad as indicated. The front panel of all equipment in the enclosure must be visible from at least one of the enclosure openings. Where necessary, provide a two-door enclosure to meet this criterion. The enclosure is to be used for the installation of control and communications equipment, as well as a standard duplex receptacle, convenience light, surge protection and other ancillary equipment.

Provide an enclosure equipped with EIA standard 19 inch racks with fixed front frame. Provide a pull-out shelf of sufficient size to support a laptop computer.

Provide all enclosure accessories powered from a power distribution panel to be furnished and installed as an integral part of the enclosure. Size the power distribution panel, circuit breaker and all power system components according to the loads required to operate the DMS. Feed the power distribution panel from the main circuit breaker. Provide a power distribution panel that has the following ratings:

- 120/240 V
- Single Phase
- Three Wire
- 10 KAIC (Symmetrical)*
- 60 A Main Lugs (Minimum)
- Four Single Pole Circuit Breaker Capacity (Minimum)
- Isolated Neutral Bus
- Ground Bus

*-Fault Duty to be confirmed with the Utility Company and increased as required

Provide power distribution panel containing the following circuit breakers. Provide single pole, 120 Volt Rated, 10 KAIC (Symmetrical) circuit breakers with the following current capacity:

- 20 A spare circuit breaker
- 15 A circuit breaker for heating system and cooling fan
- 20 A circuit breaker for lamp and duplex convenience outlet
- 20 A circuit breaker (minimum) for ITS field equipment

(i) Main Power Supply and Energy Distributions. Provide a nominal single-phase power line voltage of 120/240 VAC protected by one 60 A, two-pole main circuit breaker for the sign and its controller. Limit subsystem operation to a voltage range of 97 VAC to 135 VAC as specified in NEMA TS4, Subsection 2.1.3.1.

Supply all service lines inside the sign by 120 VAC independently protected by a thermomagnetic circuit breaker at the sign housing's entry point. Locate all 120 VAC wiring in conduit, pull boxes, raceways, or control enclosures as required by the NEC. Prevent exposure of 120 VAC wiring inside or outside of the sign housing. Do not use the sign housing as a wiring raceway or control enclosure.

Provide sign and controller with an operating frequency of 60 hertz (Hz), ±3.0 Hz, as stated in NEMA TS4, Subsection 2.1.3.2. Prevent a drop in the unit's voltage between no-load and full-load during normal operations from exceeding 10% of the nominal voltage. Provide power protection through the use of a thermomagnetic circuit breaker connected to a 5-milliampere GFI device that protects all service outlets. Provide a 100 A 120/240 VAC two-pole load center with mounting space for at least 20 breakers. Provide separate circuit breakers for each sign circuit.

Provide power cables with insulation material fabricated specifically for damp and moist conditions. Size power cables as required by the NEC for acceptable voltage drops while supplying alternating current to the sign. Prevent sign power consumption from exceeding 7,000 VA under any circumstance, including operation of the fans, heaters (if provided within the sign), sign controllers and communication equipment, and all pixels illuminated at maximum brightness.

Provide protection devices such as surge suppressors and lightning arrestors installed or incorporated in the sign subsystem by the manufacturer to guard against lightning, transient voltage surges, and induced current. Use transient voltage surge suppression devices on all electric power and data communication connections entering and exiting the DMS housing and in the DMS enclosure.

Surge suppression units must meet the following criteria:

- Maximum clamp voltage: 340V;
- Peak Current: 20,000 A;
- Response Time: 5 nanoseconds;
- Occurrences: 20 times at peak current;
- Minimum Series Inductance: 200 microhenries;
- Temperature Range: -40F to +165F.

Provide surge suppression units for AC circuit configured for both normal mode (L N) and common mode (L+N G) protection. Provide Underwriters Laboratories (UL) 1449 listed surge protectors.

Provide DC and AC voltage ratings and dissipation factors of capacitors used in the sign subsystem that exceed the worst-case design parameters of the circuitry by 50%. Mechanically mount all capacitors using a clamp or fastener that is resistant to cracking, peeling, and discoloration.

Provide resistors within 5% of the tolerance of the specified temperature range and, if operated in excess of 50% of its power rating, have an adequate heat sink. Provide standard type transistors, integrated circuits, and diodes that are listed by the EIA and clearly identifiable.

(j) Uninterruptible Power Supply (UPS). Section 1201.2(d) and as follows: Provide DMS with an UPS subsystem that is capable of powering critical components at the DMS, including all related communications equipment for a minimum of 0.5 hours. Provide sealed Absorbed Glass Mat (AGM) type batteries that are maintenance free. Install UPS within the sign housing or in the DMS enclosure so it does not obstruct regular maintenance efforts or access to indicator lights or panels.

(k) Ground Rod. Section 1101.11(j)

(l) DMS Structure. Section 930 and Section 948

1230.3 CONSTRUCTION—As indicated and specified by IT or District TMC Personnel according to ECMS contracted project documents. Coordinate work with PennDOT and the proposed DMS Manufacturer on final configuration and options. Install DMS as shown on the Standard Drawings, and as follows:

(a) Installation and Mounting. Install DMS at a location that provides maximum visibility of the DMS message as outlined in PennDOT Publication 646, Section 3. Install DMS on structure as indicated so the structure does not interfere with the visibility requirements. Configure DMS to automatically test the operational status of each pixel in the sign once per day.

(b) DMS Communications Enclosure. Install the DMS enclosure in a location that adheres to the guidelines for DMS enclosures contained in Publication 647. Properly secure all electronic equipment contained within the DMS or DMS enclosures from damage due to weather, moisture, dust, dirt and corrosion.

1. Enclosure Foundation. For base mounted enclosures, construct the foundation as specified in Sections 951.3(a) and (b).

2. Maintainer Pad. Section 1201.3(a)9

(c) Integration. Section 1201.3(c)

(d) DMS Structure and Foundation. Section 948.3

(e) Grounding. Section 910.3(q)

(f) Testing. Section 1201.3(b)

(g) Training. Section 1201.3(d)

(h) Documentation. Section 1201.2(f)

1230.4 MEASUREMENT AND PAYMENT—

(a) Dynamic Message Sign (DMS) Subsystem. Each
Includes the DMS sign, sign housing, controller, enclosure, enclosure foundation, maintainer pad, grounding, mounting, documentation, installation, training, integration and all related equipment.

- 70% of payment will be made upon complete installation of DMS sign.
- 20% of payment will be made upon completion of the standalone acceptance tests as specified in Section 1201.3(b).
- 10% of payment will be made upon completion of the 60-day test as specified in Section 1201.3(b).

Completion of tests includes completion of training, submission of all manuals and documentation as required, and completion of all final inspections, as required by the Representative.

(b) Class 3 Excavation. Section 204.4(a)

(c) Class A Concrete. Section 1001.4(a)

(d) Reinforcement Bars. Section 1002.4(a)

SECTION 1231—PORTABLE DYNAMIC MESSAGE SIGNS

1231.1 DESCRIPTION—This work is to furnish and install a portable dynamic message sign (PDMS) subsystem for use in temporary and semi-permanent installations, and construction zones.

1231.2 MATERIAL—

(a) General. Provide a PDMS in trailer configuration, equipped with wheels for portability. Provide portable devices according to the physical display and operational requirements of the MUTCD. Provide PDMS consisting of a display panel, controller, support structure for sign display panel, a photovoltaic cell array, battery bank subsystem for powering the PDMS, an electronic control console, wireless communications interface, remote control software, and a heavy-duty trailer frame.

Equip PDMS with a hitch to facilitate towing of the trailer. Provide capability of displaying a variety of messages using Light Emitting Diode (LED) matrices. Provide PDMS that functions in two mechanical modes, one mode for sign use and message display, and another for safely and securely transporting the sign. Provide PDMS capable of operating continuously on the solar power subsystem without regular maintenance for minimum of 3 month intervals. Furnish PDMS to meet a minimum 10 year lifespan.

Furnish a sign according to NTCIP requirements for dynamic message signs. Fabricate all nuts, bolts, washers and other fasteners of corrosion resistant material. Provide a PDMS with the following components:

- DMS
- Trailer and DMS mount structure
- DMS controller and Wireless Communications Interface
- Solar power supply subsystem including solar array and battery bank

(b) PDMS. Provide a DMS for mounting to the PDMS trailer frame. Provide DMS display capable of displaying messages with minimum of two phases, with each phase consisting of up to three lines of eight characters per line. Provide sign face that is colored black, and complies with Federal Specification TT-E-489. Equip sign display panel with an ultraviolet (UV) resistant, scratch resistant, glare reducing protective cover. Provide display panel protective cover with a glare-eliminating feature that prevents blurring and obstruction of the DMS messages. Provide DMS that is modular in design to facilitate easy repair.

Equip display assembly with an automatic dimming operational mode capable of a minimum of 50% dimming under varying light conditions and a separate manual dimmer switch. Provide ambient light sensor to interface with automatic dimming functionality. Provide DMS display with minimum dimensions of 74 inches high by 126 inches wide, including the sign housing. Furnish DMS panel and mounting capable of rotating 360 degrees on its support mast. Provide capability to lock into position at any angle about the vertical axis to allow for optimizing viewing angle to oncoming motorists. Provide DMS enclosure that is weatherproof, dust proof, and rated for continuous operation or storage under the following conditions:

- Temperature of -30F and +165F
- Relative humidity of 20% to 95%, non-condensing
- Maintain physical integrity of equipment when subjected to a vibration of 5Hz to 30 Hz up to 0.5 gravity applied in each of three mutually perpendicular planes.
- Prevent equipment from suffering permanent mechanical deformation or any change rendering the unit inoperable if subjected to a shock of 10 gravities applied in each of three mutually perpendicular planes.

Ensure PDMS operation is unaffected by radio frequency interference (RFI) or electro-magnetic interference (EMI). Provide PDMS able to withstand constant wind speeds of 80 miles per hour in operating position and 70 miles per hour in transporting position. Equip DMS display with a sighting device to assist the operators in orienting the DMS display to provide maximum viewing capacity to motorists approaching the sign.

1. LED and Pixel Specifications. Provide all pixels containing at minimum three LED arranged in a circular or triangular pattern to produce the appearance of a round dot to oncoming motorists. Provide 592 nanometer wavelength, amber-colored LEDs. Provide minimum DMS display brightness of 10,000 candela per square meter at maximum intensity. Provide pixels with a minimum viewing angle of 15 degrees about the vertical and horizontal axes, with no loss in intensity, color, or legibility within this cone of vision. Furnish interchangeable display modules that are mounted to the DMS using simple tools and nominal force, and provide for easy replacement or changeability without the need for special tools.

2. Character Displays – Text and Graphics. Provide DMS display capable of displaying three lines of 8 characters per line with a minimum separation of 3 pixels between characters. Provide minimum 12 inch high characters. Present each displayed character using minimum 5 horizontal pixels and minimum 7 vertical pixels.

Provide capability to display simple graphics on the DMS, including, but not limited to individual and series of vertical arrows with maximum height that matches the height of the full-matrix sign face, individual and series of horizontal arrows with maximum width that matches the width of the full-matrix sign face. Ensure line of sight is optimized according to Publication 646.

(c) Trailer. Provide a wheeled trailer fabricated of steel. Deburr and finish all metal with a corrosion resistant coating. Equip trailer with tie-down points to facilitate storage and transport by securing the trailer to a utility trailer or flatbed truck. Equip trailer with class-A tail lights, using a plug adaptor.

Furnish trailer that can be set up at the site with its own chassis and outriggers, without being hitched to a vehicle. Equip trailer with fenders over the tires that are made from heavy-duty material sufficient to allow a person to stand and operate or perform maintenance on the unit. Delineate the trailers on a permanent basis by affixing retroreflective material in a continuous line on the face of the trailer as seen by oncoming road users. Finish trailer with a glossy federal safety aliphatic acrylic urethane finish. Provide orange color to conform to the MUTCD requirements for portable changeable message signs (PCMS).

Provide a trailer mounting structure for the PDMS. Provide accessible mechanism to easily raise and lower the display assembly. Provide a locking device to lock the display panel in the raised or lowered position. Provide a single metal telescoping mast pole to mount the DMS that is an integral piece of the body of the trailer. Provide support capable of adjusting the height of the sign, and allows the sign to rotate 360 degrees around the vertical axis of the support beam, without requiring more than a single operator to perform height or angle adjustments. Equip DMS with locking mechanisms that enable the DMS to be locked at any angle of rotation. Provide capability to elevate the center-point of the sign face to a minimum height of 10 feet. The locking mechanisms must prevent the DMS from changing angles during windy conditions or vibrations.

Equip trailer with a hitch for connection to a towing vehicle. Provide hitch with a towing capacity of 5,000 pounds. All trailer hitch components must conform to SAE J684 Standards for Class II trailers. Equip hitch with a 1/4 inch safety chain for secure attachment to towing vehicle. Provide trailer with sealed, flush-mounted, combination stop, tail and turn lights, and front and rear sided marker lights. Provide a rear license plate display holder, and a rear center identification light bar for illuminating the trailer license plate. Provide a rear fender.

Provide four hydraulically or mechanically adjustable outrigger leveling pads permanently installed at each of the four corners of the sign trailer for leveling and support functions. Provide leveling pads with a minimum capacity of 2,000 pounds each. Provide leveling pads that are adjustable using a single operator, and without any special tools. The leveling pads must be capable of lifting the trailer so the tires do not touch the ground. Equip trailer with tires according to ST225/75R15 Load Range C. Provide 5-lug pattern wheel configuration. Affix the manufacturer's name and the trailer make and model to trailer. Provide an operator's manual within the control enclosure of each unit.

(d) PDMS Controller. Equip PDMS with a sign controller containing all the necessary hardware and software to control the DMS. Provide electrical and communications connections to the controller of locking-type connectors to permit quick and simple removal of connections. Provide sign controller with a liquid crystal display (LCD) console for programming and operations. All DMS functions must be programmable and operable locally at the controller, using a built-in graphical user interface (GUI) that is integral to the controller. Provide controller that displays an on-site graphical representation that visibly depicts the message displayed on the sign face. Provide controller and associated on-board circuitry to meet the requirements of the FCC Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise by Class A digital devices.

Provide capability of remote control operation of the sign via a wireless communications interface that utilizes the ports specified, or locally via a laptop computer. Local connections to a laptop computer must facilitate routine repairs,

diagnostics and all other operational functions. Provide, at a minimum, the following interfaces to the sign controller: a USB port, Ethernet port, and serial port.

Provide a wireless communications interface, field-hardened for long-term freeway deployment where it is typically subject to wide daily and seasonal temperature swings, wind gusts and typical road vibrations with an extended operating temperature range from -30F to + 165F. Coordinate wireless communications interface type and configuration with the Representative for network compatibility. The wireless carrier data account will be provided by the Department. Provide the wireless interface as a unit detached from the PDMS controller to facilitate easy change out to other communications means.

Equip controller with interface to accommodate a portable keyboard for inputting sign messages. Furnish portable keyboard that is compatible with the PDMS controller, and deliver keyboard to location identified by the Representative. If Representative does not identify delivery location for the portable keyboard, place keyboard in the PDMS controller enclosure. Facilitate static and dynamic Internet Protocol (IP) network connections in addition to serial dial-up modem connection and cellular 4G data modem connection. Protect all data and electrical connections from the DMS controller using transient voltage surge suppression (TVSS) equipment.

Furnish controller capable of retaining time and date information and utilizing time and date information to facilitate an operational schedule for the display and removal of messages. Provide capability of storing 50 distinct messages locally in a message library. Furnish controller that is unaffected by mobile radio, or any other ambient radio transmissions.

Provide software for the control, monitoring, maintenance and operation of the PDMS from a remote location. Include provision in the controller software that enforces authentication of operator credentials for control of the PDMS, for both local and remote controls. Include provision in the controller firmware that disallows the display of words contained in a user-defined list of disallowed words. Provide controller to monitor and display battery voltage levels on the GUI. The controller must provide battery voltage levels at any remote monitoring location and the ability to alert the system computer of a power failure or low battery voltage condition. Unacknowledged alerts will be resent a minimum of three times.

Provide PDMS that is NTCIP compatible, supporting the following NTCIP standards:

- NTCIP 1201 (v3.03b) – Global Object Definitions
- NTCIP 1203 (v3A-SE.06) – Object Definitions for Dynamic Message Signs (comply with all mandatory User Need and Protocol Requirements as specified in section 3.3.8)
- NTCIP 2101 (v1.19) – Subnetwork Profile: PMPP over RS232
- NTCIP 2104 (v1.11) – Subnetwork Profile: Ethernet
- NTCIP 2201 (v1.15) – Transport Profile: Transportation
- NTCIP 2202 (v1.05) – Transport Profile: Internet

Equip the PDMS trailer with a metallic enclosure to house the sign controller. Provide a weatherproof and rust resistant enclosure that is securely fastened to the trailer structure. Equip the enclosure with a door with a key locking mechanism, and provisions for externally locking the door using a typical pad lock.

(e) Solar Array and Battery Bank. Equip PDMS with solar array and battery bank to provide power to the sign and sign equipment. Using solar array, supply nominal voltage 12V DC. Provide solar array consisting of photovoltaic, single crystal silicon modules. Provide automatic recharging of power supply batteries to normal operating levels with meters showing charge.

Securely mount the solar array to the PDMS for operation and transport. Provide mounting capable of swiveling, tilting, and re-angling the cells in order to optimize exposure to solar rays. Include capability to lock the solar panels at any angle necessary to optimize solar exposure.

Provide AC/DC battery charger. Provide battery bank that at full charge is able to power 20% of the PDMS pixels at continuous use for 7 days without recharging from the solar array. Equip battery bank with a battery controller to prevent overcharging and over-discharging. Provide battery controller with external battery level indicator. Protect the battery, controller, and power panel from the elements and vandalism. Provide battery subsystem with automatic recharging of power supply batteries. Equip battery subsystem with meter to indicate if batteries are being charged or used.

Provide battery bank consisting of low-maintenance, gel batteries. Contain the battery in a NEMA-rated compartment or enclosure that prevents water ingress during operation or transport. Fabricate the compartment to

completely contain all spills from damaged or malfunctioning batteries. Provide battery enclosure that is separate from enclosure to house DMS controller.

1. Plug-In AC Power. Provide an AC-to-DC power converter and a power receptacle behind a lockable window at the main frame of the PDMS, to allow the use of power feed from an alternate power source such as a generator set on trailer, or road-side power outlet. Provide a selector switch inside the window that connects the internal loads of the PDMS to the battery-powered subsystem, or the above AC-to-DC power converter. Include provision for the external AC power to charge the batteries if the PDMS operates using the external AC power. Provide AC-to-DC power converter that converts 120 VAC power to DC power suitable for operating the PDMS. Provide window with a grommet-lined semi-circular notch at the bottom to allow passage of extension cord with the window closed. Provide twist locking type receptacle. Provide an extension cord with male plugs at both ends that is suitable for outdoor uses, oil resistant, minimum 50 feet long, and equipped with three 12 AWG conductors. Provide cord if one of the plugs is regular type and the other plug is suitable for use with twist locking type receptacle. Deliver cord to the location identified by the Representative.

(f) Grounding Terminal. Provide means to connect a grounding conductor to the PDMS assembly. Provide deliberate grounding connection from the trailer frame and the PDMS controller frame, to this grounding terminal. Provide grounding terminal suitable for terminating a wire of up to 2 AWG. Provide painted signage next to the grounding terminal, with 1-inch tall black letters on white background, stating "PROVIDE GROUNDING TERMINATION HERE."

1231.3 CONSTRUCTION—As shown on the Standard Drawings and as follows:

(a) PDMS. Install DMS on trailer and DMS mount structure as indicated so the mount structure does not interfere with the visibility requirements.

1. PDMS Controller. Configure PDMS controller to display messages. Enable activation and editing of messages using a typical keyboard and GUI of the control software.

2. Solar Array and Battery Bank. Orient and lock solar panels in a position to optimize exposure to sunlight.

3. Integration. Section 1201.3(c)

4. Testing. Section 1201.3(b)

5. Training. Section 1201.3(d)

6. Documentation. Section 1201.2(f)

(b) Trailer Unit. Install trailer unit as specified in contract documents. Ensure the trailer is located in an area free of debris so a maintainer can access the unit and be protected from most vehicular traffic. Configure all outriggers to equally support the weight of the trailer and ensure the unit is completely level.

1231.4 MEASUREMENT AND PAYMENT—

(a) PDMS Subsystem. Each
Includes trailer, DMS mount, DMS display, batteries, solar array, wires, connectors, integration, training, documentation, and all work for a complete subsystem.

- 50% of payment will be made upon delivery of the PDMS.
- 30% of payment will be made upon demonstration of full functionality of the sign locally (not from the TMC/RTMC). Full functionality is demonstrated upon successful completion of standalone acceptance test as specified in Section 1201.3(b).

- 20% of payment will be made upon successful integration of PDMS controls at the TMC/RTMC and completion of system test as specified in Section 1201.3(b), as required.

SECTION 1236—MAINTENANCE, DYNAMIC MESSAGE SIGNS (DMS)

1236.1 DESCRIPTION—This work is to furnish, install, modify, repair, replace, and remove components of a DMS subsystem.

1236.2 MATERIAL—Section 1230.2

1236.3 CONSTRUCTION—Section 1230.3 and as follows:

(a) Preventive Maintenance (PM).

1. General. Section 1206.3(a)1

2. Site. Section 1206.3(a)2

3. Enclosures. Section 1206.3(a)3

4. Structure. Perform a visual inspection for wear, rust, cracks, missing, damaged or bent parts, loose connections, frayed cables, and general condition. Check attachment hardware and anchor bolts for rust and tightness. Check welds for cracks and rust. Notify the Representative immediately upon discovery of any structural or electrical abnormalities.

5. Sign. Test operation of sign, all lamps and LED clusters, fiber bundle and pixels, fiber optic shutters, and perform diagnostic tests. Verify that all LED and fiber pixels are functioning from the control enclosure. Visually inspect and ensure all LEDs are illuminated, and check brightness to ensure photocell is properly functioning. Do this according to the manufacturer's testing procedure by using the keyboard and display in the DMS control enclosure or using a laptop computer and connecting to a communications/data connector in the control enclosure. Pixel test can also be performed remotely from the TMC. Software will be provided by the Department if necessary.

Clean surface of signs. Clean semi-permanent filters during every PM inspection according to the manufacturer's recommendations. Replace semi-permanent filters if media integrity is ripped, torn, punctured, or contaminated beyond normal cleaning methods. Replace disposable filters twice annually with nylon-based filter media. Use of paper filters is not acceptable. Test ground rods for 25 ohms or less resistance utilizing fall of potential test. Test communication system to verify communications between DMS and TMC. Test power and communications line surge suppressors and replace as necessary.

