Pennsylvania Asphalt Improvement Network (PASIN)

Hot Mix Asphalt Industry Baseline Assessment Report

December 2006

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Introduction

The following report contains materials from a report prepared by r. bowen international, inc., under Pennsylvania Department of Transportation CPO #4500301139, "Asphalt Pilot Measurement Assurance".

Note to reader: The members of the Baseline Assessment Team would like to express their gratitude to the Pennsylvania Asphalt Paving Association (PAPA) and its member companies for their critical help and support in planning, conducting, and reporting the Baseline Assessment.

Section 1: Executive Summary

1. Methodology

From July to October, 2006, an independent team consisting of Jesse Dunlap, Mike Lohenitz, and Robert Bowen from r. bowen international, inc. along with Frank Colella, PAPA Technical Representative, visited five hot mix asphalt (HMA) producers and associated paving sites located strategically throughout the state. The purpose of these visits was to conduct a high-level assessment to determine current asphalt industry practice compared to:

i. PASIN Quality Manual (PASIN: Pennsylvania Asphalt Improvement Network; a joint industry-PENNDOT task force)

ii. ISO 9001-2000, "Quality Management System"

iii. Best Practice Lists supplied by PASIN sub-committees made up of industry members

Additionally, the assessment team verified a series of process maps describing the production and placement of HMA.

The assessment methodology consisted of an opening meeting, lab visit, plant visit, and visit to a nearby HMA placement site.

2. Observations and Findings

The assessment team observed both strengths and deficiencies at the five companies. It observed both similar and unique issues at each company visited. Combining all observations into five major categories, the team developed 33 findings that represent the general state of the industry. The team edited related Process Maps and annotated a Best Practice List. The following table summarizes and compares these results to the total number of findings.

	Findings by Quality Management System Category					
	Strengths		Deficiencies		Total Findings	
Category	Number	% of Total	Number	% of Total	Number	% of total
Management responsibility	1	3%	6	18%	7	21%
Measurement, analysis, and improvement	3	9%	4	12%	7	21%
Subtotal	4	12%	10	30%	14	42%
Control of essential documentation	2	6%	8	24%	10	30%
Subtotal	2	6%	8	24%	10	30%
Control of operations	3	9%	5	15%	8	24%
Resource management	0	0%	1	3%	1	3%
Subtotal	3	9%	6	18%	9	27%
Grand total	**9**	**27%**	**24**	**73%**	**33**	**100%**

3. Conclusions

Combining data from all sources, the team established an overall baseline for the Pennsylvania Hot Mix Asphalt Industry to implement PASIN and/or ISO 9001-2000 quality management systems. Although the data are from a limited number of companies, the team found a very high degree of similarity in the operations of the companies reviewed. The PENNDOT oversight process, based on company Quality Plans and a combination of technician certification programs, lab testing, District inspection, and District and Central Office quality assurance visits has effectively produced a disciplined methodology for the production, delivery, and placement of HMA throughout the state.

Because numerous established procedures are already in place, the greatest benefits with PASIN implementation will be:

a. Implementing a documentation methodology to prevent loss of existing core knowledge in HMA companies. Currently, there is a lack of internal documentation of established procedures and lessons learned that could be used to effectively train new employees as staff turnover occurs.

b. Creating a framework for process improvement that goes beyond the current oversight process that is linked to acceptance sampling and inspection.

c. Establishing proactive measurement systems to determine process and product variations that can be used to correct the product in advance to preclude an adverse effect to the finished product.

Implementing the PASIN procedures is consistent with the intent of the FHWA stewardship process defined under "Quality Assurance for Construction" of Title 23, CFR, Part 637B (1995/1998) and Technical Advisory T 6120.3, which calls for improving transportation system performance by statistically understanding the current operating characteristic curves of relevant processes rather than basing action points on historical reference.

Section 2: Management Responsibility and Measurement, Analysis, and Improvement

1. PASIN Requirements

The key elements required for each member of the PASIN organization are:

a. Quality policy and measurable goals

b. Availability of adequate resources

c. Periodic management reviews

d. Communication by top management to their organizations about:

i. the importance of meeting contractual, regulatory, and legal requirements

ii. the equal importance of understanding and satisfying the needs of the motoring public, and other customers, contractors, suppliers, and vendors, as appropriate

e. Clearly defined responsibilities and authorities including up-to-date organization charts and job descriptions

f. Documented plan for measuring and monitoring process operation, product conformance, customer satisfaction, and continual improvement

g. Internal audits of the Quality Plan and all other activities affecting quality

h. Procedures to identify, analyze, and resolve problems revealed through customer complaints or rejections, project or material nonconformities, and overall quality system noncompliance or ineffectiveness.