(b) On-call Maintenance.

1. General. Section 1206.3(b)1
After On-call Maintenance (OM) has been completed, perform PM as described in Section 1236.3(a).

2. Responsiveness. Section 1206.3(b)2

1236.4 MEASUREMENT AND PAYMENT—

(a) PM, DMS Subsystem. Each
All labor, materials, and equipment required for routine preventive maintenance are incidental to this item including, but not limited to, the Statewide Device Identification Number, cleaning materials, caulk, metal meshing, lubricants, filters, lamps, paint, surge suppressors, fuses, circuit breakers, attachment hardware, insect prevention measures, rodent control measures, clearing and grubbing, selective tree trimming, snow and ice removal, and weed control measures. Mobilization is incidental to this item.

(b) OM, DMS Subsystem Mobilization. Each

Mobilization will not be paid for procurement of parts. Travel to and from the site and district stockpile is incidental to this item.

(c) OM, DMS Subsystem Repair. Hour

Repair time will not be paid for procurement of parts. Travel to and from the site and district stockpile is incidental to this item. Site specific snow and ice removal requested by the Department is included within this item.

(d) OM, DMS Subsystem Parts. Dollar

Includes all cables, connectors, equipment racks, conductor(s), and other parts necessary for proper installation and configuration of a DMS subsystem.

(e) Maintenance and Protection of Traffic. Section 901.4(a)

SECTION 1237—MAINTENANCE, PORTABLE DYNAMIC MESSAGE SIGN (PDMS)

1237.1 DESCRIPTION—This work is to furnish, install, modify, repair, replace, and remove components of a portable Dynamic Message Sign (PDMS) subsystem.

1237.2 MATERIAL—Section 1231.2

1237.3 CONSTRUCTION—Section 1231.3 and as follows:

(a) Preventive Maintenance.

1. General. Section 1206.3(a)1

2. Site. Section 1206.3(a)2

3. Enclosures. Section 1206.3(a)3

4. Trailer and Mount Structure. Lubricate all hinges, jacks stands, mast and trailer hitches. Inspect for wear, rust, cracks, missing, damaged or bent parts, loose connections, frayed cables, and general condition. Check attachment hardware and tighten if necessary to the appropriate parameters. Clean, repaint, and repair as necessary.

5. Sign. Test operation of sign, all lamps and LED clusters, fiber bundle and pixels, fiber optic shutters, and perform diagnostic tests. Verify that all LED and fiber pixels are functioning from the control enclosure. Do this by following the manufacturer's testing procedure by using the keyboard and display in the PDMS control enclosure or using a laptop computer and connecting to a RS 232 connector in the control enclosure. Pixel test can also be performed by the TMC. Software will be provided by the Department where necessary. Visually ensure that all LEDs are illuminated and bright.

Check batteries and add distilled water (record group voltage, split voltage, specific gravity).Check and thoroughly clean solar panels and power the battery packs. Clean surface of signs. Clean filters during every Preventive Maintenance (PM) inspection. Replace filters (twice annually). Test ground rods for 25 ohms or less resistance utilizing fall of potential test. Test communication system. Test power and communications line surge suppressors and replace as necessary

(b) On-call Maintenance.

1. General. Section 1206.3(b)1
After On-call Maintenance (OM) has been completed, perform PM as described in Section 1237.3(a).

2. Responsiveness. Section 1206.3(b)2

1237.4 MEASUREMENT AND PAYMENT—

(a) Preventive Maintenance, Portable Dynamic Message Sign (PDMS) Subsystem. Each
All labor, materials, and equipment required for routine preventive maintenance are incidental to this item including, but not limited to, the Statewide Device Identification Number, cleaning materials, caulk, metal meshing, lubricants, filters, lamps, paint, surge suppressors, fuses, circuit breakers, attachment hardware, insect prevention measures, rodent control measures, clearing and grubbing, selective tree trimming, snow and ice removal, and weed control measures. Mobilization is incidental to this item.

(b) On-call, Portable Dynamic Message Sign (PDMS) Subsystem Mobilization. Each
Mobilization will not be paid for procurement of parts. Travel to and from the site and/or district stockpile is incidental to this item.

(c) On-call, Portable Dynamic Message Sign (PDMS) Subsystem Repair. Hour

Repair time will not be paid for procurement of parts. Travel to and from the site and/or district stockpile is incidental to this item. Site specific snow and ice removal requested by the Department is included within this item.

(d) On-call, Portable Dynamic Message Sign (PDMS) Subsystem Parts. Dollar

Includes all cables, connectors, equipment racks, conductor(s), and other parts necessary for proper installation and configuration of a PDMS subsystem.

(e) Maintenance and Protection of Traffic. Section 901.4(a)

SECTION 1240—VEHICLE DETECTOR SUBSYSTEM

1240.1 DESCRIPTION—This work is to furnish and install a complete Vehicle Detector Subsystem (VDS) consisting of a microwave vehicle detector, Bluetooth vehicle detector, or radio-frequency identification (RFID) tag reader vehicle detector.

1240.2 MATERIAL—

(a) General. Furnish a complete, functional VDS that includes a vehicle detection device, mounting hardware, cables and conduits, installation, and integration. Provide field-hardened subsystems for long-term freeway deployment where it is typically subject to wide daily and seasonal temperature swings, wind gusts, typical road vibrations. Provide all solid state electronic components and circuits. Minimize the possibility that failure of any one component or module causes total subsystem failure. Failure of one component or module must not cause the failure of any other component or module.

(b) Microwave Vehicle Detector (MVD). Furnish a MVD that uses frequency modulated continuous wave principle (FMCW), and determines vehicle presence by the return or reflection of radar output waves, which are converted to a data signal that corresponds to vehicle presence. Provide MVD that is easy to install and remove, and is fully programmable to support a variety of applications. Comply with all applicable mandatory NTCIP-1209 requirements, and optional requirements defined by the following User-Need (UN) or Functional Requirement (FR) section numbers:

UN section #	FR section #	Description
2.5.5.1	3.5.1.1	Get sample end time
2.5.5.1	3.5.1.2	Get volume
2.5.5.1	3.5.1.3	Get percent occupancy
2.5.5.1	3.5.1.4	Get speed
2.5.5.1	3.5.1.5	Get zone status

Provide all solid state electronic components and circuits. Provide MVD to operate without degradation in performance under temperature range of -40F to +165F, and relative humidity of lower than 95%, non-condensing, without auxiliary heating or cooling.

Provide a true presence MVD, which can provide presence, volume, lane occupancy and speed information on a minimum of eight detection zones. Make information available via serial communications lines. Provide user-defined 7-foot resolution for each zone range limit. Provide MVD with area of detection defined as an oval shaped beam, with minimum detection range and coverage angles as follows:

- Elevation Beam Width 45 degrees.
- Azimuth Beam Width 12 degrees.
- Range 10 feet to 200 feet.

Furnish a MVD that complies with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules or the appropriate Spectrum Management Authority. Provide MVD that does not interfere with any adjacent equipment. Where measurement energy is radiated, the radiated power must not exceed 10 milli-Watts.

Furnish MVD with processor that performs and generates, at minimum, the following statistical calculations over a set time duration: average speed, percent occupancy, vehicle count. Provide MVD that is capable of resolving closely spaced vehicles, and does not detect vehicles that remain stationary for over 5 minutes within a detection zone. Enable the operator to select if data is output as contact closures emulating standard loop detector outputs, and/or as accumulated statistical data using detector serial ports. Provide time duration for the statistical calculations that are user-adjustable from 10 seconds to 3600 seconds. Provide MVD that produces data in ASCII format. Provide full description of the protocol used for packaging the transmitted data, and full listing of what and how certain information may be queried. Store all VDS configurations data and all traffic parameters data within an internal, nonvolatile

memory. Store all collected data within the MVD unit for a minimum of 7 days, regardless of whether or not the data was already transmitted.

Furnish MVD that meets or exceeds the following accuracy requirements:

- Identify vehicle presence within each detection zone with a minimum accuracy of 95%
- Detect average travel speed with a minimum accuracy of 90%, independent of the vehicle's direction of travel through the detection zone.
- Maximum permissible error of 5% in the detection of the direction and magnitude of radial speed and 10% in the case of transverse speed.

Provide MVD that operates using nominal input voltage of 12 VDC to 24 VDC and less than 8 watts and is compatible with all power requirements in Section 1201.2(b).

1. Communication. Provide MVD that generates and transmits data in serial RS-232 or RS-422 format. Furnish terminal server to convert signals to Ethernet format where required.

(c) RFID Tag Reader Vehicle Detector (RTVD). Furnish a complete RFID transponder based RTVD. Detection targets are the vehicle-mounted RFID transponder tags used in the E-ZPass Interagency Group (IAG) Electronic Toll Collection (ETC) systems.

Provide RTVD that operates on 120 VAC, or is provided with relevant power conversion module that accepts 120 VAC power supply and is compatible with Section 1201.2(b).

Provide a RTVD that polls the transponder tags in vehicles passing through related detection zone, detects the transponder identification information responded by the transponder tags, time-stamps and transmits the detected information to the TMC/RTMC for further processing.

Provide detection antenna, related antenna cable, and related processing unit that operates without degradation in performance under temperature range of -40F to +165F, and relative humidity of lower than 95%, non-condensing, in absence of auxiliary heating or cooling. Provide detection antenna that radiates polling signal of no more than 4 milli-Watts per square centimeter, has a detection range of minimum 15 feet when placed above the center of a 12 foot wide lane, and has a coverage angle of greater than 60 degrees to allow detection from both lanes when placed above the center of two 12 foot wide lanes. Provide detection antenna with front surface measuring not more than 20 inches at each side, and is not more than 3 inches thick. Unless other length is specifically required, provide antenna cable that supports connection distance between a detection antenna and related processing unit of up to 200 feet.

Furnish a RTVD that complies with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules or the appropriate Spectrum Management Authority. Provide detector that does not interfere with any adjacent equipment.

Furnish RTVD that meets or exceeds the following accuracy requirements:

- Identify vehicle presence within each detection zone with a minimum accuracy of 95%
- Detect average travel speed with a minimum accuracy of 90%, independent of the vehicle’s direction of travel through the detection zone.
- Maximum permissible error of 5% in the detection of the direction and magnitude of radial speed and 10% in the case of transverse speed.

1. Processing Unit. Provide processing unit to interface with and process data from up to eight detection antennas; provide blank cover plate on opening for all unused module slots. Provide RTVD that supports F2C data rate of up to 500Kbps, and properly interacts with and processes data from up to eight streams of transponder tags all moving at up to 100 miles per hour and spaced as close as 50 feet apart, within respective lanes. Provide processing unit that is equipped with at least one EIA RS232 port for configuration and monitoring, and at least one RJ45 ports for 10Mbps IP-based F2C communication.

2. Communication. Furnish RTVD that supports at least serial (RS-232) communications (or preferred serial and internet protocol (IP) communications platform) for field-to-center (F2C) communication. Provide RTVD that includes one or more microwave transponder based vehicle detection antennas and a related processing unit (tag reader).

(d) Bluetooth Vehicle Detector (BVD). Furnish a BVD capable of detecting vehicles with active Bluetooth signals along the roadway. Provide BVD equipped with a standard Class 1 Bluetooth Antenna at minimum and able to simultaneously detect at least four lanes of traffic when placed along the shoulder of the roadway. Provide BVD with the ability to be powered through utility power, solar power, battery power, and PoE as outlined in the contract documents. Provide a BVD having a minimum operating range of -22F to +145F and be able to connect to an existing network or communicate over a cellular (CDMA) network. The BVD must have onboard storage which can store all collected data for a minimum of 1 year. Provide a BVD which has the capability of GPS location. The BVD must have a MTBF of 90,000 hours, minimum.

(e) Detector Housings and Mounts. If detector is not provided as a weatherproof unit, enclose detector in a rugged weatherproof box and seal to protect the unit from wind, dust and airborne particles, and exposure to moisture. Weatherproof any control cable connection from the housing. The maximum total weight of the detector assembly is 20 pounds, excluding any batteries.

Provide mounting assembly consisting of all painted steel, stainless steel, or aluminum construction, and supporting a load of a minimum 20 pounds. Excluding the sensing surface, construct housing of aluminum, stainless steel, NEMA 4X rated polycarbonate, or steel with a corrosion-resistant finish. Furnish housing and mounting arrangement to withstand winds of 100 miles per hour with a 30-percent gust factor, and to withstand vibration of up to 0.03 inch total excursion from 5 Hz to 30 Hz, and peak random vibrations of 5G's from 30 Hz to 1,000 Hz.

For MVD, provide mounting hardware assembly to incorporate a ball-and-socket joint, or other approved mechanism, that can be tilted in both axes, then locked into place, to provide the optimum area of coverage.

Provide mounting for MVD to be installed in either a "side-fire" orientation, whereby the detector is mounted on the side of the roadway and projects a detection area perpendicular to the roadway, or "forward-looking" orientation, whereby the detector is mounted above the roadway, aimed downward, and projects a detection area parallel to the roadway.

For BVDs, provide a sealed, waterproof and tamperproof enclosure with has a locking mechanism and is capable of being chained or banded to structures along the roadway if necessary.

(f) Software. Where no vehicle detector software exists at the TMC/RTMC, furnish software to be installed on a PC or laptop computer at a TMC/RTMC. Furnish software to allow an operator to program, operate, and read current status of all VDS features and functions using the laptop, PC or TMC/RTMC workstation. Provide software to display detection zones and allow control of all detection zone parameters using a simple graphical user interface (GUI). Provide software that enables operators to configure, maintain, operate, setup, calibrate, and perform diagnostics for each detector location. Save all configuration data on the PC or laptop at the TMC/RTMC workstation. Provide detector with the capability to self-tune, and to allow manual calibration via vendor-supplied software. Provide software with the capability to perform autocalibration and autoconfiguration.

(g) Grounding. Section 1101.11(j)

1240.3 CONSTRUCTION—

(a) MVD. Where installing MVD in forward-looking orientation above the roadway, mount the MVD at a minimum height of 17 feet 6 inches above road surface. Where installing MVD in side-fire orientation, mount the detector at a height that minimizes the masking of vehicles. Install MVD in accordance with the manufacturer's recommendations, such that all detection zones are contained within the specified elevation angle. Provide mechanical means to adjust vertical and horizontal detector aiming angles, and to lock the detector aiming position securely. Provide means to double lock the final aiming position which is not prone to loosening or drifting when subject to road vibration.

For Side-Fire applications configure the MVDs to collect and send traffic data for traffic in both directions, for at least eight traffic lanes or as indicated, and within the coverage limitations of the MVD at the installed position. For overhead, forward looking configurations, mount the MVD over the center of the desired lane, or as directed. Configure and integrate the MVD into the Transportation Sensor System (TSS), travel time, or central control software at the related TMC/RTMC and any additional PCs or Laptops as directed by the Representative.

1. Detector Cables. Provide nominal 12-inch cable slack in drip loop configuration at the MVD to allow for aiming adjustments. Provide detector cable that is flexible and rated for outdoor use. Provide weatherproof connectors

for external connections between the cable and the detector. Install single, continuous run signal and control cable without splice between a detector assembly and related ITS enclosure.

(b) RTVD. Install the RTVD at a height of minimum 17 feet 6 inches, maximum 20 feet above road surface, or as specified. Provide mechanical means to adjust vertical and horizontal detector aiming angles, and to lock the detector aiming position securely. Provide means to double lock the final aiming position which is not prone to loosening or drifting when subject to road vibration.

1. Detector Cables. Provide nominal 24-inch cable slack in drip loop configuration at the RTVD to allow for aiming and height mounting adjustments. Install single, continuous run antenna cable without splice between a detector antenna and related communications enclosure. Provide detector cable that is flexible and rated for outdoor use. Provide weatherproof connectors for external connections between the cable and the detector antenna.

2. Permission. Acquire written permission from the E-ZPass IAG for the use of related transponder technology. This permission is a requirement for the procurement of the related products. Provide provisions to address any and all privacy concerns as identified by the E-ZPass IAG, and as required to obtain permission to utilize the RFID tag reading equipment. Coordinate with the Representative to obtain permission before procurement of RTVD.

(c) BVD. Install the BVD at the location indicated in the contract documents. Follow all manufacturers' recommendations for maximum detection along the roadway, including height, distance from farthest travel lane and security. Ensure all cabling is terminated according to the contract documents and as specified by the manufacturer.

(d) Integration. Section 1201.3(c)

(e) Grounding. Section 910.3(q)

(f) Testing. Section 1201.3(b)

(g) Training. Section 1201.3(d)

(h) Documentation. Section 1201.2(f)

1240.4 MEASUREMENT AND PAYMENT—

(a) Vehicle Detector Subsystem (VDS). Each
Includes wiring, connectors, detector, mounting, housing, cabling, software, terminal server, grounding, installation and integration work for a complete subsystem.

- 50% of payment will be made upon complete installation of VDS
- 30% of payment will be made upon completion of the standalone acceptance tests as specified in Section 1201.3(b).
- 20% of payment will be made upon successful completion of the 60-day test as specified in Section 1201.3(b).

Completion of test includes completion of training, submission of all manuals and documentation as required, and completion of all final inspections as required by the Representative.

SECTION 1246—MAINTENANCE, VEHICLE DETECTOR SUBSYSTEM

1246.1 DESCRIPTION—This work is to furnish, install, modify, repair, replace, and remove components of a Vehicle Detector Subsystem (VDS).

1246.2 MATERIAL—Section 1240.2

1246.3 CONSTRUCTION—Section 1240.3 and as follows:

(a) Preventive Maintenance.

1. General. Section 1206.3(a)1

2. Site. Section 1206.3(a)2

3. Enclosures. Section 1206.3(a)3

4. Structure. Inspect for wear, rust, cracks, missing, damaged or bent parts, loose connections, frayed cables, and general condition. Check attachment hardware and tighten if necessary to the appropriate parameters. Clean, repaint, and repair as necessary. Check anchor bolts for rust and tightness. Tighten if necessary to the appropriate parameters. Check welds. Install or replace screening at the base plate as necessary.

5. Detector. Inspect for wear, rust, cracks, missing, damaged or bent parts, loose connections, frayed cables, and general condition. Check housing and attachment hardware. Clean, repaint, and repair as necessary. Test communications system. Inspect and realign detector zone and range, as necessary, to ensure that presence is being recorded. Test power and communications line surge suppressors and replace as necessary.

(b) On-call Maintenance.

1. General. Section 1206.3(b)1
After On-call Maintenance (OM) has been completed, perform Preventive Maintenance (PM) as described in Section 1246.3(a).

2. Responsiveness. Section 1206.3(b)2

1246.4 MEASUREMENT AND PAYMENT—

(a) Preventive Maintenance, Vehicle Detector Subsystem (VDS). Each
All labor, materials, and equipment required for routine preventive maintenance are incidental to this item including, but not limited to, the Statewide Device Identification Number, cleaning materials, caulk, metal meshing, lubricants, filters, lamps, paint, surge suppressors, fuses, circuit breakers, attachment hardware, insect prevention measures, rodent control measures, clearing and grubbing, selective tree trimming, snow and ice removal, and weed control measures. Mobilization is incidental to this item.

(b) On-call, Vehicle Detector Subsystem (VDS) Mobilization. Each
Mobilization will not be paid for procurement of parts. Travel to and from the site and/or district stockpile is incidental to this item.

(c) On-call, Vehicle Detector Subsystem (VDS) Repair. Hour
Repair time will not be paid for procurement of parts. Travel to and from the site and/or district stockpile is incidental to this item. Site specific snow and ice removal requested by the Department is included within this item.

(d) On-call, Vehicle Detector Subsystem (VDS) Parts. Dollar

Includes all cables, connectors, equipment racks, conductor(s), and other parts necessary for proper installation and configuration of a Vehicle Detector subsystem.

(e) Maintenance and Protection of Traffic. Section 901.4(a)

APPENDIX A
METRIC (SI) INFORMATION

General: This Appendix provides guidance on the selection of metric (SI) units and how they relate to their counterparts in English or I-P units. Topics include definitions, dual units, conversion rules, basic units of measure, commonly used SI prefixes, SI measurements, and conversion tables. The conversion tables show multiplication values to change I-P units to SI units.

Several additional tables in this Appendix provide specific I-P / SI relationships. These tables include:

- **Table A-1.** mm^2 Equivalents of American Wire Gage
- **Table A-2.** NEMA Metric Non-Metallic and Metallic Conduit and Fittings
- **Table A-3.** Reinforcing Bar Information
- **Table A-4.** Standard Test Sieves (U.S.A. Standard Sieves)

Definitions: Important terms include the following:

- **SI Units**—Units belonging to the International System of Units, which is abbreviated SI, as interpreted or modified for use in the United States by the Secretary of Commerce.
- **English or I-P Units**—Units based upon the yard and the pound, commonly used in the United States, and defined by the National Institute of Standards and Technology.
- **Soft Conversion**—An I-P measurement that is mathematically converted to its exact SI equivalent. (Example: Lane Width = 12 feet (I-P) = 3.658 m (SI).)
- **Hard Conversion**—A close approximation of the I-P unit but is rounded logically in the SI system. (Example: Lane Width = 12 feet (I-P) or 3.6 m (SI).)
- **SI Base Units**—The SI system consists of seven base units of measurement, six of which are used in design and construction. (The seventh, mole, is the amount of molecular substance and is used in physics.)

Quantity	Unit	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
temperature	kelvin	K
luminous intensity	candela	cd

- **SI Derived Units**—Derived units are formed by combining base units, supplementary units, and other derived units according to the algebraic relations linking the corresponding quantities. The symbols for derived units are obtained by means of the mathematical signs for multiplication, division, and use of exponents. See the list entitled "Basic Units of Measure" for examples of SI derived units.

Dual Units: Measurements in these Specifications may be stated in dual units—SI units followed by I-P units in parentheses. Dual units may be found in references to SI or dual unit codes and standards (e.g., ASTM, AASHTO, etc.). In other situations, where references to other sources are not available, logical "Conversion Rules" are applied.

Many SI measurements in these Specifications are soft conversions of the I-P measurements. Over time, these SI measurements will be changed, through the consensus process, into hard conversions—rationalized, rounded SI dimensions of the I-P measurements.

Situations may occur where specifications are stated in SI units only or in I-P units only. These situations may occur when:

- Existing specifications have not been fully converted.

- The specification was developed exclusively using I-P units only or SI units only. (i.e., Specified products may be available exclusively in SI sizes or I-P sizes.)

Conversion Rules: The *Metric Guide for Federal Construction*, published by the National Institute of Building Sciences, provides further direction about developing specifications. The publication presents "Conversion Rules" which aids in developing construction specifications. The "Conversion Rules" include the following:

- Use ASTM E 621, *Standard Practice for the Use of Metric (SI) Units in Building Design and Construction*, as a basic reference.

- Follow the rules for usage, conversion, and rounding in IEEE/ASTM SI 10-1997, *Standard for Use of International System of Units (SI): The Modern Metric System*, Annex B, or ANSI/IEEE 268, *American National Standard Metric Practice*, Sections 3.5 and 4.

- Wherever possible, convert measurements to rounded, rationalized, "hard" SI numbers. For instance, if anchor bolts are to be imbedded to a depth of 10 inches, the exact converted length (i.e., soft conversion) of 254 mm might be rounded to either 250 mm (9.84 inches) or 260 mm (10.24 inches). The less critical the number, the "rounder" it can be, but ensure that allowable tolerances or safety factors are not exceeded. When in doubt, stick with the exact "soft" conversion.

- Round to "preferred" SI numbers (i.e., hard conversion). While the preferred numbers for the "1 foot = 12 inches" system are, in order of preference, those divisible by 12, 6, 4, 3, 2, and 1, preferred SI numbers are, in order of preference, those divisible by 10, 5, 2, and 1 or decimal multiples thereof.

- Use hand calculators or software conversion programs that convert I-Ps to SI. They are readily available and are indispensable to the conversion process. Simply check with any store or catalogue source that sells calculators or software.

- Be careful with the decimal marker when converting areas and volumes; SI numbers can be significantly larger than I-P numbers (a cubic meter, for instance, is one billion cubic millimeters).

Basic Units of Measure

micrometer	(µm)
millimeter	(mm)
meter	(m)
square meter	(m^2)
thousandth	
cubic meter	(m^3)
hectare	(ha)
liter	(L)
pascal	(Pa)
kilopascal	(kPa)
megapascal	(MPa)
newton	(N)
kilonewton	(kN)
day	(d)
second	(s)
hour	(h)
degree Celsius	(°C)
kelvin	(K)
gram	(g)
kilogram	(kg)
megagram	(Mg) or tonne (t)
tonne	(t)
kilogram per square meter	(kg/m^2)
radian	(rad)
ampere	(A)
farad	(F)
henry	(H)
joule	(J)
lumen	(lm)
lux	(lx)
volt	(V)
watt	(W)

SI Prefixes

deci (d)*	10^{-1}	one tenth
centi (c)*	10^{-2}	one hundredth
milli (m)	10^{-3}	one
micro (µ)	10^{-6}	one millionth
nano (n)	10^{-9}	one billionth
deca (da)	10^{1}	ten
hecto (h)	10^{2}	one hundred
kilo (k)	10^{3}	one thousand
mega (M)	10^{6}	one million
giga (G)	10^{9}	one billion

*Not in SI system

SI Measurements

Apparent Power = volt-amperes (V×A)
Length = millimeters, meters, kilometers
Area = square meters or hectares (10,000 square meters)
Volume = Liters or cubic meters
Mass = kilograms, tonnes
Force = newton (N = (kg × m)/s^2)
Pressure, Stress = Pascal (Pa = N/m^2)
Energy, Work = Joule (J = N × m)
Torque = Newton meter (N × m)
Speed, Velocity = meter/second, kilometers/hour
Acceleration = meters/second squared, kilometers/hours squared
Density = kilograms/cubic meter
Temperature = degrees Celsius
Power = Watt (W = (N × m)/s)
Viscosity (Dynamic) = Pascal second (Pa×s)
Viscosity (Kinematic) = square meter per second (m^2/s)
Luminous Flux = lumen
Illuminance = lux
Luminous Intensity = candela

Conversions	From English	To SI	Multiply By
ANGLE	degree	rad	0.017 453 29
AREA	square inch	mm^2	645.16
	square foot	m^2	0.092 903 04
	square yard	m^2	0.836 127 4
	acre	m^2	4 046.873
	acre	ha	0.404 685
	square mile	km^2	2.59
ENERGY	foot pound	J	1.355 818
FORCE	pound-force	N	4.448 222
	kip	kN	4.448 222
FORCE/UNIT LENGTH	lb./in.	N/mm	0.175 127
	lb./ft.	N/m	14.593 39
LENGTH	inch	mm	25.4
	foot	mm	304.8
	foot	m	0.3048
	yard	m	0.9144
	mile	km	1.609 344
	mile	m	1 609.344
	inches/mile	mm/km	15.7828
LIGHT	candlepower	cd	1
	footcandle	lx	10.763 91

Conversions	**From English**	**To SI**	**Multiply By**
MASS	ounce	g	28.349 523
	pound	kg	0.453 592
	kip (1000 lbs.)	tonne	0.453 592
	ton	tonne	0.907 185
MASS/UNIT AREA	ounces/sq. yd.	kg/m^2	0.033 905 75
	lbs./sq. ft.	kg/m^2	4.882 428
	lbs./sq. yd.	kg/m^2	0.542 5
	lbs./cu. ft.	kg/m^3	16.018 46
	lbs./cu. yd.	kg/m^3	0.593 276 4
	lbs./acre	kg/ha	1.1208
	ton/acre	tonne/ha	2.2417
PRESSURE, STRESS	lbs./sq. ft.	Pa	47.880 26
	kips/sq. ft.	kPa	47.880 26
	lbs./sq. in.	kPa	6.894 757
	lbs./sq. in.	MPa	0.006 895
	kips/sq. in.	MPa	6.894 757
TEMPERATURE	(F - 32)/1.8 = °C		
VOLUME	cubic inch	mm^3	16 387.064
	cubic foot	m^3	0.028 316 85
	cubic yard	m^3	0.764 554 9
	gallon	L	3.785 41
	gal./yd.	L/m	4.1398
	gal./sq. yd.	L/m^2	4.5273
	gal./cu. yd.	L/m^3	4.9511
	gal./acre	L/ha	9.3539
	gal./ton	L/tonne	4.1726

TABLE A-1
mm^2 Equivalents of American Wire Gage

AWG American Wire Gage	ASTM B 3 Soft or Annealed Copper Wire	ASTM B 8 Concentric-Lay-Stranded Copper Conductors Hard, Medium-Hard, or Soft					ASTM B 258 Solid Round Wires
		3 Wires	7 Wires	19 Wires	37 Wires	61 Wires	
0000	107.0	—	107.3	107.2	107	107	107.2
000	85.0	—	85.00	85.1	84.9	84.9	85.03
00	67.4	—	67.45	67.4	67.5	67.4	67.42
0	53.5	—	53.49	53.4	53.5	53.5	53.49
1	42.4	42.39	42.37	42.4	42.5	42.3	42.41
2	33.6	33.61	33.6	33.6	33.7	—	33.62
3	26.7	26.69	26.7	26.6	26.6	—	26.67
4	21.2	21.17	21.1	21.2	21.2	—	21.15
5	16.8	—	16.8	16.7	16.8	—	16.77
6	13.3	—	13.3	13.3	13.3	—	13.30
7	10.5	—	10.5	10.5	10.5	—	10.55
8	8.37	—	8.38	8.38	8.35	—	8.367
9	6.63	—	6.62	6.61	6.63	—	6.631
10	5.26	—	5.26	5.27	5.23	—	5.261
11	4.17	—	—	—	—	—	4.17
12	3.31	—	3.30	3.30	3.32	—	3.30
13	2.63	—	—	—	—	—	2.63
14	2.08	—	2.08	2.08	2.07	—	2.08
15	1.65	—	—	—	—	—	1.65
16	1.31	—	1.31	1.32	—	—	1.31
17	1.04	—	—	—	—	—	1.04
18	0.823	—	0.819	0.81	—	—	0.823
19	0.654	—	—	—	—	—	0.653
20	0.517	—	0.519	0.51	—	—	0.519
21	0.411	—	—	—	—	—	0.412
22	0.324	—	0.33	0.32	—	—	0.324
23	0.259	—	—	—	—	—	0.259
24	0.205	—	0.20	0.20	—	—	0.205
25	0.162	—	—	—	—	—	0.162
26	0.128	—	—	—	—	—	0.128
27	0.102	—	—	—	—	—	0.102
28	0.081	—	—	—	—	—	0.081
29	0.065	—	—	—	—	—	0.0645
30	0.051	—	—	—	—	—	0.0506
31	0.040	—	—	—	—	—	0.0401
32	0.032	—	—	—	—	—	0.0325
33	0.026	—	—	—	—	—	0.0255
34	0.020	—	—	—	—	—	0.0201
35	0.016	—	—	—	—	—	0.0159

TABLE A-1 (Continued)
mm^2 Equivalents of American Wire Gage

AWG American Wire Gage	ASTM B 3 Soft or Annealed Copper Wire	ASTM B 8 Concentric-Lay-Stranded Copper Conductors Hard, Medium-Hard, or Soft					ASTM B 258 Solid Round Wires
		3 Wires	7 Wires	19 Wires	37 Wires	61 Wires	
36	0.013	—	—	—	—	—	0.0126
37	0.010	—	—	—	—	—	0.0103
38	0.0081	—	—	—	—	—	0.00813
39	0.0062	—	—	—	—	—	0.00621
40	0.0049	—	—	—	—	—	0.00487
41	—	—	—	—	—	—	0.00397
42	—	—	—	—	—	—	0.00317
43	—	—	—	—	—	—	0.00245
44	—	—	—	—	—	—	0.00203
45	—	—	—	—	—	—	0.00157

TABLE A-2
NEMA Metric Non-Metallic and Metallic Conduit and Fittings

Table Size (Inches)	Metric Size Designations
1/2	16
3/4	21
1	27
1 1/4	35
1 1/2	41
2	53
2 1/2	63
3	78
3 1/2	91
4	103
5	129
6	155

TABLE A-3
Reinforcing Bar Information

SI Bar Information					I-P Bar Information				
SI Bar No.[1]	**SI Diam. (mm)**	**SI Area (mm^2)**	**SI Mass (kg/m)**	**SI Grades [2] (MPa)**	**I-P Bar No.**	**I-P Bar Diam. (in)**	**I-P Area (in^2)**	**I-P Weight (lbs/ft)**	**I-P Grades [2],[7] (ksi)**
10	9.5	71	0.560	300[3],[5], 350[4], 400[3],[4],[5],[6]	3	0.375	0.11	0.376	40[3][5], 50[4], 60[3],[4],[5],[6]
13	12.7	129	0.994	300[3],[5], 350[4], 400[3],[4],[5],[6]	4	0.500	0.20	0.668	40[3][5], 50[4], 60[3],[4],[5],[6]
16	15.9	200	1.552	300[3],[5], 350[4], 400[3],[4],[5],[6]	5	0.625	0.31	1.043	40[3][5], 50[4], 60[3],[4],[5],[6]
19	19.1	284	2.235	300[3],[5], 350[4], 400[3],[4],[5],[6]	6	0.750	0.44	1.502	40[3],[5], 50[4], 60[3],[4],[5],[6], 75[3]
22	22.2	387	3.042	300[5], 350[4], 400[3],[4],[5],[6], 500[3]	7	0.875	0.60	2.044	40[5], 50[4], 60[3],[4],[5],[6], 75[3]
25	25.4	510	3.973	300[5], 350[4], 400[3],[4],[5],[6], 500[3]	8	1.000	0.79	2.670	40[5], 50[4], 60[3],[4],[5],[6], 75[3]
29	28.7	645	5.060	300[5], 350[4], 400[3],[4],[5],[6], 500[3]	9	1.128	1.00	3.400	40[5], 50[4], 60[3],[4],[5],[6], 75[3]
32	32.3	819	6.404	300[5], 350[4], 400[3],[4],[5],[6], 500[3]	10	1.270	1.27	4.303	40[5], 50[4], 60[3],[4],[5],[6], 75[3]
36	35.8	1006	7.907	300[5], 350[4], 400[3],[4],[5],[6], 500[3]	11	1.410	1.56	5.313	40[5], 50[4], 60[3],[4],[5],[6], 75[3]
43	43.0	1452	11.38	400[3],[6], 500[3]	14	1.693	2.25	7.650	60[3],[6], 75[3]
57	57.3	2581	20.24	400[3],[6], 500[3]	18	2.257	4.00	13.600	60[3],[6], 75[3]

(1) PennDOT has not added the "M" suffix appearing in some standard literature to SI bar numbers.
(2) Grade is equivalent to Min. Yield Designation, f_y.
(3) ASTM A 615/A 615 M billet-steel.
(4) ASTM A 616/A 616 M rail-steel.
(5) ASTM A 617/A 617 M axle-steel.
(6) ASTM A 706/A 706 M low-alloy steel.
(7) Equivalent MPa values for I-P grades follow: 40 ksi = 276 MPa, 50 ksi = 345 MPa, 60 ksi = 414 MPa, and 75 ksi = 517 MPa.

TABLE A-4
Standard Test Sieves
(U.S.A. Standard Series)

Standard Sieve Designation	Alternative Sieve Designation	Standard Sieve Designation	Alternative Sieve Designation
125 mm	5 in.	2.36 mm	No. 8
106 mm	4.24 in.	2.00 mm	No. 10
100 mm(1)	4 in.(1)	1.70 mm	No. 12
90 mm	3 1/2 in.	1.40 mm	No. 14
75 mm	3 in.	1.18 mm	No. 16
63 mm	2 1/2 in.	1.00 mm	No. 18
53 mm	2.12 in.	850 µm	No. 20
50 mm(1)	2 in.(1)	710 µm	No. 25
45 mm	1 3/4 in.	600 µm	No. 30
37.5 mm	1 1/2 in.	500 µm	No. 35
31.5 mm	1 1/4 in.	425 µm	No. 40
26.5 mm	1.06 in.	355 µm	No. 45
25.0 mm(1)	1 in.(1)	300 µm	No. 50
22.4 mm	7/8 in.	250 µm	No. 60
19.0 mm	3/4 in.	212 µm	No. 70
16.0 mm	5/8 in.	180 µm	No. 80
13.2 mm	0.530 in.	150 µm	No. 100
12.5 mm(1)	1/2 in.(1)	125 µm	No. 120
11.2 mm	7/16 in.	106 µm	No. 140
9.5 mm	3/8 in.	90 µm	No. 170
8.0 mm	5/16 in.	75 µm	No. 200
6.7 mm	0.265 in.	63 µm	No. 230
6.3 mm(1)	1/4 in.(1)	53 µm	No. 270
5.6 mm	No. 3½	45 µm	No. 325
4.75 mm	No. 4	38 µm	No. 400
4.00 mm	No. 5	32 µm	No. 450
3.35 mm	No. 6	25 µm(1)	No. 500(1)
2.80 mm	No. 7	20 µm(1)	No. 635(1)

(1) These sieves are not in the standard series but they have been included because they are in common usage.

APPENDIX B
STANDARD SPECIAL PROVISIONS TO PUBLICATION 408

General: This Appendix contains an explanation of the seven Standard Special Provision (SSP) Indices (C, D, G, I, N, P, and S) relating to Publication 408. These indices and the full text of their SSP can be found on the ECMS Website. SSPs contain instructions, standards, requirements or directions applying to a project, as set forth in the bid proposal, but not contained within Publication 408. In many applications they must be further tailored by designers and reviewers for use on specific projects.

Internet Access: Internet access to all SSPs and their contents may be obtained on the ECMS website. Once at the ECMS homepage select "Construction Projects", then "Resources", then "Special Provisions".

Revisions: Revisions will occur to the indices and their associated contents. Changes and updates to SSPs may be identified by new versions (example: A to B) or by their "From" dates. As SSP entries are revised they will be retained in their original format with an appropriate notation to indicate documents that might have replaced them or their effective "To" dates. Thus entries will not be deleted, only annotated and added. Therefore, it will always be possible to determine what SSPs were in effect at a certain point in time.

SSP Indices. Following is an explanation of the seven indices relating to the series of SSPs to Publication 408, found in ECMS:

- **C INDEX.** This index addresses ***Changes to Specifications Related*** SSPs. This index includes changes that will be included in the next change to Publication 408 and are included on all projects. They will exist until the next change to Publication 408 becomes effective and then they will become inactive.

- **D INDEX.** This index addresses ***Design Build Related*** SSPs. This index includes SSPs that are specific to Design Build Projects only.

- **G INDEX.** This index includes ***General Provision Related*** SSPs. The index associated with this series addresses issues that apply to Publication 408 General Provisions, contract terms and conditions. General Provision related issues that apply to <u>numbered</u> sections within Publication 408 are found in the S Index.

- **I INDEX.** This index includes standard and non-standard Construction ***Item Related*** SSPs. All Non-Standard "9000" Construction Items and many Standard Master Construction Items cannot be included in bid proposals without reference to SSPs found in this index.

- **N INDEX.** This index includes ***Non-pay Item Related*** SSPs relating to those issues not paid for separately.

- **P INDEX.** This index addresses ***Provisional Specification Related*** SSPs that are to be used on a case-by-case or trial basis, and require close monitoring when used in conjunction with construction projects. They may be removed at any time, but they also have the potential for being incorporated into the text of Publication 408. An appropriate Strike-Off Letter further addresses each provision within this index.

- **S INDEX.** This index includes ***Section Related*** SSPs. This particular index addresses issues and conditions that apply to Publication 408 numbered sections.

APPENDIX C
DESIGNATED SPECIAL PROVISIONS

General: This appendix to Publication 408 contains standard documents previously included in PennDOT Bid Proposals. Effective with the publication of Publication 408 they will be maintained within this Appendix in all versions and will be referenced in bid proposals. Governing Specifications, the applicable Designated Special Provisions, and other details will be specified in a single Standard Special Provision to each bid proposal. This Standard Special Provision is entitled: "GOVERNING SPECIFICATIONS AND APPLICABLE DESIGNATED SPECIAL PROVISIONS."

Standard Documents: Designated Special Provisions (DSPs) that are referenced to this Appendix in PennDOT Bid Proposals are:

DSP1. Offset Provision for State Contracts. See page C1-1.

DSP2. Contractor Responsibility Provisions. See page C2-1.

DSP3. Provisions for State Contracts Concerning the Americans with Disabilities Act. See page C3-1.

DSP4. Diverse Business (DB) Requirements For Non-Federally Funded Construction Projects. See page C4-1.

DSP7. Disadvantaged Business Enterprise (DBE) Requirements For Federally-Funded Construction Projects. See page C7-1.

DSP8. F. A. R.—Required Contract Provisions Federal-Aid Construction Contracts – FHWA-1273 (Revised May1, 2012). See attachments to the Proposal. See C8-1.

DSP9. Special Supplement—Anti-Pollution Measures – August 26, 1999. See page C9-1.

DSP10. Nondiscrimination/Sexual Harassment Clause. See page C10-1.

DSP11. Contractor Integrity Provisions. See page C11-1.

DSP12. Executive Order 11246, with Appendices A and B. See page C12-1.

DSP13. Buy America. This is used on a project when any phase of the project was completed using Federal funds. See page C13-1.

DSP14. Enhanced Minimum Wage Provisions. See page C14-1.

APPENDIX C
DESIGNATED SPECIAL PROVISION 1 (DSP1)

OFFSET PROVISION FOR STATE CONTRACTS

The Contractor agrees that the Commonwealth of Pennsylvania (Commonwealth) may set off the amount of any state tax liability or other obligation of the Contractor or its subsidiaries to the Commonwealth against any payments due the Contractor under any contract with the Commonwealth.

APPENDIX C
DESIGNATED SPECIAL PROVISION 2 (DSP2)

CONTRACTOR RESPONSIBILITY PROVISIONS

For the purpose of these provisions, the term contractor is defined as any person, including, but not limited to, a bidder, offeror, loan recipient, grantee or lessor, who has furnished or performed or seeks to furnish or perform, goods, supplies, services, leased space, construction or other activity, under a contract, grant, lease, purchase order or reimbursement agreement with the Commonwealth of Pennsylvania (Commonwealth). The term contractor includes a permittee, licensee, or any agency, political subdivision, instrumentality, public authority, or other public entity of the Commonwealth.

1. The Contractor certifies, in writing, for itself and its subcontractors required to be disclosed or approved by the Commonwealth, that as of the date of its execution of this Bid/Contract, that neither the Contractor, nor any such subcontractors, are under suspension or debarment by the Commonwealth or any governmental entity, instrumentality, or authority and, if the Contractor cannot so certify, then it agrees to submit, along with its Bid/Contract, a written explanation of why such certification cannot be made.

2. The Contractor also certifies, in writing, that as of the date of its execution of this Bid/Contract it has no tax liabilities or other Commonwealth obligations, or has filed a timely administrative or judicial appeal if such liabilities or obligations exist, or is subject to a duly approved deferred payment plan if such liabilities exist.

3. The Contractor's obligations pursuant to these provisions are ongoing from and after the effective date of the Contract through the termination date thereof. Accordingly, the Contractor shall have an obligation to inform the Commonwealth if, at any time during the term of the Contract, it becomes delinquent in the payment of taxes, or other Commonwealth obligations, or if it or, to the best knowledge of the Contractor, any of its subcontractors are suspended or debarred by the Commonwealth, the federal government, or any other state or governmental entity. Such notification shall be made within 15 days of the date of suspension or debarment.

4. The failure of the Contractor to notify the Commonwealth of its suspension or debarment by the Commonwealth, any other state, or the federal government shall constitute an event of default of the Contract with the Commonwealth.

5. The Contractor agrees to reimburse the Commonwealth for the reasonable costs of investigation incurred by the Office of State Inspector General for investigations of the Contractor's compliance with the terms of this or any other agreement between the Contractor and the Commonwealth, that results in the suspension or debarment of the Contractor. Such costs shall include, but shall not be limited to, salaries of investigators, including overtime; travel and lodging expenses; and expert witness and documentary fees. The Contractor shall not be responsible for investigative costs for investigations that do not result in the Contractor's suspension or debarment.

6. The Contractor may obtain a current list of suspended and debarred Commonwealth contractors by either searching the Internet at http://www.dgs.state.pa.us/ or contacting the:

Department of General Services
Office of Chief Counsel
603 North Office Building
Harrisburg, PA 17125
Telephone No: (717) 783-6472
FAX No: (717) 787-9138

APPENDIX C
DESIGNATED SPECIAL PROVISION 3 (DSP3)

PROVISIONS FOR STATE CONTRACTS CONCERNING THE AMERICANS WITH DISABILITIES ACT

For the purpose of these provisions, the term Contractor is defined as any person, including, but not limited to, a bidder, offeror, supplier, or grantee, who will furnish or perform or seeks to furnish or perform, goods, supplies, services, construction or other activity, under a purchase order, contract, or grant with the Commonwealth of Pennsylvania (State).