2. Quality Policy

The success of every HMA-producing organization depends on understanding and satisfying the current and future needs and expectations of present and potential customers in PENNDOT, as well as, end-users of HMA pavement. PASIN expects management with executive authority in each HMA-producing organization to develop a brief "quality policy" as a means of leading the organization toward performance improvement and maintaining a customer focus.

3. Quality Policy Implementation

In preparing the quality policy, top management must consider the following:

a. Current state of the organization and the level and type of future improvement needed for the organization to be successful

b. Identification and development of new skills and back-up staff for people currently in the organization

c. Needs and expectations of other partners, such as FHWA

d. Potential contributions of suppliers to the success of the organization

The organization must publish the resulting quality policy. It provides the framework to establish annual quality improvement objectives; to implement practices, procedures, and processes to accomplish the policy; and to review formally the performance of the entire organization in achieving its quality objectives.

To ensure implementation of the quality policy, PASIN requires that each organization train all employees about the quality policy, provide adequate staffing to implement the quality policy, and ensure everyone in the organization has up-to-date job descriptions reflecting their responsibilities to implement the quality policy.

As an example, the PASIN quality policy is:

"We will satisfy those we serve by consistently designing, constructing, and maintaining durable, high quality asphalt highways through the use of processes that have minimum adverse effect on surrounding communities and are continuously improved."

PASIN has developed specific documented procedures to implement this policy, such as, an Internal Auditing Process, a Management Review Process, and numerous Service Realization Processes for producing HMA and paving highways.

4. Continuous Quality Improvement

PASIN desires to establish a continuous quality improvement culture throughout the HMA supply line where executive management in each company leads its organization according to the following principles (adapted from ISO/TC 176 and ASQ "Interpretative Guide for the Design and Construction Project Team):

Principle		PASIN Goal for Each Member Company
1	Customer Focused Organization	Understand current and future PENNDOT needs; meet specifications; quick and effective response to customer feedback
2	Leadership	Set challenging goals to measure implementation of the Quality Policy; establish shared vision of how to satisfy PENNDOT and other customers
3	Involvement of People	Establish and measure competency levels; provide up-to-date organizations charts and job descriptions
4	Process Approach	Establish statistical control of relevant processes and document them; understand the interdependence of all processes
5	Systems Approach to Management	Write a quality systems manual that shows how processes are aligned to achieve continuous improvement; measure progress
6	Continuous Improvement Framework	Give everyone the tools and opportunities to improve continually through use of management review meetings, internal quality system audits, written preventive and corrective action reports.
7	Factual Approach to Decision Making	Actions based on analysis of data; use trend data to align all work activity toward the goals of the quality policy
8	Mutually Beneficial Relationships	Build trust; create teams of PENNDOT and industry personnel to achieve recognizable continuous improvement for both

5. Current State of Management Responsibility and Measurement, Analysis, and Improvement

During the baseline assessments, ten (10) areas of noncompliance were observed in these two areas, approximately 30% of total findings. Generally, these areas of noncompliance involved the lack of a quality policy aimed at continuous improvement, of objectives to drive continuous improvement, and of a management review to monitor trend data to achieve continuous improvement. Four (4) observations, or about 12% of the findings, did note good practices in the area of "management responsibility/customer focus". In one case, the company's effort exceeded the basic PASIN requirements for satisfying customer needs.

The quality of organization charts and job descriptions observed was mixed. Most organizations had adequate job descriptions as a part of their PENNDOT Quality Plan. However, this was not uniform at all organizations and several observed job descriptions had not been up-dated to reflect current changes in job duties. One organization had gone beyond the requirements of the Quality Plan to develop off-line job descriptions with clearly stated quality responsibilities and training plans linked to achieving these duties.

Quality Plans observed were excellent methods to monitor product acceptance by PENNDOT; however, very few measurements were observed that were aimed to improve process operation. Most operations visited had redundant controls in place to ensure that parameters effecting payment consistently were met. Only one site provided trend data or statistical analyses that were used to analyze process performance and improve operations.