During the term of this contract, the Contractor agrees as follows:

1. Pursuant to federal regulations promulgated under the authority of the *Americans with Disabilities Act, 28 C.F.R.§, 35.101 et seq.*, the Contractor understands and agrees that no individual with a disability is, on the basis of the disability, to be excluded from participation in this contract or from activities provided for under this contract. As a condition of accepting and executing this contract, the Contractor agrees to comply with the *"General Prohibitions Against Discrimination," 28 C.F.R.§, 35.130*, and all other regulations promulgated under *Title II* of the *Americans with Disabilities Act* which are applicable to the benefits, services, programs, and activities provided by the State through contracts with outside contractors.

2. The Contractor is to be responsible for and agrees to indemnify and hold harmless the State from all losses, damages, expenses, claims, demands, suits, and actions brought by any party against the State as a result of the Contractor's failure to comply with the provisions of paragraph 1.

APPENDIX C
DESIGNATED SPECIAL PROVISION 4 (DSP4)

DIVERSE BUSINESS (DB) REQUIREMENTS
For Non-Federally Funded Construction Projects

NOTE: For use in non-federally funded construction contracts administered and issued by the Pennsylvania Department of Transportation (Department).

I. GENERAL GOOD FAITH EFFORT REQUIREMENTS—

Section 303 of Title 74 of the Pennsylvania Consolidated Statutes, 74 Pa.C.S. §303, requires bidders on contracts funded pursuant to the provisions of Title 74 (Transportation) and 75 (Vehicle Code) administered and issued by the Department to make good faith efforts to solicit subcontractors that are Diverse Businesses (DBs) as defined in Section 303. The DB requirements of Section 303 apply to this contract.

Under the statute, bidders must make good faith efforts as set forth below to ensure that DBs have the opportunity to compete for and perform contracts. Do not discriminate on the basis of race, color, national origin, or sex in the award and performance of contracts. Failure to exert good faith efforts in the solicitation of subcontractors that are DBs may result in the bidder being declared ineligible for the contract.

Document and submit to the Department all good faith efforts to solicit subcontractors that are DBs as more fully described below. Bidders are encouraged to utilize and give consideration to second-tier or lower-tier subcontractors offering to utilize DBs in the selection and award of contracts.

When declared the low bidder provide to the Department within 7 calendar days of being declared the low bidder, the name and business address of each subcontractor that is a DB and will provide the contractor with construction or professional services in connection with the performance of the contract, all as set forth below.

If it becomes necessary to replace a subcontractor that is a DB at any time during the evaluation of a bid or construction of a project the bidder or contractor, as appropriate, immediately notify the Department of the need to replace the DB. Include the reasons for the replacement in the notice.

Good faith efforts to solicit and use DBs are in addition to all other equal opportunity requirements of the contract.

Failure to comply with requirements of Section 303 or as specified may constitute a breach of contract and may result in imposition of sanctions as appropriate under Section 531 of the Procurement Code, 62 Pa.C.S. §531 (relating to debarment and suspension).

The Department requires that all prime contractors including DB prime contractors perform at least 50% of the work on a Department construction project. The Department strongly encourages DB prime contractors to make additional outreach efforts to solicit DBs to perform subcontracting work on the project.

If there is a conflict between any term or condition of this special provision and the Department's Publication 408 Specifications, the term or condition of this special provision applies, including but not limited to the definition of subcontractor and the prompt payment requirements in subsection V(f).

II. DEFINITIONS—

The following definitions apply for terms used in this specification:

(a) Disadvantaged Business. A business that is owned or controlled by a majority of persons, not limited to members of minority groups, who are subject to racial or ethnic prejudice or cultural bias.

(b) Diverse Business (DB). A disadvantaged business, minority-owned or women-owned business or service-disabled veteran-owned or veteran-owned small business that has been certified by a third-party certifying organization and is both an ECMS Business Partner and pre-qualified, if required.

(c) ECMS. The Department's Engineering and Construction Management System.

(d) ECMS Business Partner. An individual, firm, partnership, or corporation that has a valid Registered Business Partner Identification issued by the Department through ECMS.

(e) Good Faith Effort Review Officer. The Department's Executive Deputy Secretary for Administration or his/her designee, who reviews good faith efforts submitted by bidders.

(f) Minority-owned Business. A business owned and controlled by a majority of individuals who are African Americans, Hispanic Americans, Native Americans, Asian Americans, Alaskans or Pacific Islanders.

(g) Professional Services. An industry of infrequent, technical or unique functions performed by independent contractors or consultants whose occupation is the rendering of the services, including design professional services as defined in Section 901 of the Procurement Code, 62 Pa.C.S. §901 (relating to definitions); legal services; advertising or public relations services; accounting, auditing or actuarial services; security consulting services; computer and information technology services; and insurance underwriting services.

(h) Service-disabled Veteran. Being in possession of a disability rating letter issued by the United States Department of Veterans Affairs or a disability determination from the United States Department of Defense or, if approved by the Department of General Services, a surviving spouse or permanent caregiver of a such a service-disabled veteran.

(i) Service-disabled Veteran-owned Small Business. A business in the United States which is independently owned and controlled by a service-disabled veteran or veterans, not dominant in its field of operation, and employs 100 or fewer employees.

(l) Subcontractor. Any individual, partnership, firm, or corporation entering into a contract with the prime contractor for work under the contract, including those providing professional and other services.

(m) Third-party Certifying Organization. An organization that certifies a small business, minority-owned business, women-owned business or veteran-owned small business as a DB, including the National Minority Supplier Development Council; the Women's Business Enterprise Council, the Small Business Administration; the Department of Veterans Affairs; and the Pennsylvania Unified Certification Program.

(o) Veteran. An individual who served on active duty in the United States Armed Forces, including a reservist or member of the National Guard who was discharged or released from the service under honorable conditions, a reservist or member of the National Guard who completed an initial term of enlistment or qualifying period of service, and a reservist or member of the National Guard who was disabled in the line of duty during training.

(p) Veteran-owned Small Business. A business in the United States which is independently owned and controlled by a veteran or veterans, is not dominant in its field of operation, and employs 100 or fewer employees.

III. ACTIONS REQUIRED BY THE BIDDER AT THE BIDDING STAGE AND PRIOR TO AWARD—

(a) Submission Requirements. The apparent low bidder that will self-perform 100% of its contract is required to submit paper documentation by 3:00 P.M. prevailing local time within 7 calendar days after the bid opening. Submit paper documentation by email to minorityparticipation@pa.gov or by fax to (717) 705-1504. This paper documentation will become part of the contract.

The apparent low bidder that will not self-perform 100% of its contract is required to demonstrate its good faith efforts to solicit subcontractors that are DBs through the Department's ECMS website by 3:00 P.M. prevailing local time within 7 calendar days after the bid opening. Present good faith efforts by either completing the commitment and solicitation screens in ECMS or submitting paper documentation by email to minorityparticipation@pa.gov or by fax to (717) 705-1504 for all DBs that are not listed in ECMS. The good faith efforts will become part of the contract.

The paper documentation of good faith efforts must include the business name and business address of each DB that is not an ECMS Business Partner, as well as all good faith efforts to solicit other DBs that are not ECMS Business Partners. Supporting documentation must also include a DB acknowledgment for each DB providing construction or professional services, proof of certification for DBs that are not ECMS Business Partners, and any explanation of good faith efforts the bidder would like the Department to consider. Any services to be performed by a DB are required to be readily identifiable to the project.

If you have any questions on using a DB not listed on the ECMS DB Listing, contact the ECMS help desk at 855-783-8330 or at 717-783-8330.

When the seventh (7th) calendar day after the bid opening falls on a day that the Department offices are closed, submit the good faith efforts by 3:00 P.M. prevailing local time on the next business day. If assistance with the DB submission is needed, contact the ECMS Help Desk at 855-783-8330 or at 717-783-8330. ECMS Help Desk assistance is available 24 hours a day, 7 days a week.

Failure to electronically submit good faith efforts (including the commitment and solicitation screens as well as all supporting paper documentation) within 7 calendar days of the bid opening by the 3:00 P.M. deadline will result in rejection of the bid. The apparent next lowest bidder will be notified by email to electronically submit good faith efforts in the manner described above by 3:00 P.M. prevailing local time within 7 calendar days notification.

(b) Good Faith Efforts Requirements. Good faith efforts are demonstrated by seeking out DB participation in the project given all relevant circumstances. The following illustrate the types of efforts that may be taken, but they are not deemed to be exclusive or exhaustive. The Good Faith Review Officer may consider other factors and types of efforts included in a bidder's submission of good faith efforts if deemed relevant.

1. Efforts made to solicit through all reasonable and available means (e.g., use of the DB Directory, attendance at pre-bid meetings, advertising and/or written notices) the interest of all certified DBs with the capability to perform subcontracted work. The bidder should provide written notification, at least 15 calendar days before the bid opening, to allow the DBs to respond to the solicitation. The bidder must determine with certainty if the DBs are interested by taking appropriate steps to follow up initial solicitations.

2. Efforts made to select portions of the work to be performed by DBs. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate DB participation.

3. Efforts made to provide interested DBs with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation.

4. Efforts made to negotiate in good faith with interested DBs. Bidders are encouraged to make a portion of the work available to DBs and to select those portions of the work needs consistent with the available DBs so as to facilitate participation of DBs. Evidence of such negotiation includes the names, addresses, and telephone numbers of DBs that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional agreements could not be reached for DBs to perform the work. A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including DB subcontractors, and would take a firm's price and capabilities into consideration as well as its own ability or desire to perform the work with its own work force.

5. Efforts made to thoroughly investigate DBs for qualification based on their capabilities. Bidders cannot

reject or withhold solicitation of DBs as being unqualified without sound reasons based on this investigation of their capabilities. The DB's standing within its industry, membership in specific groups, organizations, or associations and political or social affiliations (for example union vs. non-union employee status) are not legitimate causes for the rejection or non-solicitation of bids in the contractor's efforts to meet the good faith efforts requirement.

6. Efforts to assist interested DBs in obtaining bonding, lines of credit, or insurance.

7. Efforts to assist interested DBs in obtaining necessary equipment, supplies, materials, or related assistance or services.

8. Efforts to effectively use existing databases and the resources of supportive services to assist in finding DBs.

IV. ACTIONS TO BE TAKEN BY THE DEPARTMENT BEFORE AWARD—

(a) Approval. If the apparent low bidder submits acceptable good faith efforts by the deadline and meets all other contract requirements, the Department will approve the submission. The Good Faith Review Officer will make the determination of whether the good faith efforts are acceptable. The contractor may be contacted for clarifications during the review.

(b) Conditional Approval. The Department will issue a conditional approval of the good faith efforts to the apparent low bidder if any DB listed is not prequalified, if required, or not an ECMS Business Partner at the time the Department desires to award the contract.

(c) Rejection of Bid. If the Good Faith Review Officer determines that the apparent low bidder has failed to make acceptable good faith efforts, the bid will be rejected and the apparent low bidder will be notified of the rejection. The Department will then notify, by email, the apparent next lowest bidder on the project to electronically submit good faith efforts through ECMS by 3:00 P.M. prevailing local time within 7 calendar days after notification. When the seventh (7th) calendar day after the notification falls on a day the Department offices are closed, submit good faith efforts by 3:00 P.M. prevailing local time on the next business day.

V. ACTIONS REQUIRED BY THE CONTRACTOR DURING CONSTRUCTION—

(a) DB Participation. Continue good faith efforts for the life of the project.

(b) Subcontractor Approval. Firms are not to commence work until they are approved.

All firms listed in the good faith efforts submission, including those providing professional and other services, must be submitted for subcontractor approval after the contract is executed and approved before the DB's actual performance of work. Submit for subcontractor approval any DB to be utilized whether or not they are listed in the good faith efforts submission approved by the Good Faith Review Officer.

For a contractor that declared that it will self-perform 100% of its project, adding a subcontractor requires a good faith effort. Attach the good faith effort documentation along with the Public Works Employment Verification Form to the ECMS subcontractor request.

When submitting a request for subcontractor approval, provide, in accordance with Section 108.01(e), a copy of the subcontract or agreement or:

- A copy of the executed signature page,
- A copy of the description of the scope of work, and

- A copy of the unit prices as they appear in the subcontract or agreement.

(c) Conditional Approval Resolution. Continually monitor conditional approval of DB subcontractors. Examples of these conditional approvals may include prequalification requirements.

(d) Replacement of DB. If it becomes necessary to replace a subcontractor that is a DB at any time during construction of the project immediately notify the Department of the need to replace the DB. Include the reasons for the replacement in the notice.

(e) Additional Work. The obligation to make good faith efforts to solicit subcontractors that are DBs extends to additional work required for any classification of work which is identified as to be performed by a DB.

(f) Progress Payments. Make payments to DB subcontractors in accordance with the prompt payment requirements of Chapter 39, Subchapter D of the Procurement Code, 62 Pa.C.S. §§3931 et seq. Performance of work by a DB subcontractor in accordance with the terms of the contract entitles the subcontractor to payment. Enter DB progress payments into ECMS monthly. The payments cannot be entered into ECMS until there is an approved subcontractor request. Bring to the attention of the Department, in writing, any situation in which regularly scheduled progress payments are not made to DB subcontractors.

(g) Records and Reports. Keep such project records as are necessary to perform the reporting function discussed below. These records can be used as documentation of good faith efforts. Design these records to indicate:

1. The number of DB and non-DB subcontractors and the type of work or services performed on the project.

2. The progress and efforts made in seeking out DB contractor organizations and individual DBs for work on the project.

3. Documentation of all correspondence, personal contacts, telephone calls, etc., to obtain the services of DBs for the project. Submit reports, as required by the Department. Certify that the amounts were actually paid to the DB for work performed on the project and keep cancelled checks on file in the home office to reflect payment for the specific project and for inspection and audit by the Department. Enter the payment information in ECMS "DB Payments" within 5 business days after the end of the month and include the following:

a. The number of contracts awarded (with approved subcontractor requests) to DBs, noting the type of work and amount of each contract executed with each firm and including the execution date of each contract.

b. The amount paid to each DB during the month and the amount paid to date. If no payments are made to a DB during the month, enter a zero ($0.00) payment.

c. Paid invoices or a certification attesting to the actual amount paid to each firm, upon completion of the individual DBs work. In the event the actual amount paid is less than the award amount, provide a complete explanation of the difference.

Maintain all such records for a period of 3 years following acceptance of final payment. Make these records available for inspection by the Department.

VI. ACTIONS REQUIRED BY THE CONTRACTOR FOLLOWING COMPLETION OF CONSTRUCTION—

When requested, or within 30 days of the end of the contract submit a report to the Department summarizing the use of approved subcontractors not on the ECMS DB Listing.

Identify in the report the name of the subcontractor; the nature of the work performed by the subcontractor (i.e. prime contractor, direct or tiered subcontractor; who certified the subcontractor as a DB; the subcontractor's ECMS Business Partner number; the subcontractor's ECMS contract number; and the amount of their subcontract.

For direct and tiered subcontractors, provide the amount of the contract that is performed, managed and supervised by the DB's own forces. Include the cost of supplies and materials obtained by the DB for the work of the subcontract, including supplies purchased or equipment leased by the DB. The amount a DB subcontracts or leases to another non-DB firm must be excluded. The value of the subcontracted work may be counted only if the DB's subcontractor is itself a DB; work that a DB subcontracts to a non-DB firm does not count.

VII. ACTIONS TO BE TAKEN BY THE DEPARTMENT FOLLOWING CONSTRUCTION—

Upon completion of the work the Department will review the actual DB participation and make a determination regarding the contractor's compliance with Section 303 and this special provision. Sanctions may be imposed for noncompliance.

APPENDIX C
DESIGNATED SPECIAL PROVISION 7 (DSP7)

DISADVANTAGED BUSINESS ENTERPRISE (DBE) REQUIREMENTS
For Federally-Funded Construction Projects

NOTE: Requires special provision for participation DBE goal percentage.

I. DBE GOAL—

The Department has established, in connection with this contract, a DBE goal as specified in the proposal of the original contract amount for the utilization of firms owned and controlled by socially and economically disadvantaged individuals certified as DBEs. If the DBE goal is zero, make an effort to identify and use DBEs. This DBE goal remains in effect for the life of the project.

Include the following provisions (paragraphs a through d) in every subcontract, so that such provisions will be binding not only upon the prime contractor but also upon each subcontractor, supplier, service provider or consultant.

(a) **Policy for Federally-Funded Projects.** It is the policy of the U.S. Department of Transportation (DOT) and the Department that DBEs, as defined in 49 CFR Part 26, as amended, (Part 26) and this specification, be given the opportunity to participate in the performance of contracts financed in whole or in part with Federal funds under this contract. Consequently, the DBE requirements of Part 26, as amended, apply to this contract.

(b) **DBE Obligation.** Take all necessary and reasonable steps to ensure that all DBEs have the opportunity to compete for and perform contracts. Do not discriminate on the basis of race, color, national origin, or sex in the award and performance of PennDOT and DOT-assisted contracts.

(c) **Failure to Comply with DBE Requirements.** Failure to carry out the requirements as specified constitutes a breach of contract and may result in termination of the contract, being barred from bidding on Department contracts for up to three (3) years, withholding progress payments, assessing sanctions, assessing liquidated damages, or any other remedy that the Department deems appropriate. Failure to comply with DBE requirements may include, but is not limited to, failure to submit DBE Minority Participation and Commitment within the time period specified, failure to exert a reasonable Good Faith Effort to meet the established DBE goal, or failure to realize the approved DBE participation level set forth may result in the bidder being declared ineligible for the contract.

(d) **Small Business Enterprise (SBE) Participation.** Recruitment and utilization of certified SBEs is in addition to all other equal opportunity requirements of the contract. There is no SBE goal.

II. DEFINITIONS—

The following definitions apply for terms used in this specification:

(a) **Disadvantaged Business Enterprise (DBE).** A for-profit small business concern:

1. An entity certified by the Pennsylvania Unified Certification Program (PAUCP) as listed on www.paucp.com.
2. That meets the ownership and control requirements of the DBE certification program.
3. That meets the Personal Net Worth requirements of the DBE certification program.

(b) **Small Business Enterprise (SBE)**. A for-profit small business concern:

1. An entity certified by the PennDOT as listed on www.dotsbe.pa.gov.
2. That meets the ownership and control requirements of the Small Business Element (SBE) certification

program.

3. That meets the Personal Net Worth requirements of the SBE certification program.

(c) Commercially Useful Function. A DBE performs a Commercially Useful Function (CUF) when it is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. To perform a CUF, the DBE must also be responsible, with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material, installing (where applicable), and paying for the material itself.

(d) Interdisciplinary Review Team (IRT). A team of three representing both the Bureau of Equal Opportunity and the Bureau of Project Delivery (Contract Management Section) that performs the initial review of the Good Faith Effort documentation and makes the recommendation to the Director.

(e) Committee. The Good Faith Effort Review Committee.

(f) Days. Calendar days. In computing any period of time described in this specification, the day from which the period begins to run is not counted, and when the last day of the period is a Saturday, Sunday, or state holiday, the period extends to the next day that is not a Saturday, Sunday, or state holiday. Similarly, in circumstances where the PennDOT offices are closed for all or part of the last day, the period extends to the next day on which the PennDOT offices are open.

(g) Director. Director, Bureau of Equal Opportunity.

(h) DBE Participation. Minority Participation and Commitment that is accessed by the Department's ECMS website (www.dot14.state.pa.us/ECMS).

(i) Revised DBE Participation. Minority Participation and Commitment that is accessed by the Department's ECMS website which includes new DBE firm(s) as well as those not affected by the revision.

(j) Supplier. A manufacturer, regular dealer, or transaction expeditor/broker.

1. **Manufacturer.** A DBE/SBE that operates or maintains a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the contract and of the general character described by the specifications.
2. **Regular Dealer.** A DBE/SBE that owns, operates, or maintains a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described by the specifications and required under the contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business. To be a regular dealer, the firm must be an established, regular business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question. A person may be a regular dealer in such bulk items as petroleum products, steel, cement, gravel, stone, or asphalt without owning, operating, or maintaining a place of business as provided above if the person both owns and operates distribution equipment for the products. Any supplementing of regular dealers' own distribution equipment shall be by a long-term lease agreement and not on an ad hoc or contract-by-contract basis. Whether a DBE/SBE firm meets the criteria for being treated as a regular dealer is a contract-by-contract determination to be made by the Department.
3. **Transaction Expeditor/Broker.** A DBE/SBE packager, broker, manufacturers' representatives, or other persons who arrange or expedite transactions and who arrange for material drop-shipments.

(k) Service Provider. A DBE/SBE that performs work that does not have a prequalification requirement on a project.

(l) Shortfall. The difference between the dollar amount on the approved DBE commitment in ECMS and the amount of payments to the approved DBE entities as listed in ECMS.

III. COUNTING PARTICIPATION—

COUNTING DBE PARTICIPATION TOWARD THE DBE GOAL

Utilization of certified DBEs is in addition to all other equal opportunity requirements of the contract.

Count DBE participation toward meeting the DBE goal for federal projects as follows: If a firm is a certified DBE contractor or subcontractor at the time that submission of DBE Minority Participation and Commitment documents are due, the total dollar value of the contract awarded to the certified DBE is counted toward the applicable DBE goal as provided below. Any services to be performed by a DBE are required to be readily identifiable to the project.

(a) Construction.

1. **Prime Contractor.** The Department requires that all prime contractors including DBE prime contractors perform at least 50% of the work on a Department project. A DBE prime contractor will receive credit for all work performed with its own forces. The Department strongly encourages DBE prime contractors to make additional outreach efforts to solicit DBEs to perform subcontracting work on the project.

2. **Subcontractor.** When a DBE participates in a contract directly as a subcontractor or as a second-tier or lower-tier subcontractor, count only the value of the work actually performed by the DBE.

   Count the entire amount of that portion of a construction contract that is performed by the DBE's own forces. Include the cost of supplies and materials obtained by the DBE for the work of the subcontract, including supplies purchased or equipment leased by the DBE.

   When a DBE subcontracts part of the work of its contract to another firm, the value of the subcontracted work may be counted only if the DBE's subcontractor is itself a DBE. Work that a DBE subcontracts to a non-DBE firm does not count.

   Count expenditures to a DBE contractor only if the DBE is performing a CUF on that contract.

   Count expenditures to a DBE only if the DBE is certified at the time the Subcontractor Request has been approved.

(b) Materials and Supplies.

1. **DBE Manufacturer.** If the materials or supplies are obtained from a DBE manufacturer, count 100% of the cost of the materials or supplies.