Closely aligned to the PASIN requirement of effectively using of measurement data (Section 8.4) is its requirements to have formal corrective (Section 8.6) and preventive (Section 8.7) action reporting systems to drive continuous improvement. The companies addressed each observed PENNDOT acceptance failure related to payment promptly and effectively. However, none of the locations visited entered PENNDOT failure notices --- from the Lab or otherwise --- into a formal system. None of the organizations observed formally analyzed failure notices to determine if related defects might be occurring elsewhere; nor did any of the organizations utilize any type of long-term verification of the effectiveness of corrective actions resulting from PENNDOT failure notices.

6. Recommended Actions

Based on the baseline assessment reviews the following are recommended actions related to management responsibility and measurement, analysis, and improvement:

a. Develop an effective quality policy within each PASIN member organization

b. Establish company specific quality objectives within each PASIN member organization

c. Develop these objectives based on the company's quality policy and establish a measurement system to track progress

d. Develop a company specific quality plan that briefly describes what the organization will do to comply with each relevant section of the PASIN Quality manual (The company could modify or adopt the PASIN quality manual)

e. Develop and implement a "Management Review" Procedure

f. Update job descriptions and organization charts to reflect the new quality policy

g. Develop a procedure to formalize an annual review and update of the Quality Plan to include new quality objectives or changes in the quality policy

h. Establish periodic internal audits of all activities affecting quality

i. Establish a Corrective and Preventive Action Reporting System (CPAR) including a formalized problem solving approach of a degree appropriate to the magnitude of the problem

7. Implementation Suggestions

The following are suggestions for initial implementation of the management responsibility and measurement, analysis and improvement procedures:

a. Conduct at least bi-weekly management review meetings during the Pilot to review progress and discuss issues. Assure that top management, the people who direct and control the organization are involved and attend each meeting, along with the Quality Manager, and the foremen from the HMA plant and job site. Keep the meetings to no more than an hour. Document and track action assignments. Publish and distribute the meeting notes to everyone involved in the Pilot.

b. Exhibit 1 at the end of this report shows an example of a typical management review meeting agenda; Exhibit 2 shows a CPAR procedure with an example of a CPAR form (Exhibit 3).

Section 3: Control of Essential Documentation

1. PASIN Requirements

The PASIN documentation requirements include:

a. Meeting the requirements of

i. The PASIN Quality Manual

ii. ISO 9001-2000, "Quality Management System", and,

iii. The PASIN Best Practice Lists

b. Standard operating procedures, process maps, best practices, detailed work instructions, specifications and/or forms covering HMA design, production, testing, and placement and procedures governing management of the quality system

c. Written procedures for the development and control of documents and records

2. Documentation Procedures

Management must define the documentation needed to take part in the PASIN Pilot, including the relevant records. Companies usually do this by keeping a master list, or equivalent, of the current versions of all relevant documents. Documentation may be in any form or medium. Information about operating or improving any portion of the company involved in the PASIN pilot must be readily available at point of use and at time of use. Examples of documents controlled in this manner include relevant specifications and PENNDOT bulletins, relevant test procedures, the PENNDOT approved Quality Plans and its supporting test records and reporting forms, minutes from the management review meetings, records of quality improvement projects, contracts or purchase orders, equipment calibration and maintenance records, etc.

The company specific Quality Plan should describe the basic document control system. This Quality Plan often points to a subordinate procedure to locate the details of how the document control system works in a particular organization or company. The following is a quote from the PASIN Quality Manual describing its policy about document control:

"QMS documents are maintained by PASIN member organizations, provide evidence of conformance to requirements, and verify the effectiveness of the quality management system. Up-to-date documents are essential to preclude the use of invalid or obsolete information. Documents are prepared, reviewed, approved by authorized personnel, distributed to locations where essential operations are performed, revised when necessary, and disposed of to provide appropriate control. PASIN organization members use documents of external origin and these are also appropriately controlled per documented procedures."

Once this type of basic documentation policy is established, an overarching written procedure is then developed to explain how to write and store documents or records related to the quality system. In the PASIN example shown above, the detailed instructions for document control would be found in a specific procedure such as QPM001-02.