2. **DBE Regular Dealer.** If the materials or supplies are purchased from a DBE regular dealer, count 60% of the cost of the materials or supplies. There is no North American Industry Classification System (NAICS) code for regular dealer.

3. **DBE Transaction Expeditor/Broker.** If the materials or supplies are purchased from a DBE which is neither a manufacturer nor a regular dealer, count the entire amount of fees or commissions charged for assistance in the procurement of the materials and supplies, or fees or transportation charges for the delivery of materials or supplies required on a job site, provided the fees are determined to be reasonable and not excessive as compared with fees customarily allowed for similar services. Do not count any portion of the cost of the materials and supplies themselves.

(c) Service Providers. Count the entire amount of fees or commissions charged by a DBE firm for providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance the contract, provided the fee is reasonable and not excessive as compared with fees customarily allowed for similar services.

(d) Trucking Firms. Count 100% of trucking costs using the following factors to determine what can be counted:

1. Count if the DBE is responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting DBE goals.

2. Count if the DBE owns and operates at least one fully licensed, insured, and operational truck used on the contract.

3. Count the total value of the transportation services the DBE provides on the contract using trucks it owns, insures, and operates using drivers it employs.

4. The DBE may lease trucks from another DBE firm, including an owner-operator who is a certified DBE. If the DBE leases trucks from another DBE, count the total value of the transportation services the lessee DBE provides on the contract.

5. The DBE may also lease trucks from a non-DBE firm, including an owner-operator. If the DBE leases trucks from a non-DBE firm and the DBE operates these leased trucks (with its own forces), count the total value of the transportation services the lessee non-DBE provides on the contract. If the DBE leases trucks from a non-DBE owner-operator, count only the fee or commission it paid as a result of the lease arrangement. Do not count the total value of the transportation services provided by the lessee (non-DBE owner-operator), since these services are not provided by a DBE.

6. For purposes of this provision, a lease must indicate that the DBE has exclusive use of and control over the truck. This does not preclude the leased truck from being used for work for others during the term of the lease with the consent of the DBE, so long as the lease gives the DBE absolute priority for use of the leased truck. Leased trucks must display the name and identification number of the DBE.

(e) Specialty Items. In cases where specialty items and DBE involvement overlap, follow the requirements specified in Section 108.01(c).

COUNTING SBE PARTICIPATION

(a) Recruitment and utilization of certified SBEs is in addition to all other equal opportunity requirements of the contract**.**

(b) There is no SBE goal.

(c) Count SBE participation the same as DBE participation.

IV. ACTIONS REQUIRED BY THE DBE AT THE BIDDING STAGE AND PRIOR TO AWARD FOR PROJECTS WITH A DBE GOAL—

Include the applicable North American Industry Classification System (NAICS) code(s) for each type of work that the DBE firms quotes and intends to perform on the contract.

V. ACTIONS REQUIRED BY BIDDERS AT THE BIDDING STAGE AND PRIOR TO AWARD FOR PROJECTS WITH A DBE GOAL—

(a) Submission Preparation. All bidders are obligated to obtain and to provide all applicable NAICS codes for each proposed DBE and type of work that it will perform on the contract.

(b) Submission Requirements. When the DBE goal established by the Department is met or exceeded, the

bidders are required to electronically submit evidence of such commitments, by accessing the Department's ECMS website to complete and submit the DBE Minority Participation and Commitment including DBE acknowledgement by 3:00 P.M. prevailing local time within five (5) calendar days after the bid opening. The DBE Minority Participation and Commitment Detail Screen must include the applicable NAICS code(s) for each proposed DBE and type of work that it will perform on the contract. If the DBE Minority Participation and Commitment Detail Screen is not sufficient to provide all DBE NAICS information, email the remaining DBE NAICS information to minorityparticipation@pa.gov or fax the remaining DBE NAICS information to (717) 705-1504 so that it is received by the time specified below for consideration. DBE Minority Participation and Commitment Screen completed in ECMS regarding commitments to certified DBEs will become part of the contract. When the fifth (5th) calendar day after the bid opening falls on a day that the PennDOT offices are closed, submit the DBE Minority Participation and Commitment by 3:00 P.M. prevailing local time on the next business day. If assistance with the DBE submission is needed, contact the ECMS Help Desk at 855-783-8330 or at 717-783-8330. ECMS Help Desk assistance is available 24 hours a day, 7 days a week.

When the DBE goal established by the Department is not met (the Department will not round up), demonstrate a Good Faith Effort (GFE) to meet the contract DBE goal. Demonstrate that the efforts made were those that a bidder seeking to meet the DBE goal established by the Department would make, given all relevant circumstances. Email the GFE documentation to minorityparticipation@pa.gov or upload or fax to (717) 705-1504 so that it is received by the time specified above for consideration. All submissions must include, as a part of the GFE documentation, copies of each DBE and non-DBE subcontractor quote when a non-DBE subcontractor was selected over a DBE subcontractor for work on the contract due to the apparent low bidders' determination that the DBE's quote was too high or unreasonable. Also, indicate on the DBE Minority Participation and Commitment screen that the Good Faith Effort is being submitted for consideration.

Failure to electronically submit the DBE Minority Participation and Commitment Screen including DBE acknowledgement completed in ECMS or upload or email or fax any applicable GFE documentation for consideration within five (5) calendar days of the bid opening by the 3:00 P.M. deadline will result in the rejection of the bid.

(c) Good Faith Effort Requirements. The demonstration of GFEs is accomplished by seeking out DBE participation in the project given all relevant circumstances. The following illustrate the types of efforts that may be taken, but they are not deemed to be exclusive or exhaustive (for more guidance on GFE requirements, refer to 49 CFR Part 26 Appendix C). The Director and/or Committee will consider other factors and types of efforts that may be relevant:

- Efforts made to conduct market research to identify small business contractors and suppliers and solicit through all reasonable and available means (e.g., use of the DBE Directory, attendance at pre-bid meetings, advertising and/or written notices) the interest of all certified DBEs who have the capability to perform the work of the contract. The bidder should provide written notification, at least 15 calendar days before the bid opening, to allow the DBEs to respond to the solicitation. The bidder must determine with certainty if the DBEs are interested by taking appropriate steps to follow up initial solicitations.

- Efforts made to select portions of the work to be performed by DBEs in order to increase the likelihood that the DBE goal will be achieved. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate DBE participation, even when the prime contractor might otherwise prefer to perform these work items with its own forces.

- Efforts made to provide interested DBEs with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation.

- Efforts made to negotiate in good faith with interested DBEs. It is the bidder's responsibility to make a portion of the work available to DBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available DBE subcontractors and suppliers, so as to facilitate DBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers

of DBEs that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional agreements could not be reached for DBEs to perform the work. A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including DBE subcontractors, and would take a firm's price and capabilities as well as contract DBE goals into consideration. However, the fact that there may be some additional costs involved in finding and using DBEs is not in itself sufficient reason for a bidder's failure to meet the contract DBE goal, as long as such costs are reasonable. Also, the ability or desire of a bidder to perform the work of a contract with its own work force does not relieve the bidder of the responsibility to make a GFE. Bidders are not, however, required to accept quotes from DBEs if the price difference is too high or unreasonable.

- Bidder's determination of a DBE as being unqualified without sound reasons based on a thorough investigation of their capabilities. The contractor's standing within its industry, membership in specific groups, organizations, or associations and political or social affiliations (for example union vs. non-union employee status) are not legitimate causes for the rejection or non-solicitation of bids in the contractor's efforts to meet the contract DBE goal. Another practice considered an inadequate GFE is the rejection of a DBE because its quotation for the work was not the lowest received. However, nothing in this paragraph shall be construed to require the bidder or prime contractor to accept unreasonable quotes in order to satisfy the contract DBE goal.

- Efforts to assist interested DBEs in obtaining bonding, lines of credit, or insurance.

- Efforts to assist interested DBEs in obtaining necessary equipment, supplies, materials, or related assistance or services.

- Efforts to effectively use the services of the Department's DBE Supportive Services Center; services of the Department's SBE Supportive Services Center; services of available minority/women community organizations; minority/women contractors' groups; local, State, and Federal minority/women business assistance offices; and other organizations as allowed on a case-by-case basis to provide assistance in the recruitment and placement of DBEs.

VI. ACTIONS TO BE TAKEN BY THE DEPARTMENT BEFORE AWARD—

(a) **Approval.** If the apparent low bidder submits the DBE Minority Participation and Commitment by the deadline and meets the contract DBE goal and all other contract requirements, the Department will approve the submission.

(b) **Conditional Approval.** The Department will issue a conditional approval of the DBE Minority Participation and Commitment to the apparent low bidder if (1) any DBE listed on the DBE Minority Participation and Commitment is not prequalified, if required, at the time the Department desires to award the contract or (2) the distinction between regular dealer and transaction expeditor/broker is unclear.

(c) **Good Faith Effort Review.** If the apparent low bidder submits the DBE submission by the deadline but fails to meet the contract DBE goal and requests a GFE review, the Department will review the GFE documentation. If, during the review of the Contractor's GFE information, the reviewers have questions, the Contractor may be contacted for clarification. The GFE steps are as follows:

1. IRT reviews and makes a recommendation to the Director.

2. The Director either
- **a.** Approves recommendation that the GFE was met and the DBE Minority Participation and Commitment will be approved, or
- **b.** Recommends that the Committee make a determination.

3. If forwarded to them, the Committee meets and makes the final determination. If the Committee

determines that the apparent low bidder met the GFE, the DBE Minority Participation and Commitment will be approved. If the Committee determines that the apparent low bidder has failed to make a GFE, the bid will be rejected and the apparent low bidder will be notified of the rejection.

VII. ACTION TO BE TAKEN BY THE DEPARTMENT DURING CONSTRUCTION—

To ensure that all obligations awarded to DBEs under this contract are met, the Department will review the Contractor's DBE involvement efforts during the performance of the project whether or not the DBE is listed on the approved DBE Minority Participation and Commitment. The review will include a CUF review and analysis.

Sanctions. Upon completion of the work the Department will review the actual DBE participation and make a determination regarding the Contractor's compliance with the applicable requirements. Sanctions may be imposed for noncompliance or unwarranted shortfalls in the approved DBE goal.

VIII. ACTIONS REQUIRED BY THE CONTRACTOR DURING CONSTRUCTION—

(a) DBE Participation. Must continue to make GFEs for the life of the project. When DBE Minority Participation and Commitment is approved with a DBE participation less than the contract DBE goal, continue GFE toward meeting the contract DBE goal. Ensure that the Commitment is attained. Proof of attainment is provided by payments to DBEs and documented in ECMS.

(b) DBE Subcontractor Approval. Firms listed on DBE Minority Participation and Commitment are not to commence work until they are approved.

All firms listed on the approved DBE Minority Participation and Commitment, including those business types other than subcontractor (i.e. dealers, truckers, service providers), must be submitted for subcontractor approval after the contract is executed and approved before DBEs actual performance of work. The subcontractor request must be equal to or greater than the committed amount. Submit for subcontractor approval any other DBE whether or not they are listed on the approved DBE Minority Participation and Commitment. When submitting request for subcontractor approval, attach a copy of the DBE subcontract or agreement or:

- A copy of the executed signature page,
- A copy of the description of the scope of work, and
- A copy of the unit prices as they appear in the DBE's subcontract or agreement.

(c) Conditional Approval Resolution. Continually monitor conditional approval of DBE subcontractors. Examples of these conditional approvals may include prequalification requirements and distinction between dealer and broker.

(d) Substitution. Obtain written approval from the Department before substituting an approved DBE subcontractor or making any change to the DBE participation listed on the approved DBE Minority Participation and Commitment. Immediately request substitution authorization from the District in writing. The request must include documentation supporting the substitution and written agreement from the DBE to the change. Include proof that a certified letter giving the DBE five (5) days to respond with acceptance or to notify the Department of non-acceptance. Demonstrate that every effort has been made to allow the DBE to perform. The District will contact the Bureau of Project Delivery, Contract Awards.

A prime contractor may not self-perform any work committed to a DBE without prior written approval from the Department. Any work committed to a DBE that is instead self-performed by a prime contractor without obtaining prior written approval from the Department will result in non-payment for the specified work. The

Department may also seek additional remedies as stated in Part I(c) - Failure to Comply with DBE Requirements.

1. If the DBE agrees to be removed by the Contractor and the Department approves, document the following procedures:

- Make a GFE in accordance with V.(b) to subcontract the work with another DBE, or subcontract other work items to DBE firms, to make up the DBE shortfall. A prime contractor's inability to find a replacement DBE at the contract price is not, in and of itself, adequate to support a finding that GFEs have been made to replace the original DBE. The fact that the prime contractor has the ability and/or desire to perform the contract work with its own forces does not relieve the prime contractor of the obligation to make GFEs to find a replacement DBE, and it is not a sound basis for rejecting a prospective replacement DBE's reasonable quote.

- When the substitution results in meeting the DBE goal, complete a revised DBE Minority Participation and Commitment with DBE acknowledgement and/or a revised subcontractor approval request within five (5) days of a revision being opened in ECMS. If the DBE performed on the project, the Revised DBE Minority Participation and Commitment and/or subcontractor approval request should include the total amount paid to the DBE before the DBE substitution.

- When the substitution does not result in meeting the DBE goal, complete a revised DBE Minority Participation and Commitment with DBE acknowledgement and/or a revised subcontractor approval request within five (5) days of a revision being opened in ECMS and provide additional GFE documentation, including (1) a statement of efforts made to negotiate with DBEs for specific work or supplies, including the names, addresses, telephone numbers, and emails of those DBEs that were contacted; (2) the time and date each DBE was contacted; (3) a description of the information provided to DBEs regarding plans and specifications for portions of the work to be performed or the materials supplied; and (4) an explanation of why an agreement between the prime contractor and DBE was not reached. If the DBE performed on the project, the Revised DBE Minority Participation and Commitment and/or subcontractor approval request should include the total amount paid to the DBE before the DBE substitution.

  Good Faith Effort Review. The Department will review the GFE documentation for substitution. If, during the review of the Contractor's GFE information, the reviewers have questions, the Contractor may be contacted for clarification. The GFE steps are as follows:

  a. Contract Awards reviews and, if acceptable, approves the GFE and DBE revision or recommends that the IRT made the determination.

  b. The IRT either
  - Approves recommendation that the GFE was met and the Minority Participations substitution will be approved, or
  - Disapproves the GFE resulting in a shortfall requiring the contractor to continue GFEs.

  c. If forwarded to them, the IRT makes a final determination.

Do not perform any of the DBE work included in the substitution request without prior approval from the Department.

If the projected DBE participation on an approved DBE Minority Participation and Commitment meets or exceeds the DBE goal amount for the contract without replacing the DBE, then no contract shortfall exists. A Revised DBE Minority Participation and Commitment and/or subcontractor approval request must be submitted to reflect the decreased dollar amount.

2. If the arrangement to be replaced is not agreeable between the Contractor and the DBE, the following procedures are required:

- Until a determination is made, do not perform the DBE work without prior approval.
- The IRT will review and make a determination and the District will notify both the Contractor and the DBE.
- The Contractor or the DBE may request a meeting with the Department by contacting the District Office.

(e) SBE Participation. SBE Firms are not to commence work until they are approved. The SBE, including those business types other than subcontractor (i.e. supplier, trucking, service provider), must be submitted for subcontractor approval after the contract is executed and approved before the SBEs actual performance of work.

(f) Additional Work. When additional work is required for any classification of work which is identified on the DBE Minority Participation and Commitment to be performed by the DBE, at least 50% of this additional work will be performed by the same DBE unless the DBE submits, in writing, that it cannot perform the work due to its own limitations.

(g) Progress Payments. Make payments in accordance with Section 110.05. Enter DBE and SBE progress payments into ECMS monthly. Bring to the attention of the Department, in writing, any situation in which regularly scheduled progress payments are not made to DBE/SBE subcontractors, suppliers, service provider or consultant.

(h) Records and Reports. Keep such project records as are necessary to determine compliance with DBE Requirements. These records can be used as GFE documentation. Design these records to indicate:

- The number of disadvantaged and non-disadvantaged subcontractors, small businesses, regular dealers, manufacturers, consultants, and service providers, and the type of work or services performed on or materials incorporated in this project.
- The progress and efforts made in seeking out DBE and SBE contractor organizations and individual DBEs and SBEs for work on this project.
- Documentation of all correspondence, personal contacts, telephone calls, etc., to obtain the services of DBEs and SBEs for this project. Submit reports, as required by the Department. Certify that the amounts were actually paid to the DBE and SBE for work performed on the project and keep cancelled checks on file in the home office to reflect payment for the specific project and for inspection and audit by the Department. Enter the payment information in ECMS "DBE Payments" within 5 business days after the end of the month and include the following:
- The number of contracts awarded to DBEs and SBEs, noting the type of work and amount of each contract executed with each firm and including the execution date of each contract.
- The amount paid to each DBE and SBE during the month and the amount paid to date. If no payments are made to a DBE/SBE during the month, enter a zero ($0.00) payment.
- Paid invoices or a certification attesting to the actual amount paid to each firm, upon completion of the individual DBE's and SBEs work. In the event the actual amount paid is less than the award amount, provide a complete explanation of the difference.

Maintain all such records for a period of three (3) years following acceptance of final payment. Make these records available for inspection by the Department and FHWA.

If DBE credit is being claimed for material costs included in a DBE subcontract or agreement, submit purchase orders for the material to the Inspector-in-Charge on a monthly basis.

FHWA-1273 -- Revised May 1, 2012

APPENDIX C
DESIGNATED SPECIAL PROVISION 8 (DSP8)

REQUIRED CONTRACT PROVISIONS
FEDERAL-AID CONSTRUCTION CONTRACTS

I. General
II. Nondiscrimination
III. Nonsegregated Facilities
IV. Davis-Bacon and Related Act Provisions
V. Contract Work Hours and Safety Standards Act Provisions
VI. Subletting or Assigning the Contract
VII. Safety: Accident Prevention
VIII. False Statements Concerning Highway Projects
IX. Implementation of Clean Air Act and Federal Water Pollution Control Act
X. Compliance with Governmentwide Suspension and Debarment Requirements
XI. Certification Regarding Use of Contract Funds for Lobbying

ATTACHMENTS

A. Employment and Materials Preference for Appalachian Development Highway System or Appalachian Local Access Road Contracts (included in Appalachian contracts only)

I. GENERAL

1. Form FHWA-1273 must be physically incorporated in each construction contract funded under Title 23 (excluding emergency contracts solely intended for debris removal). The contractor (or subcontractor) must insert this form in each subcontract and further require its inclusion in all lower tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services).

The applicable requirements of Form FHWA-1273 are incorporated by reference for work done under any purchase order, rental agreement or agreement for other services. The prime contractor shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Form FHWA-1273 must be included in all Federal-aid design-build contracts, in all subcontracts and in lower tier subcontracts (excluding subcontracts for design services, purchase orders, rental agreements and other agreements for supplies or services). The design-builder shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Contracting agencies may reference Form FHWA-1273 in bid proposal or request for proposal documents, however, the Form FHWA-1273 must be physically incorporated (not referenced) in all contracts, subcontracts and lower-tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services related to a construction contract).

2. Subject to the applicability criteria noted in the following sections, these contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.

3. A breach of any of the stipulations contained in these Required Contract Provisions may be sufficient grounds for withholding of progress payments, withholding of final payment, termination of the contract, suspension / debarment or any other action determined to be appropriate by the contracting agency and FHWA.

4. Selection of Labor: During the performance of this contract, the contractor shall not use convict labor for any purpose within the limits of a construction project on a Federal-aid highway unless it is labor performed by convicts who are on parole, supervised release, or probation. The term Federal-aid highway does not include roadways functionally classified as local roads or rural minor collectors.

II. NONDISCRIMINATION

The provisions of this section related to 23 CFR Part 230 are applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more. The provisions of 23 CFR Part 230 are not applicable to material supply, engineering, or architectural service contracts.

In addition, the contractor and all subcontractors must comply with the following policies: Executive Order 11246, 41 CFR 60, 29 CFR 1625-1627, Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The contractor and all subcontractors must comply with: the requirements of the Equal Opportunity Clause in 41 CFR 60-1.4(b) and, for all construction contracts exceeding $10,000, the Standard Federal Equal Employment Opportunity Construction Contract Specifications in 41 CFR 60-4.3.

Note: The U.S. Department of Labor has exclusive authority to determine compliance with Executive Order 11246 and the policies of the Secretary of Labor including 41 CFR 60, and 29 CFR 1625-1627. The contracting agency and the FHWA have the authority and the responsibility to ensure compliance with Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), and Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The following provision is adopted from 23 CFR 230, Appendix A, with appropriate revisions to conform to the U.S. Department of Labor (US DOL) and FHWA requirements.

1. Equal Employment Opportunity: Equal employment opportunity (EEO) requirements not to discriminate and to take affirmative action to assure equal opportunity as set forth under laws, executive orders, rules, regulations (28 CFR 35, 29 CFR 1630, 29 CFR 1625-1627, 41 CFR 60 and 49 CFR 27) and orders of the Secretary of Labor as modified by the provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140 shall constitute the EEO and specific affirmative action standards for the contractor's project activities under this contract. The provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. In the execution of this contract, the contractor agrees to comply with the following minimum specific requirement activities of EEO:

a. The contractor will work with the contracting agency and the Federal Government to ensure that it has made every good faith effort to provide equal opportunity with respect to all of its terms and conditions of employment and in their review of activities under the contract.

b. The contractor will accept as its operating policy the following statement:

"It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, national origin, age or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, pre-apprenticeship, and/or on-the-job training."

2. EEO Officer: The contractor will designate and make known to the contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active EEO program and who must be assigned adequate authority and responsibility to do so.

3. Dissemination of Policy: All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

a. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer.

b. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the contractor's EEO obligations within thirty days following their reporting for duty with the contractor.

c. All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the contractor's procedures for locating and hiring minorities and women.

d. Notices and posters setting forth the contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

e. The contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

4. Recruitment: When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minorities and women in the area from which the project work force would normally be derived.

a. The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minorities and women. To meet this requirement, the contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority and women applicants may be referred to the contractor for employment consideration.

b. In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, the contractor is expected to observe the provisions of that agreement to the extent that the system meets the contractor's compliance with EEO contract provisions. Where implementation of such an agreement has the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Federal nondiscrimination provisions.

c. The contractor will encourage its present employees to refer minorities and women as applicants for employment. Information and procedures with regard to referring such applicants will be discussed with employees.

5. Personnel Actions: Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, national origin, age or disability. The following procedures shall be followed:

a. The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

b. The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

c. The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

d. The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with its obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of their avenues of appeal.