3. Current State of Control of Essential Documentation

During the baseline assessments, eight (8) areas of noncompliance were observed in the area of documentation, approximately 24% of the total findings. Two (2) or about 6% of the total findings were good practices relating to documentation that met the PASIN requirements.

The areas of noncompliance involved:

a. Lack of written procedures on PASIN core requirements including:

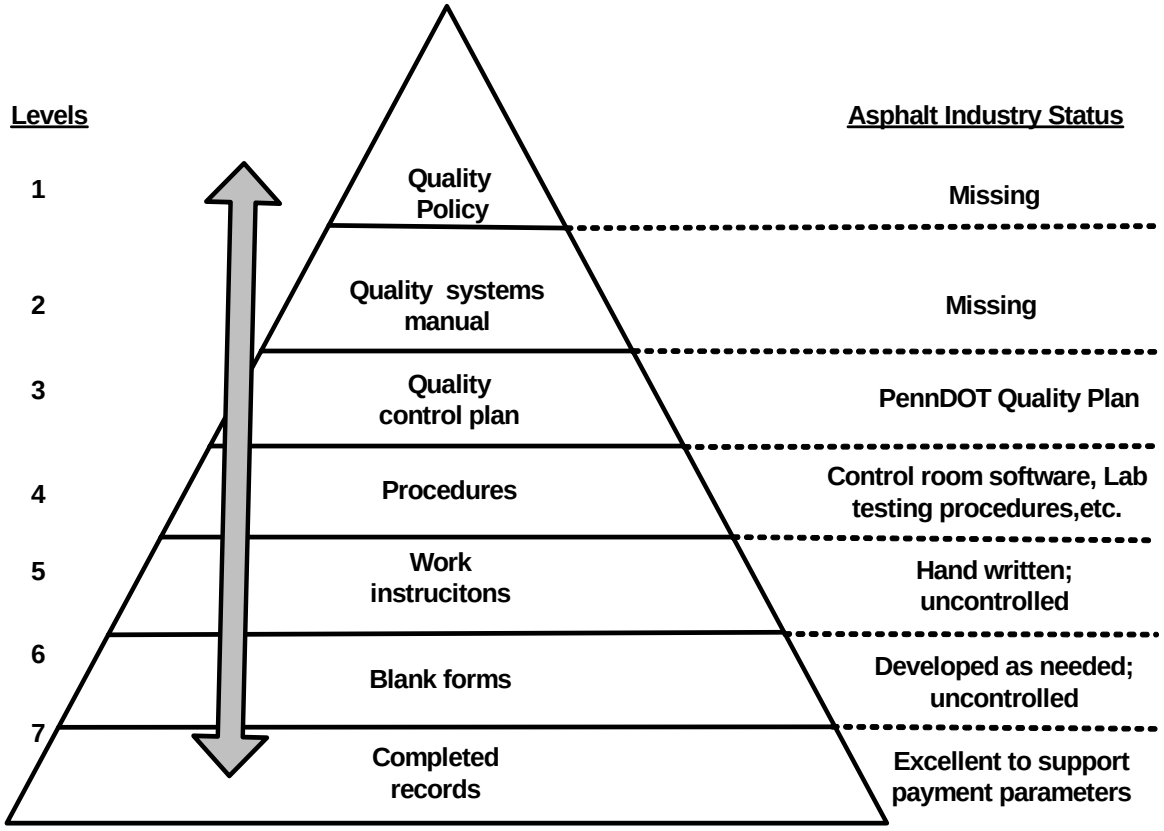
i. Documentation of an internal quality audit system

ii. Documentation of corrective and preventive action systems, and

iii. Documentation of procedures for distribution of new documents, and removal or identification of obsolete documents.

b. Lack of an accessible, central location for important process control information. In many cases, this information was in the form of "lessons learned the hard way" written on personal note cards or notebooks rather than documented in procedures accessible to everyone.