6. Training and Promotion:

a. The contractor will assist in locating, qualifying, and increasing the skills of minorities and women who are applicants for employment or current employees. Such efforts should be aimed at developing full journey level status employees in the type of trade or job classification involved.

b. Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision. The contracting agency may reserve training positions for persons who receive welfare assistance in accordance with 23 U.S.C. 140(a).

c. The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

d. The contractor will periodically review the training and promotion potential of employees who are minorities and women and will encourage eligible employees to apply for such training and promotion.

7. Unions: If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use good faith efforts to obtain the cooperation of such unions to increase opportunities for minorities and women. Actions by the contractor, either directly or through a contractor's association acting as agent, will include the procedures set forth below:

a. The contractor will use good faith efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minorities and women for membership in the unions and increasing the skills of minorities and women so that they may qualify for higher paying employment.

b. The contractor will use good faith efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, national origin, age or disability.

c. The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the contracting agency and shall set forth what efforts have been made to obtain such information.

d. In the event the union is unable to provide the contractor with a reasonable flow of referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, national origin, age or disability; making full efforts to obtain qualified and/or qualifiable minorities and women. The failure of a union to provide sufficient referrals (even though it is obligated to provide exclusive referrals under the terms of a collective bargaining agreement) does not relieve the contractor from the requirements of this paragraph. In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the contracting agency.

8. Reasonable Accommodation for Applicants / Employees with Disabilities: The contractor must be familiar with the requirements for and comply with the Americans with Disabilities Act and all rules and regulations established there under. Employers must provide reasonable accommodation in all employment activities unless to do so would cause an undue hardship.

9. Selection of Subcontractors, Procurement of Materials and Leasing of Equipment: The contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The contractor shall take all necessary and reasonable steps to ensure nondiscrimination in the administration of this contract.

a. The contractor shall notify all potential subcontractors and suppliers and lessors of their EEO obligations under this contract.

b. The contractor will use good faith efforts to ensure subcontractor compliance with their EEO obligations.

10. Assurance Required by 49 CFR 26.13(b):

a. The requirements of 49 CFR Part 26 and the State DOT's U.S. DOT-approved DBE program are incorporated by reference.

b. The contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the contracting agency deems appropriate.

11. Records and Reports: The contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of three years following the date of the final payment to the contractor for all contract work and shall be available at reasonable times and places for inspection by authorized representatives of the contracting agency and the FHWA.

a. The records kept by the contractor shall document the following:

(1) The number and work hours of minority and non-minority group members and women employed in each work classification on the project;

(2) The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women; and

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minorities and women;

b. The contractors and subcontractors will submit an annual report to the contracting agency each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form FHWA-1391. The staffing data should represent the project work force on board in all or any part of the last payroll period preceding the end of July. If on-the-job training is being required by special provision, the contractor will be required to collect and report training data. The employment data should reflect the work force on board during all or any part of the last payroll period preceding the end of July.

III. NONSEGREGATED FACILITIES

This provision is applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more.

The contractor must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, or national origin cannot result. The contractor may neither require such segregated use by written or oral policies nor tolerate such use by employee custom. The contractor's obligation extends further to ensure that its employees are not assigned to perform their services at any location, under the contractor's control, where the facilities are segregated. The term "facilities" includes waiting rooms, work areas, restaurants and other eating areas, time clocks, restrooms, washrooms, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing provided for employees. The contractor shall provide separate or single-user restrooms and necessary dressing or sleeping areas to assure privacy between sexes.

IV. DAVIS-BACON AND RELATED ACT PROVISIONS

This section is applicable to all Federal-aid construction projects exceeding $2,000 and to all related subcontracts and lower-tier subcontracts (regardless of subcontract size). The requirements apply to all projects located within the right-of-way of a roadway that is functionally classified as Federal-aid highway. This excludes roadways functionally classified as local roads or rural minor collectors, which are exempt. Contracting agencies may elect to apply these requirements to other projects.

The following provisions are from the U.S. Department of Labor regulations in 29 CFR 5.5 “Contract provisions and related matters” with minor revisions to conform to the FHWA-1273 format and FHWA program requirements.

1. Minimum wages

a. All laborers and mechanics employed or working upon the site of the work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph 1.d. of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph 1.b. of this section) and the Davis-Bacon poster (WH–1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

b. (1) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(i) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(ii) The classification is utilized in the area by the construction industry; and

(iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(2) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(3) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Wage and Hour Administrator for determination. The Wage and Hour Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(4) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs 1.b.(2) or 1.b.(3) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

c. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

d. If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

2. Withholding

The contracting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract, or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the contracting agency may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and basic records

a. Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably

anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

b. (1) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the contracting agency. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/esa/whd/forms/wh347instr.htm or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the contracting agency for transmission to the State DOT, the FHWA or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the contracting agency.

(2) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(i) That the payroll for the payroll period contains the information required to be provided under §5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(ii) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(iii) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(3) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH–347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 3.b.(2) of this section.

(4) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

c. The contractor or subcontractor shall make the records required under paragraph 3.a. of this section available for inspection, copying, or transcription by authorized representatives of the contracting agency, the State DOT, the FHWA, or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the FHWA may, after written notice to the contractor, the contracting agency or the State DOT, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

4. Apprentices and trainees

a. Apprentices (programs of the USDOL).

Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice.

The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.

Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.

In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

b. Trainees (programs of the USDOL).

Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration.

The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration.

Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee

performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.

In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

c. Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

d. Apprentices and Trainees (programs of the U.S. DOT).

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.

5. Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

6. Subcontracts. The contractor or subcontractor shall insert Form FHWA-1273 in any subcontracts and also require the subcontractors to include Form FHWA-1273 in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

7. Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of eligibility.

a. By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

b. No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
c. The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

V. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

The following clauses apply to any Federal-aid construction contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by 29 CFR 5.5(a) or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

1. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

2. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (1.) of this section, the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1.) of this section, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1.) of this section.

3. Withholding for unpaid wages and liquidated damages. The FHWA or the contacting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2.) of this section.

4. Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (1.) through (4.) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1.) through (4.) of this section.

VI. SUBLETTING OR ASSIGNING THE CONTRACT

This provision is applicable to all Federal-aid construction contracts on the National Highway System.

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the contracting agency. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR 635.116).

a. The term “perform work with its own organization” refers to workers employed or leased by the prime contractor, and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor or lower tier subcontractor, agents of the prime contractor, or any other assignees. The term may include payments for the costs of hiring leased employees from an employee leasing firm meeting all relevant Federal and State regulatory requirements. Leased employees may only be included in this term if the prime contractor meets all of the following conditions:

(1) the prime contractor maintains control over the supervision of the day-to-day activities of the leased employees;
(2) the prime contractor remains responsible for the quality of the work of the leased employees;
(3) the prime contractor retains all power to accept or exclude individual employees from work on the project; and
(4) the prime contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance and all other Federal regulatory requirements.

b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid or propose on the contract as a whole and in general are to be limited to minor components of the overall contract.

2. The contract amount upon which the requirements set forth in paragraph (1) of Section VI is computed includes the cost of material and manufactured products which are to be purchased or produced by the contractor under the contract provisions.

3. The contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the contracting officer determines is necessary to assure the performance of the contract.

4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the contracting agency has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

5. The 30% self-performance requirement of paragraph (1) is not applicable to design-build contracts; however, contracting agencies may establish their own self-performance requirements.

VII. SAFETY: ACCIDENT PREVENTION

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

2. It is a condition of this contract, and shall be made a condition of each subcontract, which the contractor enters into pursuant to this contract, that the contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under construction safety and health standards (29 CFR 1926) promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704).

3. Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.3704).

VIII. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, Form FHWA-1022 shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined under this title or imprisoned not more than 5 years or both."

IX. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

By submission of this bid/proposal or the execution of this contract, or subcontract, as appropriate, the bidder, proposer, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any person who is or will be utilized in the performance of this contract is not prohibited from receiving an award due to a violation of Section 508 of the Clean Water Act or Section 306 of the Clean Air Act.
2. That the contractor agrees to include or cause to be included the requirements of paragraph (1) of this Section X in every subcontract, and further agrees to take such action as the contracting agency may direct as a means of enforcing such requirements.

X. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

This provision is applicable to all Federal-aid construction contracts, design-build contracts, subcontracts, lower-tier subcontracts, purchase orders, lease agreements, consultant contracts or any other covered transaction requiring FHWA approval or that is estimated to cost $25,000 or more – as defined in 2 CFR Parts 180 and 1200.

1**. Instructions for Certification – First Tier Participants:**

a. By signing and submitting this proposal, the prospective first tier participant is providing the certification set out below.

b. The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective first tier participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective first tier participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction.

c. The certification in this clause is a material representation of fact upon which reliance was placed when the contracting agency determined to enter into this transaction. If it is later determined that the prospective participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the contracting agency may terminate this transaction for cause of default.

d. The prospective first tier participant shall provide immediate written notice to the contracting agency to whom this proposal is submitted if any time the prospective first tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

e. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. "First Tier Covered Transactions" refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). "Lower Tier Covered Transactions" refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). "First Tier Participant" refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). "Lower Tier Participant" refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

f. The prospective first tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

g. The prospective first tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transactions," provided by the department or contracting agency, entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

h. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (www.epls.gov), which is compiled by the General Services Administration.

i. Nothing contained in the foregoing shall be construed to require the establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of the prospective participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

j. Except for transactions authorized under paragraph (f) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

2. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – First Tier Participants:

a. The prospective first tier participant certifies to the best of its knowledge and belief, that it and its principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency;

(2) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (a)(2) of this certification; and

(4) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

b. Where the prospective participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

2. **Instructions for Certification - Lower Tier Participants:**

(Applicable to all subcontracts, purchase orders and other lower tier transactions requiring prior FHWA approval or estimated to cost $25,000 or more - 2 CFR Parts 180 and 1200)

a. By signing and submitting this proposal, the prospective lower tier is providing the certification set out below.

b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department, or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances.

d. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations. “First Tier Covered Transactions” refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). “Lower Tier Covered Transactions” refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). “First Tier Participant” refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). “Lower Tier Participant” refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required

to, check the Excluded Parties List System website (www.epls.gov), which is compiled by the General Services Administration.

h. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Participants:

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency.

2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

XI. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts which exceed $100,000 (49 CFR 20).

1. The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

b. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

2. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

3. The prospective participant also agrees by submitting its bid or proposal that the participant shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such recipients shall certify and disclose accordingly.

ATTACHMENT A - EMPLOYMENT AND MATERIALS PREFERENCE FOR APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM OR APPALACHIAN LOCAL ACCESS ROAD CONTRACTS

This provision is applicable to all Federal-aid projects funded under the Appalachian Regional Development Act of 1965.

1. During the performance of this contract, the contractor undertaking to do work which is, or reasonably may be, done as on-site work, shall give preference to qualified persons who regularly reside in the labor area as designated by the DOL wherein the contract work is situated, or the subregion, or the Appalachian counties of the State wherein the contract work is situated, except:

a. To the extent that qualified persons regularly residing in the area are not available.

b. For the reasonable needs of the contractor to employ supervisory or specially experienced personnel necessary to assure an efficient execution of the contract work.

c. For the obligation of the contractor to offer employment to present or former employees as the result of a lawful collective bargaining contract, provided that the number of nonresident persons employed under this subparagraph (1c) shall not exceed 20 percent of the total number of employees employed by the contractor on the contract work, except as provided in subparagraph (4) below.

2. The contractor shall place a job order with the State Employment Service indicating (a) the classifications of the laborers, mechanics and other employees required to perform the contract work, (b) the number of employees required in each classification, (c) the date on which the participant estimates such employees will be required, and (d) any other pertinent information required by the State Employment Service to complete the job order form. The job order may be placed with the State Employment Service in writing or by telephone. If during the course of the contract work, the information submitted by the contractor in the original job order is substantially modified, the participant shall promptly notify the State Employment Service.

3. The contractor shall give full consideration to all qualified job applicants referred to him by the State Employment Service. The contractor is not required to grant employment to any job applicants who, in his opinion, are not qualified to perform the classification of work required.

4. If, within one week following the placing of a job order by the contractor with the State Employment Service, the State Employment Service is unable to refer any qualified job applicants to the contractor, or less than the number requested, the State Employment Service will forward a certificate to the contractor indicating the unavailability of applicants. Such certificate shall be made a part of the contractor's permanent project records. Upon receipt of this certificate, the contractor may employ persons who do not normally reside in the labor area to fill positions covered by the certificate, notwithstanding the provisions of subparagraph (1c) above.

5. The provisions of 23 CFR 633.207(e) allow the contracting agency to provide a contractual preference for the use of mineral resource materials native to the Appalachian region.

6. The contractor shall include the provisions of Sections 1 through 4 of this Attachment A in every subcontract for work which is, or reasonably may be, done as on-site work.

APPENDIX C
DESIGNATED SPECIAL PROVISION 9 (DSP9)

SPECIAL SUPPLEMENT[1]
ANTI-POLLUTION MEASURES

PART I, SECTION A
PENNSYLVANIA STATUTES

Act Relating to Abandoned Mines, Act of May 7, 1935, 52 Pa. Stat. §§ 809 et seq., as amended.

Act Relating to Black Powder, Act of May 31, 1974, 73 Pa. Stat. §§ 169 et seq., as amended.

Act Relating to Camp Regulation, Act of Nov. 10, 1959, 35 Pa. Stat. §§ 3001 et seq., as amended.

Act Relating to Cave-in or Subsidence of Surface Above Mines, Act of July 2, 1937, 52 Pa. Stat. §§ 1407 et seq., as amended.

Act Relating to Caving-in, Collapse, Subsidence, Act of May 27, 1921, 52 Pa. Stat. §§ 661 et seq., as amended.

Act Relating to Coal Land Improvement, Act of July 19, 1965, 52 Pa. Stat. §§ 30.101 et seq., as amended.

Act Relating to Coal Mine Subsidence Insurance Fund, Act of Aug. 23, 1961, 52 Pa. Stat. §§ 3201 et seq., as amended.

Act Relating to Coal Stripping, Act of June 18, 1941, 52 Pa. Stat. §§ 1471 et seq., as amended.

Act Relating to Coal Under State Lands, Act of June 1, 1933, 52 Pa. Stat. §§ 1501 et seq., as amended.

Act Relating to Control and Drainage of Water from Coal Formations, Act of July 7, 1955, 52 Pa. Stat. §§ 682 et seq., as amended.

Act Relating to Delaware River Pollution, Act of Apr. 19, 1945, 32 Pa. Stat. §§ 815.31 et seq., as amended.

Act Relating to Discharge of Coal into Banks of Streams, Act of June 27, 1913, 52 Pa. Stat. §§ 631 et seq., as amended.

Act Relating to Excavation and Demolition, Act of Dec. 10, 1974, 73 Pa. Stat. §§ 176 et seq., as amended.

Act Relating to Explosives, Act of July 1, 1937, 73 Pa. Stat. §§ 151 et seq., as amended.

Act Relating to Explosives, Act of July 10, 1957, 73 Pa. Stat. §§ 164 et seq., as amended.

Act Relating to Flood Control, Act of Aug. 7, 1936, 32 Pa. Stat. §§ 653 et seq., as amended.

Act Relating to General Safety, Act of May 18, 1937, 43 Pa. Stat. §§ 25-1 et seq., as amended.

Act Relating to Hazardous Materials Transport, Act of June 30, 1984, 75 Pa. C.S.A. §§ 8301 et seq., as amended.

Act Relating to Junkyards along Highways, Act of July 28, 1966, 36 Pa. Stat. §§ 2719.1 et seq., as amended.
Act Relating to Land Use, Act of Jan. 13, 1966, 16 Pa. Stat. §§ 11941 et seq., as amended.

Act Relating to Maps and Plans, Act of June 15, 1911, 52 Pa. Stat. §§ 823, as amended.

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[1] The listed State and Federal statutes and regulations are for informational use. Not all of the statutes and regulations that may be applicable are listed. In addition, new statutes and regulations and amendments to existing statutes and regulations are promulgated at various times and sections of the statutes and regulations are renumbered.

Act Relating to Mine Fires and Subsidence, Act of April 3, 1968, 52 Pa. Stat. §§ 30.201 et seq., as amended.

Act Relating to Mining Safety Zones, Act of Dec. 22, 1959, 52 Pa. Stat. §§ 3101 et seq., as amended.

Act Relating to Noise Pollution, Act of June 2, 1988, 35 Pa. Stat. §§ 4501 et seq., as amended.

Act Relating to Pollution Control Devices, Act of March 4, 1971, 72 Pa. Stat. §§ 7602.1 et seq., as amended.

Act Relating to Pollution From Abandoned Mines, Act of Dec. 15, 1965, 35 Pa. Stat. §§ 760.1 et seq., as amended.

Act Relating to Potomac River Pollution, Act of May 29, 1945, 32 Pa. Stat. §§ 741 et seq., as amended.

Act Relating to Preservation and Acquisition of Land for Open Space Uses, Act of Jan. 19, 1968, 32 Pa. Stat. §§ 5001 et seq., as amended.

Act Relating to Public Eating and Drinking Places, Act of May 23, 1945, 35 Pa. Stat. §§ 655.1 et seq., as amended.

Act Relating to Schuylkill River Pollution, Act of Apr. 19, 1945, 32 Pa. Stat. §§ 815.31 et seq., as amended.

Act Relating to Stream Clearance, Act of June 5, 1947, 32 Pa. Stat. §§ 701 et seq., as amended.

Act Relating to Water Power and Water Supply Permits, Act of June 14, 1923, 32 Pa. Stat. §§ 591 et seq., as amended.

Act Relating to Weather Modification, Act of Jan. 19, 1968, 3 Pa. Stat. §§ 1101 et seq. as amended.

Administrative Code of April 9, 1929, 71 Pa. Stat. §§ 194, 510 et seq., as amended.

Agricultural Liming Material Act of March 17, 1978, 3 Pa. Stat. §§ 132-1 et seq., as amended.

Air Pollution Control Act of Jan. 8, 1960, 35 Pa. Stat. §§ 4001 et seq., as amended.

Anthracite Strip Mining and Conservation Act of June 27, 1947, 52 Pa. Stat. §§ 681.1 et seq., as amended.

The Bituminous Mine Subsidence and Land Conservation Act of Apr. 27, 1966, 52 Pa. Stat. §§ 1406.1 et seq., as amended.

Bluff Recession and Setback Act of May 13, 1980, 32 Pa. Stat. §§ 5201 et seq., as amended.

Brandywine River Valley Compact Act of Sept. 9, 1959, 32 Pa. Stat. §§ 818 et seq., as amended.

Cave Protection Act of Nov. 21, 1990, 32 Pa. Stat. §§ 5601 et seq., as amended.

Chesapeake Bay Commission Agreement, Act of June 25, 1985, 32 Pa. Stat. §§ 820.11 et seq., as amended.

The Clean Streams Law of June 22, 1937, 35 Pa. Stat. §§ 691.1 et seq., as amended.

Coal and Gas Resource Coordination Act of Dec. 18, 1984, 58 Pa. Stat. §§ 501 et seq., as amended.

The Coal Mine Sealing Act of June 30, 1947, 52 Pa. Stat. §§ 28.1 et seq., as amended.

Coal Refuse Disposal Control Act of September 24, 1968, 52 Pa. Stat. §§ 30.51 et seq., as amended.

Conservation and Natural Resources Act of June 28, 1995, 71 Pa. Stat. §§ 1340.101 et seq., as amended.

Conservation District Law, Act of May 15, 1945, 3 Pa. Stat. §§ 849 et seq., as amended.

The Crimes Code, Act of Dec. 6, 1972, 18 Pa. C.S.A. §§ 101 et seq., as amended.

Dam Safety and Encroachments Act of Nov. 26, 1978, 32 Pa. Stat. §§ 693.1 et seq. as amended.

Delaware River Basin Compact, Act of July 7, 1961, 32 Pa. Stat. §§ 815.101 et seq., as amended.

Fish and Boat Code, Act of October 16, 1980, 30 Pa. C.S.A. §§ 101 et seq., as amended.

Flood Plain Management Act of Oct. 4, 1978, section 302 and 402, 32 Pa. Stat. §§ 679 et seq., as amended.

The Game and Wildlife Code, Act of July 8, 1986, 34 Pa. C.S.A. §§ 101 et seq., as amended.

Great Lakes Protection Fund Act of July 6, 1989, 32 Pa. Stat. §§ 817.11 et seq., as amended.

Hazardous Material Emergency Planning and Response Act of Dec. 7, 1990, 35 Pa. Stat. §§ 6022.101 et seq., as amended.

Hazardous Sites Cleanup Act of Oct. 18, 1988, 35 Pa. Stat. §§ 6020.101 et seq., as amended.

Highway Vegetation Control Act of Dec. 20, 1983, 36 Pa. Stat. §§ 2720.1 et seq., as amended.

History Code, Act of May 26, 1988, 37 Pa. C.S.A. §§ 101 et seq., as amended.

Interstate Mining Compact, Act of May 5, 1966, 52 Pa. Stat. §§ 3251 et seq., as amended.

Land Recycling and Environmental Remediation Standards Act of May 19, 1995, 35 Pa. Stat. §§ 6026.101 et seq., as amended.

Land and Water Conservation and Reclamation Act of Jan. 19, 1968, 32 Pa. Stat. §§ 5101 et seq., as amended.

Low-Level Radioactive Waste Disposal Act of February 9, 1988, 35 Pa. Stat. §§ 7130.101 et seq.

Noncoal Surface Mining Conservation and Reclamation Act of Dec. 19, 1984, 52 Pa. Stat. §§ 3301 et seq., as amended.

Noxious Weed Control Law, Act of April 7, 1982, 3 Pa. Stat. §§ 255.1 et seq., as amended.

Nutrient Management Act of May 20, 1993, 3 Pa. Stat. §§ 1701 et seq.

Ohio River Valley Water Sanitation Compact, Act of Apr. 2, 1945, 32 Pa. Stat. §§ 816.1 et seq., as amended.

Oil and Gas Act of Dec. 19, 1984, 58 Pa. Stat. §§ 601.101 et seq., as amended.

Oil and Gas Conservation Law, Act of July 25, 1961, 58 Pa. Stat. §§ 401 et seq., as amended.

Oil Spill Responder Liability Act of June 11, 1992, 35 Pa. Stat. §§ 6023.1 et seq., as amended.

Pennsylvania Anthracite Coal Mine Act of Nov. 10, 1965, 52 Pa. Stat. §§70-101 et seq., as amended.