The general overall status of the HMA industry regarding PASIN requirements for documentation shown below graphically:



4. Recommended Actions

Based on the baseline assessment reviews the following are recommended actions related to resource management and documentation:

a. Develop a short, standard procedure to use throughout the organization on "How to write and control a Quality System Document or Record"

b. Develop ground rules to control the use of handwritten information and assure that appropriate information subsequently is incorporated into the controlled documentation

c. Assure that process control software is properly secured to preclude unauthorized changes

d. Develop a master list or equivalent of existing relevant documents and records

e. Purge or properly label **all** obsolete information

5. Implementation Suggestions

The following are suggestions for initial implementation related to documentation:

a. The key control point to successfully passing an outside audit on document control methodology is to establish rigorous procedures to remove obsolete information from points of use. If obsolete material cannot be removed, provide an easily visible method of identification for the material.

b. It is not necessary to document everything. The basic rule of thumb is to document everything to the extent that lack of documentation will cause an "adverse impact" on the quality of the product being produced. The purpose of PASIN documentation is to:

i. Ensure good ideas are not lost and are accessible throughout the organization

ii. Provide a resource for training new staff quickly and effectively

iii. Establish a baseline of information for trouble-shooting

c. Exhibit 4 shows a typical PASIN compliant document control procedure.

Section 4: Control of Operations and Resource Management

1. PASIN Requirements

The PASIN requirements related to the control of HMA production and placement include:

a. Project plans, process maps, procedures, work instructions, specifications, and Quality Plans that define work practices available at point of use

b. Clearly defined acceptance criteria

c. Workmanship standards (skills and knowledge combined with experience)

d. Current construction plans, drawings, and specifications in construction field offices

e. Inspection, test, and audit activities documented and implemented

f. Current project administrative manuals and test method manuals accessible in construction field offices

g. Regularly planned maintenance and calibration of equipment, measuring tools, and test devices and documentation of compliance

h. Trained, competent personnel with documented qualifications and training records

i. Defined processes for the timely release and distribution of data, test results, and status reports

j. Safe work environments with documented safety meetings

k. Documented lessons learned from completed projects documented to use as inputs for future projects and process improvements

2. Application of Quality System Management and Process Control

Top management must ensure the effective and efficient operation of all processes and the associated network to assure that the organization continues to meet customer expectations. A process is defined as a sequence of related activities. Processes must be documented to the extent necessary to support continued effective and efficient operation. Management also has the responsibility to ensure that steps are taken to identify and mitigate potential risk to the users of the products and processes of the organization.

Success oriented businesses focus on using processes that deliver quality products and services quickly, while increasing their profit margins. These businesses continuously evaluate operations to identify improvement opportunities with the greatest return on investment. To accomplish this, inspection techniques have gained wide acceptance and are used, in some form, in most environments. However, inspection alone is not the most effective method to judge quality and maximize profit potential. This is achieved by using quality-engineering tools to control and optimize processes and reduce variability. One of the primary applications used for achieving continuous improvement is Statistical Process Control (SPC). The success of this approach is most often gauged by achieving and sustaining highly consistent product characteristics as measured by the Process Capability Index (Cpk). This tool helps optimize consistent processes thus reducing unexpected results and, as a result, increasing profits.

The PASIN quality management system is a framework for continuous improvement based on the following foundation:

a. understanding and consistently meeting requirements

b. considering processes in terms of added value

c. obtaining acceptable results for process performance and effectiveness

d. continual improvement of processes based on objective measurement

PASIN calls for all steps in the process to produce, transport, place, and test hot mix asphalt pavement to be operating under "controlled conditions". The results of any work that directly affects quality must be predictable. This type of control includes:

a. documented procedures defining the manner in which these processes are carried out, wherever such procedures could affect quality of the finished product

b. suitable working environment (the conditions under which work is performed including physical, social, psychological, and environmental factors)

c. monitoring and control of identified process parameters or characteristics

d. monitoring and control of specified product parameters or characteristics

e. communicating the criteria for minimum acceptable workmanship in the clearest practical manner (e.g. written standards, representative samples, or illustrations, etc)

During the Baseline assessment, the teams developed a "Best Practices Checklist" that provides an objective basis to determine compliance with PASIN goals for the production, transport, and placement of hot mix asphalt pavement.

3. Current State of Control of Operations and Resource Management

During the Baseline assessment, six (6) noncompliance areas were observed in these two areas, approximately 18% of the total findings. Three (3) or about 9% of the total findings relating to control of operations met PASIN requirements.

The existing QA/QC model in the asphalt industry is based upon acceptance sampling and inspection as defined in the Quality Plan. This approach meets most of the basic PASIN requirements listed above, but does not provide a framework for continuous improvement (Principle 4 – page 6).