Pennsylvania Appalachian Trail Act of Apr. 28, 1978, 64 Pa. Stat. §§ 801 et seq., as amended.

Pennsylvania Bituminous Coal Mine Act of July 17, 1961, 52 Pa. Stat. §§ 701-101 et seq., as amended.

Pennsylvania Fertilizer Law of May 29, 1956, 3 Pa. Stat. §§ 68.1 et seq., as amended.

Pennsylvania Occupational Disease Act of June 21, 1939, 77 Pa. Stat. §§ 1201 et seq., as amended.

Pennsylvania Pesticide Control Act of 1973, Act of March 1, 1974, 3 Pa. Stat. §§ 111.21 et seq., as amended.

Pennsylvania Safe Drinking Water Act of May 1, 1984, 35 Pa. Stat §§ 721.1 et seq., as amended.

Pennsylvania Scenic Rivers Act of Dec. 5, 1972, 32 Pa. Stat. §§ 820.21 et seq., as amended.

Pennsylvania Sewage Facilites Act of Jan. 24, 1966, 35 Pa. Stat. §§ 750.1 et seq., as amended.

Pennsylvania Solid Waste Management Act of July 7, 1980, 35 Pa. Stat. §§ 6018.101 et seq., as amended.

Pennsylvania Solid Waste-Resource Recovery Development Act of July 20, 1974, 35 Pa. Stat. §§ 755.1 et seq., as amended.

Pennsylvania Used Oil Recycling Act of Apr. 9, 1982, 58 Pa. Stat. §§ 471 et seq., as amended.

Pennsylvania Workmen's Compensation Act of June 2, 1915, 77 Pa. Stat. §§ 1 et seq., as amended.

Phosphate Detergent Act of July 5, 1989, 35 Pa. Stat. §§ 722.1 et seq., as amended.

Plant Pest Act of Dec. 16, 1992, 3 Pa. Stat. §§ 258.1 et seq.

Plumbing System Lead Ban and Notification Act of July 6, 1989, 35 Pa. Stat. §§ 723.1 et seq., as amended.

Project 70 Land Acquisition and Borrowing Act of June 22, 1964, 72 Pa. Stat. §§ 3946.1 et seq., as amended.

The Public Bathing Law, Act of June 23, 1931, 35 Pa. Stat. §§ 672 et seq., as amended.

Publicly Owned Treatment Works Penalty Law, Act of March 26, 1992, 35 Pa. Stat. §§ 752.1 et seq., as amended.

Radiation Protection Act of July 10, 1984, 35 Pa. Stat. §§ 7110.101 et seq., as amended.

Rails to Trails Act of Dec. 18, 1990, 32 Pa. Stat. §§ 5611 et seq.

Seasonal Farm Labor Act of June 23, 1978, 43 Pa. Stat. §§ 1301.101 et seq., as amended.

Sewage System Cleaner Control Act of May 28, 1992, 35 Pa. Stat. §§ 770.1 et seq., as amended.

Sewage Treatment Plant and Waterworks Operators' Certification Act of Nov. 18, 1968, 63 Pa. Stat. §§ 1004 et seq., as amended.

Site Development Act of May 6, 1968, 73 Pa. Stat. §§ 361 et seq., as amended.

Snowmobile Law, Act of June 17, 1976, 75 Pa. C.S.A. §§ 7701 et seq., as amended.

State Highway Law, Act of June 1, 1945, 36 Pa. Stat. §§ 670-101 et seq., as amended.

Storage Tank and Spill Prevention Act of July 6, 1989, 35 Pa. Stat. §§ 6021.101 et seq., as amended.

Storm Water Management Act of Oct. 4, 1978, 32 Pa. Stat. §§ 680.1 et seq., as amended.

Surface Mining Conservation and Reclamation Act of May 31, 1946, 52 Pa. Stat. §§ 1396.1 et seq., as amended.

Susquehanna River Basin Compact, Act of July 17, 1968, 32 Pa. Stat. §§ 820.1 et seq., as amended.

Vehicle Code, Act of June 17, 1976, 75 Pa. C.S.A. §§ 101 et seq., as amended.

Water Power and Water Supply Act of June 14, 1923, 32 Pa. Stat. § 597, as amended.

Water Well Drillers License Act of May 29, 1956, 32 Pa. Stat. §§ 645.1 et seq., as amended.

Wheeling Creek Watershed Protection and Flood Prevention District Compact, Act of Aug. 2, 1967, 32 Pa. Stat. §§ 819.1 et seq., as amended.

Wild Resource Conservation Act of June 23, 1982, 32 Pa. Stat. §§ 5301 et seq., as amended.

PART I, SECTION B
PENNSYLVANIA REGULATIONS

Pursuant to the above statutes, regulations are promulgated by State agencies and are published in the Pennsylvania Code (PA. Code). The following are the sections of the PA. Code that are assigned to the following State agencies:

Pennsylvania Department of Environmental Protection—Title 25 of the PA. Code;

Pennsylvania Department of Conservation and Natural Resources—Title 17 of the PA. Code;

Pennsylvania Department of Transportation—Title 67 of the PA. Code;

Pennsylvania Department of Labor and Industry—Title 34 of the PA. Code;

Pennsylvania Department of Agriculture—Title 7 of the PA. Code;

Pennsylvania Historical and Museum Commission—Title 46 of the PA. Code;

Public Utility Commission—Title 52 of the PA. Code;

Pennsylvania Fish and Boat Commission—Title 58, Part II of the PA. Code;

Pennsylvania Game Commission—Title 58, Part III of the PA. Code;

Delaware River Commission—Title 4 of the PA. Code.

PART II
FEDERAL STATUTES AND REGULATIONS

Abandoned Mine Reclamation Act of 1990, 30 U.S.C.[2] §§ 1231 et seq.

Acid Precipitation Act of 1980, 42 U.S.C. §§ 8901-8905, 8911, 8912.

Act to Prevent Pollution from Ships, 33 U.S.C. §§ 1901-1915, as amended.
40 C.F.R[3]. Part 122

Agricultural Act of 1970, 16 U.S.C. §§ 1501-1510.

Airport and Airway Development Act of 1970, 49 U.S.C. §§ 1701-1703, 1711-1727.

Anadromous Fish Conservation Act, 16 U.S.C. §§ 757a-757g et seq., as amended.

Appalachian Regional Development Act of 1965, 40 app. §1, 2, 101-109, 201-208, 211-214, 221-225, 226, 301-304, 401-405, as amended.

Asbestos Hazard Emergency Response Act of 1986 (See Toxic Substances Control Act, Sections 201-214 (15 U.S.C. §§ 2641-2654)).

Atomic Energy Act of 1954, 42 U.S.C. §§ 2011 et seq., as amended.
10 C.F.R. Parts 1, 2, 4, 10, 15, 19, 20, 21, 25, 26, 30-36, 39, 40, 50, 52-55, 60-62, 70-76, 95, 100, 110, 150, 171, 605, 707, 710, 730, 760, 768, 770-777, 779, 782, 785-791, 799, 810, 820, 862, 960, 962, 1004, 1009, 1017, 1046, 1047
32 C.F.R. Part 518
37 C.F.R. Part 5
40 C.F.R. Parts 23, 191, 192
48 C.F.R. Parts 901, 910, 912, 917, 919-933, 935-937, 942-945, 949-952

Aviation Safety and Noise Abatement Act of 1979, 49 App. U.S.C. §§ 47501 et seq., as amended.

Bankhead-Jones Farm Tenant Act, 7 U.S.C. §§ 1000 et seq., as amended.

Clean Air Act 42 U.S.C. §§ 7401 et seq., as amended.
40 C.F.R. Parts 2, 6, 9, 15, 22, 23, 30, 31, 34, 35, 40, 42, 45, 46, 50, 51, 52, 55, 56, 57, 58, 60, 61, 62, 63, 65, 67, 69, 70, 72-74, 76-78, 80, 81, 82, 85, 86, 87, 88, 89, 90, 93, 122-124, 144, 145, 233, 270, 271, 450, 600, 613, 771, 1500, 1503-1507
10 C.F.R. Parts 101, 201
14 C.F.R. Parts 34, 1216
18 C.F.R. Parts 101, 201
19 C.F.R. Part 12
23 C.F.R. Part 450
29 C.F.R. Part 24

Clean Vessel Act of 1992, Pub. L. 102-587, Title V, 106 Stat. 5086.

Coastal Wetlands Planning, Protection and Restoration Act, 16 U.S.C. §§ 3951-3956

Coastal Zone Management Act of 1972, 16 U.S.C. §§ 1451-1464, as amended.

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[2] U.S.C. refers to the United States Code.

[3] Pursuant to the above statutes, regulations are promulgated by the Federal agencies and are published in the Code of Federal Regulations (C.F.R.).

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, 42 U.S.C. §§ 9601 et seq., as amended.
40 C.F.R. Parts 9, 51, 279, 300

Department of Transportation Act, 49 U.S.C. §§ 503, 20302, 20304, 20305, 20701-20703, 20901, 20902, 21302, as amended.

Emergency Planning and Community Right-To-Know Act of 1986, 42 U.S.C. §§ 11001 et seq., as amended.
40 C.F.R. Part 17

Endangered Species Act of 1973, 16 U.S.C. §§ 1531-1544, as amended.

Energy Supply and Environmental Coordination Act of 1974, 15 U.S.C. §§ 791-798, as amended.
10 C.F.R. Parts 303, 305
18 C.F.R. Parts 157, 270, 271, 275, 290, 292

Environmental Quality Improvement Act of 1970, 42 U.S.C. §§ 4371-4375, as amended.
40 C.F.R. Parts 1500-1508, 1515

Federal Agriculture Improvement and Reform Act of 1996, 7 U.S.C. §§ 1932, 2204f, 3224, 3319d, 2279c, 1101, 7201-7491.

Federal Aid in Fish Restoration Act (of 1950), 16 U.S.C. §§ 777 et seq., as amended.
43 C.F.R. Part 17
Note: also known as "Fish Restoration and Management Projects Act" and the "Dingell-Johnson Sport Fish Restoration Act".

Federal Facility Compliance Act of 1992, Pub. L. 102-386, 106 Stat. 1505.

Federal-Aid Highway Act, 23 U.S.C.A. §§101 et seq., as amended.

Federal Aid in Wildlife Restoration Act, 16 U.S.C. §§ 669, 669a-669i, as amended.

Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. §§ 136-136y, as amended.
19 C.F.R. Part 12
29 C.F.R. Part 1440
40 C.F.R. Parts 2, 16, 23, 30-32, 34, 35, 152, 153, 155-158, 160, 162, 166, 168, 169, 170-173

Federal Land Policy and Management Act of 1976, 43 U.S.C. §§ 1701-1785, as amended.
7 C.F.R. Part 1
36 C.F.R. Parts 222, 242, 251, 254
43 C.F.R. Parts 37, 1600, 1820, 1860, 1880, 2090, 2200, 2210, 2300, 2540, 2710, 2740, 2800, 2810, 2910, 2920, 3000, 3110, 3120, 3130, 3140, 3150, 3160, 3200, 3400, 3410, 3420, 3430, 3450, 3460, 3470, 3500, 3510, 3520, 3530, 3540, 3550, 3560, 3570, 3580, 3590, 3730, 3800, 3830, 4100, 4200, 4300, 4700, 5000, 8000, 8200, 8300, 8340, 8350, 8360, 8370, 8560, 9180, 9210, 9260

Federal Power Act, 16 U.S.C. §§ 791a et seq., as amended.
10 C.F.R. Part 205
18 C.F.R. Parts 1b, 2, 3, 4, 6, 8, 9, 11, 12, 16, 20, 24, 32-35, 45, 46, 101, 116, 125, 131, 141, 154, 225, 290, 292, 294, 375, 381, 385
33 C.F.R. Parts 208, 209, 221, 222

Federal Water Project Recreation Act, 16 U.S.C. §§ 460*l*-5, 460*l*-12 to -21, 662, as amended.
36 C.F.R. Part 297
43 C.F.R. Part 17

Fish and Game Sanctuary Act, 16 U.S.C. §§ 694-694b

Fish and Wildlife Act of 1956, 15 U.S.C. §§ 713c-3; 16 U.C.S.A. §§ 742a-742j, as amended.
30 C.F.R. Part 773
33 C.F.R. Part 209
43 C.F.R. Parts 17, 21
50 C.F.R. Parts 25-33, 70, 71

16 U.S.C. §§ 742a – 742j
50 C.F.R. Parts 10, 19, 20, 36, 217, 250, 251, 260

Fish and Wildlife Coordination Act, 16 U.S.C. §§ 661-666c, as amended.
30 C.F.R. Part 773
33 C.F.R. Part 209
43 C.F.R. Parts 17, 21
50 C.F.R. Parts 25-33, 70, 71

Flood Control, 33 U.S.C. §§ 701 et seq., as amended
7 C.F.R. Parts 622, 624, 654
33 C.F.R. Parts 208, 222

Fishermen's Protective Act of 1967 (Pelly Amendment), 22 U.S.C. §§ 1971 – 1980, as amended.
22 C.F.R. Part 33
50 C.F.R. Part 611

Food Quality Protection Act of 1996, 7 U.S.C. §§ 136-136y.

Forest and Rangeland Renewable Resources Planning Act of 1974, 16 U.S.C. §§ 1600-1614, as amended.

Forest Ecosystems and Atmospheric Pollution Control Act of 1988, 16 U.S.C. § 1641.

Game and Wildlife Act, 16 U.S.C. §§ 141b, 715d-1, 715d-3, 715e, 715e-1, 715k-1, 715s, 718b – 718e, as amended.

Geothermal Energy Research, Development, and Demonstration Act of 1974 (GERDDA), 30 U.S.C. §§ 1101, 1102, 1121-1126, 1141-1144, 1161-1164, as amended.

Global Climate Protection Act of 1987, 15 U.S.C. § 2901, as amended.

Hazardous Material Transportation Act, 46 U.S.C. § 170; 49 U.S.C. §§ 103, 104, 106; 49 App. §§ 1471, 1472, 1801-1819, as amended.

Hazardous Substance Response Revenue Act of 1980, 26 U.S.C. §§ 4611, 4612, 4661, 4662.

Hazardous Materials Transportation Authorization Act of 1994, 49 U.S.C. §§ 5101-5127, as amended.

Hazardous Materials Transportation Uniform Safety Act of 1990, 49 App. §§ 1801-1819, 2509.

Intermodal Surface Transportation Efficiency Act of 1991 (see Transportation Equity Act of the 21st Century (TEA 21)).

Lacey Act Amendments of 1981 16 U.S.C. §§ 3371 et seq., as amended.

Land and Water Conservation Fund Act of 1965, 16 U.S.C. §§460d, 460l-4 – 460l-11, as amended.

Lead-Based Paint Exposure Reduction Act, 15 U.S.C. §§ 2681-2692.

Lead-Based Paint Poisoning Prevention Act, 42 U.S.C. §§ 4801, 4811, 4821, 4822, 4831, 4841-4843, as amended.

Lead Contamination Control Act of 1988, 42 U.S.C. §§ 201 note, 247b-1, 300j-4, 300j-21 to –26.

Low-Level Radioactive Waste Policy Amendments Act of 1985, 42 U.S.C. §§ 2021b-2021j, as amended.

Magnuson-Stevens Fisheries Conservation and Management Act, 16 U.S.C. §§ 1801 et seq., as amended.

Marine Protection, Research and Sanctuaries Act of 1972, 33 U.S.C. §§ 1401-1445, as amended.

Migratory Bird Conservation Act, 16 U.S.C. §§ 715-715r, as amended.

Migratory Bird Treaty Act, 16 U.S.C. §§703-708, 709a, 710, 711.

Mining and Mineral Resources Research Institutes Act, 30 U.S.C. 1221-1230.

Multiple-Use Sustained-Yield Act of 1960, 16 U.S.C. §§ 475, 528, 531, as amended.

National Climate Program Act, 15 U.S.C. §§ 2901-2908, as amended.

National Coastal Monitoring Act, 33 U.S.C. §§ 2801-2805.

National Contaminated Sediment Assessment and Management Act, 33 U.S.C. §§ 1271.

National Emission Standards Act, 42 U.S.C. §§7521-7550, as amended.

National Energy Conservation Policy Act, Pub. L. 95-619, 92 Stat. 306, as amended.

National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended.

National Invasive Species Act of 1996, 16 U.S.C. §§ 4701-4751.

National Ocean Pollution Planning Act of 1978, 33 U.S.C. §§ 1701-1709, as amended.

National Trails System Act, 16 U.S.C. §§ 1241-1249, as amended.

National Wildlife Refuge System Administration Act of 1966, 16 U.S.C. §§ 668dd, 668ee, 715s, as amended.

Noise Control Act of 1972, 42 U.S.C. §§ 4901-4918.

Nuclear Waste Policy Act of 1982, 42 U.S.C. §§ 10101-10270, as amended.

Oil Pollution Act, 1961, 33 U.S.C. §§ 1001-1015, as amended.

Oil Pollution Act of 1990, 33 U.S.C. §§ 2701-2761, as amended.

Organotin Antifouling Paint Control Act of 1988, 33 U.S.C. §§ 2401-2410, as amended.

Outer Continental Shelf Lands Act Amendments of 1978, 43 U.S.C. §§ 1801-1866, as amended.

Pollution Prevention Act of 1990, 42 U.S.C. §§ 13101-13109.

Public Health Service Act, 42 U.S.C. §§ 300f-300j-11.

Radon Gas and Indoor Air Quality Research Act of 1986, 42 U.S.C. § 7401.

Recreation Use of Conservation Areas Act, 16 U.S.C. § 560k.

Refuse Act of 1899, 33 U.S.C. §§ 401 et seq., as amended.

Renewable Resources extension Act of 1978, 16 U.S.C. §§ 1671-1676 as amended.

Resource Conservation and Recovery Act of 1976, 42 U.S.C. §§ 6901-6991.

River and Harbor Act of 1958, 33 U.S.C. §610 as amended.

Safe Drinking Water Act (see Public Health Service Act Sections 1401-1451 (42 U.S.C. §§ 300f - 300j-11, as amended)).

Shore Protection Act of 1988, 33 U.S.C. §§2601-2609, 2622, 2623.

Soil and Water Resources Conservation Act of 1977, 16 U.S.C. §§ 2001-2009, as amended.

Soil Conservation and Domestic Allotment Act, 16 U.S.C. §§ 590a et seq., as amended.

Solid Waste Disposal Act, 42 U.S.C. §§ 6901 et seq., as amended.

Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. §§ 1201 et seq., as amended.

Toxic Substances Control Act, 15 U.S.C. §§ 2601-2692, as amended.

Transportation Equity Act of the 21st Century (TEA 21), Pub. L. 105-178, 112 Stat. 107, as amended.

Travel and Transportation Reform Act of 1998, 5 U.S.C. §§ 5701 et seq.

United States Public Vessel Medical Waste Anti-Dumping Act of 1988, 33 U.S.C. §§ 2501-2504.

Uranium Mill Tailings Radiation Control Act of 1978, 42 U.S.C. §§ 7901 - 7942.

Water Bank Act, 16 U.S.C. §§ 1301-1311, as amended.

Water Pollution Prevention and Control Act, 33 U.S.C. §§ 1251 et seq., as amended.
Commonly known as the Clean Water Act.
14 C.F.R. Part 1204
40 C.F.R. Parts 7, 9, 15, 30 – 32, 34, 104, 108, 110, 113, 116, 117, 122, 124, 125, 129, 130, 131 – 133, 136, 144, 145, 270, 271, 401, 403, 405 – 413, 415, 417 – 429, 436, 440, 443, 446, 447, 454, 457-460, 501, 503

Water Resources Research Act of 1984, 42 U.S.C. §§ 10301-10309.

Water Resources Development Act of 1996, 33 U.S.C. §§ 467-467j.

Watershed Protection and Flood Prevention Act, 16 U.S.C. §§ 1001-1008; 33 U.S.C. § 701b.

Wetlands Loan Act, 16 U.S.C. §§ 715k-3-715k-5, as amended.

Wilderness Act, 16 U.S.C. §§ 1331-1336, as amended.

Wood Residue Utilization Act of 1980, 16 U.S.C. §§ 1681-1687.

APPENDIX C
DESIGNATED SPECIAL PROVISION 10 (DSP10)

NONDISCRIMINATION/SEXUAL HARASSMENT CLAUSE

The Contractor agrees:

1. In the hiring of any employee(s) for the manufacture of supplies, performance of work, or any other activity required under the contract or any subcontract, the Contractor, each subcontractor, or any person acting on behalf of the Contractor or subcontractor shall not discriminate by reason of race, gender, creed, color , sexual orientation, gender identity or expression, or in violation of the *Pennsylvania Human Relations Act* (PHRA) and applicable federal laws, against any citizen of this Commonwealth who is qualified and available to perform the work to which the employment relates.

2. Neither the Contractor nor any subcontractor nor any person on their behalf shall in any manner discriminate by reason of race, gender, creed, color, sexual orientation, gender identity or expression, or in violation of the PHRA and applicable federal laws, against or intimidate any employee involved in the manufacture of supplies, the performance of work, or any other activity required under the contract.

3. Neither the Contractor nor any subcontractor nor any person on their behalf shall in any manner discriminate by reason of race, gender, creed, color, sexual orientation, gender identity or expression, or in violation of the PHRA and applicable federal laws, in the provision of services under the contract.

4. Neither the Contractor nor any subcontractor nor any person on their behalf shall in any manner discriminate against employees by reason of participation in or decision to refrain from participating in labor activities protected under the *Public Employee Relations Act, Pennsylvania Labor Relations Act or National Labor Relations Act*, as applicable and to the extent determined by entities charged with such Acts' enforcement, and shall comply with any provision of law establishing organizations as employees' exclusive representatives.

5. The Contractor and each subcontractor shall establish and maintain a written nondiscrimination and sexual harassment policy and shall inform their employees in writing of the policy. The policy must contain a provision that sexual harassment will not be tolerated and employees who practice it will be disciplined. Posting this Nondiscrimination/Sexual Harassment Clause conspicuously in easily-accessible and well-lighted places customarily frequented by employees and at or near where the contracted services are performed shall satisfy this requirement for employees with an established work site.

6. The Contractor and each subcontractor shall not discriminate by reason of race, gender, creed, color, sexual orientation, gender identity or expression, or in violation of PHRA and applicable federal laws, against any subcontractor or supplier who is qualified to perform the work to which the contract relates.

7. The Contractor and each subcontractor represents that it is presently in compliance with and will maintain compliance with all applicable federal, state, and local laws, regulations and policies relating to nondiscrimination and sexual harassment. The Contractor and each subcontractor further represents that it has filed a Standard Form 100 Employer Information Report ("EEO-1") with the U.S. Equal Employment Opportunity Commission ("EEOC") and shall file an annual EEO-1 report with the EEOC as required for employers' subject to *Title VII* of the *Civil Rights Act of 1964*, as amended, that have 100 or more employees and employers that have federal government contracts or first-tier subcontracts and have 50 or more employees. The Contractor and each subcontractor shall, upon request and within the time periods requested by the Commonwealth, furnish all necessary employment documents and records, including EEO-1 reports, and permit access to their books, records, and accounts by the contracting agency and the Bureau of Diversity,

Inclusion and Small Business Opportunities for purpose of ascertaining compliance with provisions of this Nondiscrimination/Sexual Harassment Clause.

8. The Contractor shall include the provisions of this Nondiscrimination/Sexual Harassment Clause in every subcontract so that those provisions applicable to subcontractors will be binding upon each subcontractor.

9. The Contractor's and each subcontractor's obligations pursuant to these provisions are ongoing from and after the effective date of the contract through the termination date thereof. Accordingly, the Contractor and each subcontractor shall have an obligation to inform the Commonwealth if, at any time during the term of the contract, it becomes aware of any actions or occurrences that would result in violation of these provisions.

10. The Commonwealth may cancel or terminate the contract and all money due or to become due under the contract may be forfeited for a violation of the terms and conditions of this Nondiscrimination/Sexual Harassment Clause. In addition, the agency may proceed with debarment or suspension and may place the Contractor in the Contractor Responsibility File.

APPENDIX C
DESIGNATED SPECIAL PROVISION 11 (DSP11)

CONTRACTOR INTEGRITY PROVISIONS

It is essential that those who seek to contract with the Commonwealth of Pennsylvania ("Commonwealth") observe high standards of honesty and integrity. They must conduct themselves in a manner that fosters public confidence in the integrity of the Commonwealth contracting and procurement process.

1. DEFINITIONS. For purposes of these Contractor Integrity Provisions, the following terms shall have the meanings found in this Section:

a. **"Affiliate"** means two or more entities where (a) a parent entity owns more than fifty percent of the voting stock of each of the entities; or (b) a common shareholder or group of shareholders owns more than fifty percent of the voting stock of each of the entities; or (c) the entities have a common proprietor or general partner.

b. **"Consent"** means written permission signed by a duly authorized officer or employee of the Commonwealth, provided that where the material facts have been disclosed, in writing, by prequalification, bid, proposal, or contractual terms, the Commonwealth shall be deemed to have consented by virtue of the execution of this contract.

c. **"Contractor"** means the individual or entity, that has entered into this contract with the Commonwealth.

d. **"Contractor Related Parties"** means any affiliates of the Contractor and the Contractor's executive officers, Pennsylvania officers and directors, or owners of 5 percent or more interest in the Contractor.

e. **"Financial Interest"** means either:

(1) Ownership of more than a five percent interest in any business; or

(2) Holding a position as an officer, director, trustee, partner, employee, or holding any position of management.

f. **"Gratuity"** means tendering, giving, or providing anything of more than nominal monetary value including, but not limited to, cash, travel, entertainment, gifts, meals, lodging, loans, subscriptions, advances, deposits of money, services, employment, or contracts of any kind. The exceptions set forth in the *Governor's Code of Conduct, Executive Order 1980-18*, the *4 Pa. Code §7.153(b)*, shall apply.

g. **"Non-bid Basis"** means a contract awarded or executed by the Commonwealth with Contractor without seeking bids or proposals from any other potential bidder or offeror.

2. In furtherance of this policy, Contractor agrees to the following:

a. Contractor shall maintain the highest standards of honesty and integrity during the performance of this contract and shall take no action in violation of state or federal laws or regulations or any other applicable laws or regulations, or other requirements applicable to Contractor or that govern contracting or procurement with the Commonwealth.

b. Contractor shall establish and implement a written business integrity policy, which includes, at a minimum, the requirements of these provisions as they relate to the Contractor activity with the Commonwealth and Commonwealth employees, and which is and made known to all Contractor employees. Posting these Contractor Integrity Provisions conspicuously in easily-accessible and well-lighted places customarily

frequented by employees and at or near where the contract services are performed shall satisfy this requirement.

c. Contractor, its affiliates, agents, employees and anyone in privity with Contractor shall not accept, agree to give, offer, confer, or agree to confer or promise to confer, directly or indirectly, any gratuity or pecuniary benefit to any person, or to influence or attempt to influence any person in violation of any federal or state law, regulation, executive order of the Governor of Pennsylvania, statement of policy, management directive or any other published standard of the Commonwealth in connection with performance of work under this contract, except as provided in this contract.

d. Contractor shall not have a financial interest in any other contractor, subcontractor, or supplier providing services, labor, or material under this contract, unless the financial interest is disclosed to the Commonwealth in writing and the Commonwealth consents to Contractor's financial interest prior to Commonwealth execution of the contract. Contractor shall disclose the financial interest to the Commonwealth at the time of bid or proposal submission, or if no bids or proposals are solicited, no later than Contractor's submission of the contract signed by Contractor.

e. Contractor certifies to the best of its knowledge and belief that within the last five (5) years Contractor or Contractor Related Parties have not:

(1) been indicted or convicted of a crime involving moral turpitude or business honesty or integrity in any jurisdiction;

(2) been suspended, debarred or otherwise disqualified from entering into any contract with any governmental agency;

(3) had any business license or professional license suspended or revoked;

(4) had any sanction or finding of fact imposed as a result of a judicial or administrative proceeding related to fraud, extortion, bribery, bid rigging, embezzlement, misrepresentation or anti-trust; and

(5) been, and is not currently, the subject of a criminal investigation by any federal, state or local prosecuting or investigative agency and/or civil anti-trust investigation by any federal, state or local prosecuting or investigative agency.

If Contractor cannot so certify to the above, then it must submit along with its bid, proposal or contract a written explanation of why such certification cannot be made and the Commonwealth will determine whether a contract may be entered into with the Contractor. The Contractor's obligation pursuant to this certification is ongoing from and after the effective date of the contract through the termination date thereof. Accordingly, the Contractor shall have an obligation to immediately notify the Commonwealth in writing if at any time during the term of the contract if becomes aware of any event which would cause the Contractor's certification or explanation to change. Contractor acknowledges that the Commonwealth may, in its sole discretion, terminate the contract for cause if it learns that any of the certifications made herein are currently false due to intervening factual circumstance or were false or should have been known to be false when entering into the contract.

f. Contractor shall comply with the requirements of the *Lobbying Disclosure Act (65 Pa.C.S. §13A01 et seq.).* regardless of the method of award. If this contract was awarded on a Non-bid Basis, Contractor must also comply with the requirements of the *Section 1641 of the Pennsylvania Election Code (25 P.S. §3260a).*

g. When Contractor has reason to believe that any breach of ethical standards as set forth in law, the Governor's Code of Conduct, or these Contractor Integrity Provisions has occurred or may occur, including but not limited to contact by a Commonwealth officer or employee which, if acted upon, would violate such ethical standards, Contractor shall immediately notify the Commonwealth contracting officer or the Office of the State Inspector General in writing.

h. Contractor, by submission of its bid or proposal and/or execution of this contract and by the submission of any bills, invoices or requests for payment pursuant to the contract, certifies and represents that it has not violated any of these Contractor Integrity Provisions in connection with the submission of the bid or proposal, during any contract negotiations or during the term of the contract, to include any extensions thereof. Contractor shall immediately notify the Commonwealth in writing of any actions for occurrences that would result in a violation of these Contractor Integrity Provisions. Contractor agrees to reimburse the Commonwealth for the reasonable costs of investigation incurred by the Office of the State Inspector General for investigations of the Contractor's compliance with the terms of this or any other agreement between the Contractor and the Commonwealth that results in the suspension or debarment of the Contractor. Contractor shall not be responsible for investigative costs for investigations that do not result in the Contractor's suspension or debarment.

i. Contractor shall cooperate with the Office of the State Inspector General in its investigation of any alleged Commonwealth agency or employee breach of ethical standards and any alleged Contractor non-compliance with these Contractor Integrity Provisions. Contractor agrees to make identified Contractor employees available for interviews at reasonable times and places. Contractor, upon the inquiry or request of an Inspector General, shall provide, or if appropriate, make promptly available for inspection or copying, any information of any type or form deemed relevant by the Office of the State Inspector General to Contractor's integrity and compliance with these provisions. Such information may include, but shall not be limited to, Contractor's business or financial records, documents or files of any type or form that refer to or concern this contract. Contractor shall incorporate this paragraph in any agreement, contract or subcontract it enters into in the course of the performance of this contract/agreement solely for the purpose of obtaining subcontractor compliance with this provision. The incorporation of this provision in a subcontract shall not create privity of contract between the Commonwealth and any such subcontractor, and no third party beneficiaries shall be created thereby.

j. For violation of any of these Contractor Integrity Provisions, the Commonwealth may terminate this and any other contract with Contractor, claim liquidated damages in an amount equal to the value of anything received in breach of these Provisions, claim damages for all additional costs and expenses incurred in obtaining another contractor to complete performance under this contract, and debar and suspend Contractor from doing business with the Commonwealth. These rights and remedies are cumulative, and the use or non-use of any one shall not preclude the use of all or any other. These rights and remedies are in addition to those the Commonwealth may have under law, statute, regulation, or otherwise.

APPENDIX C
DESIGNATED SPECIAL PROVISION 12 (DSP12)

EXECUTIVE ORDER 11246
(WITH APPENDIX A AND B)

NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY

(a) The Offeror's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth herein.

(b) The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Timetables	*Goals for minority participation in each trade	*Goals for female participation in each trade
	SEE ATTACHED APPENDIX B	SEE ATTACHED APPENDIX A

* The hours of minority and female employment is to be reported monthly, by the Contractor, on Standard Form 257 (to be supplied by PENNDOT) and expressed in percentage terms of the Contractor's aggregate workhours for each trade (craft).

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the Contractor also is subject to the goals for both its federally involved and non-federally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from contractor to contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

(c) The Contractor shall provide written notification to PENNDOT within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address, and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.

(d) As used in this Notice, and in the contract resulting from this solicitation, the "covered area" is indicated in the special provision entitled "E.E.O. Covered Area". Goals for females are listed in Appendix A, and for minorities includes the areas listed in Appendix B.

STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS (EXECUTIVE ORDER 11246)

(a) As used in these Specifications:

1. "Covered area" means the geographical area described in the solicitation from which this contract resulted;

2. "Director" means Director, Office of Federal Contract Compliance Programs, U.S. Department of Labor (DOL), or any person to whom the Director delegates authority;

3. "Employer identification number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941; and

4. "Minority" includes:

- Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
- Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);
- Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
- American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

(b) Whenever the Contractor, or any subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of $10,000 the provisions of these Specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitation from which this contract resulted.

(c) If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. DOL in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be according to that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each contractor or subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other contractors or subcontractors toward a goal in an approved Plan does not excuse any covered contractor's or subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

(d) The Contractor shall implement the specific affirmative action standards provided in paragraphs (g)1 through (g)16 of these Specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered construction contractors performing construction work in geographical areas where they do not have a Federal or Federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress toward its goals in each craft during the period specified.

(e) Neither the provisions of any collective bargaining agreement, nor the failures by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Constructor's obligations under these Specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

(f) In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. DOL.

(g) The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these Specifications shall be based upon its efforts to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:

1. Ensure and maintain a working environment free of harassment, intimidation, and coercion of all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

2. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available and maintain a record of the organizations' responses.

3. Maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefore, along with whatever additional actions the Contractor may have taken.

4. Provide immediate written notification to PENNDOT when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.

5. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the DOL. The Contractor shall provide notice of these programs to the sources compiled under (g)2 above.

6. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

7. Review, at least annually, the company's EEO policy and affirmative action obligations under these Specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment decisions including specific review of these items with on-site supervisory

personnel such as superintendents, general foreman, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

8. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other contractors and subcontractors with whom the Contractor does or anticipates doing business.

9. Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than 1 month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

10. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer, and vacation employment to minority and female youth both on the site and in other areas of the Contractor's workforce.

11. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.

12. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc.; such opportunities.

13. Ensure that seniority practices, job classifications, work assignments, and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these Specifications are being carried out.

14. Ensure that all facilities and company activities are nonsegregated except that separate or single-user toilet and necessary changing facilities shall be provided to ensure privacy between the sexes.

15. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

16. Conduct a review, at least annually of all supervisors' adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

(h) Contractors are encouraged to participate in voluntary associations that assist in fulfilling one or more of their affirmative action obligations ((g)1 through (g)16). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the Contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under (g)1 through (g)16 or these Specifications provided that the Contractor actively participates in the group, makes every effort to ensure that the group has a positive impact on the employment of minorities and women in the Industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female

workforce and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

(i) A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

(j) The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.

(k) The Contractor shall not enter into any subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

(l) The Contractor shall carry out such sanctions and penalties for violation of these Specifications and of the Equal Opportunity Clause, including suspension, termination, and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any contractor who fails to carry out such sanctions and penalties shall be in violation of these Specifications and Executive Order 11246, as amended.

(m) The Contractor, in fulfilling its obligations under these Specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph (g) of these Specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, regulations, or these Specifications, PENNDOT shall proceed according to 41 CFR 60-4.8.

(n) The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

(o) Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area resident (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

APPENDIX A

The following goals and timetables for female utilization shall be included in all Federal and federally assisted construction contracts and subcontracts in excess of $10,000. The goals are applicable to the Contractor's aggregate on-site construction workforce (public and private) whether or not part of that workforce is performing work on a Federal or federally assisted construction contract or subcontract.

AREA COVERED: See special provision entitled "E.E.O. Covered Area".

Goals and Timetables

Timetable	Goals (Percent)
From April 1, 1980, until further notice	6.9

Goals are applicable in each construction craft employed by the Contractor in the covered area.

APPENDIX B

Until further notice, the following goals for minority utilization in each construction craft shall be included in Federal or federally assisted construction contracts and subcontracts in excess of $10,000 to be performed in the respective covered areas in the State. The goals are applicable to the Contractor's aggregate on-site construction workforce regardless of whether that workforce is performing work on a Federal, federally assisted, or non-federally related construction contract or subcontract. This Appendix B shall be used jointly with Appendix A.

Economic Areas

Area	Goal (Percent)
Scranton – Wilkes Barre, PA	
SMSA Counties:	
Northeast Pennsylvania	0.6
PA Lackawanna; PA Luzerne; PA Monroe	
Non-SMSA Counties	0.5
PA Columbia; PA Wayne; PA Wyoming	
Williamsport, PA	
SMSA Counties:	
Williamsport, PA	1.0
PA Lycoming	
Non-SMSA Counties	0.7
PA Cameron; PA Centre; PA Clearfield; PA Clinton; PA Elk; PA Jefferson; PA Montour; PA Northumberland; PA Snyder; PA Sullivan; PA Union	
Erie, PA	
SMSA Counties:	
Erie, PA	2.8
PA Erie	
Non-SMSA Counties	1.8
PA Clarion; PA Crawford; PA Forest; PA Venango; PA Warren	
Pittsburgh, PA	
SMSA Counties	
Altoona, PA	1.0
PA Blair	
Johnstown, PA	1.3
PA Cambria; PA Somerset	
Pittsburgh, PA	6.3
PA Beaver; PA Washington; PA Westmoreland; PA Allegheny	
Non-SMSA Counties	4.8
PA Armstrong; PA Bedford PA Butler; PA Fayette; PA Greene; PA Indiana; MD Allegheny; MD Garrett; WV Mineral	
Harrisburg – York – Lancaster, PA	
SMSA Counties:	
Harrisburg, PA	6.2
PA Cumberland; PA Dauphin; PA Perry	
Lancaster, PA	2.0
PA Lancaster	
York, PA	2.2
PA Adams; PA York	
Non-SMSA Counties	3.1
PA Franklin; PA Fulton; PA Huntingdon; PA Juniata; PA Lebanon; PA Mifflin	

Economic Areas

Area	Goal (Percent)
Philadelphia, PA	
SMSA Counties:	
Allentown-Bethlehem-Easton, PA-NJ	1.6
PA Carbon; PA Lehigh; PA Northampton; NJ Warren	
Philadelphia, PA-NJ	17.3
PA Bucks; PA Chester; PA Delaware; PA Montgomery; PA Philadelphia; NJ Burlington; NJ Camden; NJ Gloucester	
Reading, PA	2.5
PA Berks	
Non-SMSA Counties	14.5
PA Schuylkill; DE Kent; DE Sussex; NJ Cape May	
Buffalo, NY	
Non-SMSA Counties	6.3
PA McKean; PA Potter; NY Allegany; NY Cattaraugus; NY Chautauqua; NY Wyoming	
Binghamton-Elmira, NY	
SMSA Counties:	
Binghamton, NY-PA	1.1
PA Susquehanna; NY Broome; NY Tioga	
Non-SMSA Counties	1.2
PA Bradford; PA Tioga; NY Chenango; NY Delaware; NY Otsego; NY Schuyler; NY Tompkins	
New York, NY	
Non-SMSA Counties	17.0
PA Pike; NJ Hunterdon; NJ Ocean; NJ Sussex; NY Orange; NY Sullivan; NY Ulster	
Ohio	
Non-SMSA Counties	6.7
PA Lawrence; PA Mercer; OH Columbiana; OH Cleveland	

APPENDIX C
DESIGNATED SPECIAL PROVISION 13 (DSP13)

BUY AMERICA

Section 106.10(a) applies to this project.

APPENDIX C
DESIGNATED SPECIAL PROVISION 14 (DSP14)

ENHANCED MINIMUM WAGE PROVISIONS

1. **Enhanced Minimum Wage.** Contractor/Lessor agrees to pay no less than $12.00 per hour to its employees for all hours worked directly performing the services called for in this Contract/Lease, and for an employee's hours performing ancillary services necessary for the performance of the contracted services or lease when such employee spends at least twenty per cent (20%) of their time performing ancillary services in a given work week.

2. **Adjustment.** Beginning July 1, 2019, and annually thereafter, the minimum wage rate shall be increased by $0.50 until July 1, 2024, when the minimum wage reaches $15.00. Thereafter, the minimum wage rate would be increased by an annual cost-of-living adjustment using the percentage change in the Consumer Price Index for All Urban Consumers (CPI-U) for Pennsylvania, New Jersey, Delaware and Maryland. The applicable adjusted amount shall be published in the Pennsylvania Bulletin by March 1 of each year to be effective the following July 1.

3. **Exceptions.** These Enhanced Minimum Wage Provisions shall not apply to employees:

   a. exempt from the minimum wage under the Minimum Wage Act of 1968;

   b. covered by a collective bargaining agreement;

   c. required to be paid a higher wage under another state or federal law governing the services, including the Prevailing Wage Act and Davis-Bacon Act; or

   d. required to be paid a higher wage under any state or local policy or ordinance.

4. **Notice.** Contractor/Lessor shall post these Enhanced Minimum Wage Provisions for the entire period of the contract conspicuously in easily-accessible and well-lighted places customarily frequented by employees at or near where the contracted services are performed.

5. **Records.** Contractor/Lessor must maintain and, upon request and within the time periods requested by the Commonwealth, furnish all employment and wage records necessary to document compliance with these Enhanced Minimum Wage Provisions.

6. **Sanctions.** Failure to comply with these Enhanced Minimum Wage Provisions may result in the imposition of sanctions, which may include, but shall not be limited to, termination of the contract or lease, nonpayment, debarment or referral to the Office of General Counsel for appropriate civil or criminal referral.

7. **Subcontractors.** Contractor/Lessor shall include the provisions of these Enhanced Minimum Wage Provisions in every subcontract so that these provisions will be binding upon each subcontractor.

OS-299 (11-13)

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

TRANSMITTAL LETTER

PUBLICATION:
Publication 408, 2020 Edition

DATE:
November 20, 2019

SUBJECT:

PennDOT Publication 408/2020 Initial Edition - Specifications

INFORMATION AND SPECIAL INSTRUCTIONS:

Applicability: This Transmittal Letter and its attachment constitute the Initial Edition to PennDOT Specifications, Publication 408/2020. The Initial Edition to Pub 408/2020 is hereby referred to as Pub 408/2020-IE. It is new and complete in its entirety, and is effective on projects let after April 10, 2020.

Change Format: All subsequent changes to Pub 408/2020 will be made using a "new page" format. To relate changes and conditions that are in effect each bid proposal will contain a SSP named: "GOVERNING SPECIFICATIONS AND APPLICABLE DESIGNATED SPECIAL PROVISIONS". This SSP exists in ECMS format. It will specify the Initial Edition or Numbered Change of the Pub 408, the Measurement Standard, levels/goals, and the Designated Special Provisions that apply to the particular project.

CANCEL AND DESTROY THE FOLLOWING:

Not applicable at this time.

ADDITIONAL COPIES ARE AVAILABLE FROM:

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APPROVED FOR ISSUANCE BY:

Leslie Richards,
Secretary of Transportation

by:

Melissa Batula, P.E.
Acting Director
Bureau of Project Delivery

INDEX OF CHANGES TO PUBLICATION 408/2020

General: The Index of Changes has been created to assist Publication 408/2020 users in determining the specifics of semiannual changes that have been made since the release of the Initial Edition. The Index below contains the specifics of all Changes, which includes where revisions have been made and why.

The Change Process: Changes to Publication 408/2020 will be issued biannually. ***Numbered Changes*** will consist of a Transmittal Letter with instructions for posting of revisions, an updated version of this Index, and the "new pages" containing the revisions. All ***Numbered Changes*** will also be filed electronically in sequential order on the PennDOT Website. ***Numbered Changes*** will be incorporated into the Publication 408/2020 and filed under the ***Change Letters and Indices*** portion of the Publication.

The Researching of Revisions. It is critical to many users of Publication 408 to be able to determine the point in time revisions were made and what specifically the changes were. This is particularly important from a contractual perspective when researching specifications that were applicable to projects previously awarded. To assist in this process users should refer to the Change Index that follows. If revisions have been made, users can then refer to the specifics found in the Initial Edition or subsequent Numbered Change.

CHANGE INDEX OF REVISIONS THROUGH CHANGE NO.

Section and Portion Changed		Revised w/	Effective Dates	Explanation
Section	**Part or Paragraph**	**Change No.**	**From**	**Nature and Rationale for Change**
Preface				
TOC				
100				
200				
300				
400				
500				
600				
700				

Section and Portion Changed		Revised w/	Effective Dates	Explanation
Section	**Part or Paragraph**	**Change No.**	**From**	**Nature and Rationale for Change**
800				
900				
1000				
1100				
1200				
App A				
App B				
App C				