For the most part, the Quality Plan system is successful and consistently provides product and services that meets customer and applicable regulatory requirements. Generally, the Quality Plan system does a good job to preclude known problems with meeting specifications by having action points and acceptance sampling based on historical data.

However, the PASIN system is designed to enhance overall customer satisfaction through continual improvement of conformity to customer and regulatory requirements. Therefore, the overarching requirement to comply with the PASIN system is a process control approach to quality management. External customer and stakeholder requirements provide input into a systemic approach for designing, producing, constructing, and maintaining hot mix asphalt pavements that satisfies those who use them. This methodology systematically identifies, monitors, and improves the processes employed and their interactions.

The strongest documents observed during the five PASIN baseline audits were the Quality Plans. This was no surprise since PENNDOT requires hot mix asphalt suppliers to prepare and submit comprehensive Quality Plans. The audits showed that, in general, the Quality Plans are being followed as written. There were some exceptions, such as asphalt pumps not being calibrated per the documented requirements but, overall, compliance was good.

All Quality Plans listed comprehensive requirements with appropriate reference to PENNDOT and industry standard documents. The audits revealed that the referenced documents were available to those needing the information. Numerical specifications were clearly listed in Quality Plans, with corrective action requirements described when specifications are not met. Requirements for equipment calibration were also defined. Records requirements were clearly defined.

The Quality Plans included the equipment used to manufacture and deliver the hot mix asphalt, but did not include the construction process (transfer vehicle, paver, rollers, etc.) in all instances. One quality plan described the requirements for HMA construction in some detail, but this was the exception.

Additionally, the Quality Plan system is well in compliance with "Quality Assurance for Construction", Title 23, CFR, Part 637B (1995/1998). The FHWA "stewardship process" as expressed in Technical Advisory T6120.3, calls for implementing the use of statistically sound acceptance plans, understanding statistics, determining percent within limits, and assessing associated contractor and agency risks. However, because most of the existing action points appear to be based upon historical reference rather than statistically understanding the current operating characteristic curves of relevant processes, the Quality Plan system does not provide a good framework for continuous improvement.

4. Recommended Actions

Based on the baseline assessment reviews the following are recommended actions related to control of HMA production and placement operations:

a. Train all relevant personnel in PASIN process maps and Best Practices.

b. Develop training programs to establish and maintain the skills and knowledge of the work force and assist in maintaining institutional knowledge to sustain the company for the future.

c. Statistically analyze the routine variation of measuring and test devices.

d. Perform process capability studies to produce a current operating characteristic curve and calculate a Cpk on pay point and control point parameters.

e. Reduce or eliminate unacceptable variation in all processes or actions affecting Cpk

5. Implementation Suggestions

The following are suggestions for initial implementation related to control of HMA production and construction:

a. Use the PASIN Best Practice Checklists and Key Control Points as a starting point to establish and maintain controlled operating conditions for relevant processes.

b. Adopt quality control practices at the HMA plant and at paving operations focused on monitoring the production, transport, and placement processes instead of lot acceptance. Do not rely

on PENNDOT minimum quality control requirements as adequate for controlling the quality of HMA production, transport, and placement activities.

c. Determine if Control Room software and Lab software automatically calculate Cpk. If it does, use the existing software or establish new QC charts to monitor changes in all processes affecting Cpk. (see Exhibit 5 Cpk Example for Asphalt Content.)

d. Establish documented expectations for the skills and knowledge required to perform tasks, have supervisors regularly evaluate their subordinates, and have management certify that employees meet these requirements.

Exhibit 1: Typical Management Review Meeting Agenda[1]

January	**Quality System Management Review Meeting** **Time and Date: 9:00 AM until 11:00 AM** **Location: Auditorium**		
Attendance required:			
Engineer of Tests:	✓ William Smith	**Quality Manager:**	✓ Bill Gordonski
Scribe:	✓ Kara Koonz	**Timekeeper:**	✓ Sherry Jones
Purpose: Review of the Laboratory's quality management system to ensure its continuing suitability, adequacy, and effectiveness to include assessing opportunities for improvement and the need for changes to the quality management system, the quality policy, the quality objectives, and the test results produced as related to customer requirements.			

Optional Attendees:			
✓ **P Smith, Sec. Chief** ✓ **R Jones** ✓ **M Doe** ✓ **P Millersville**	✓ **D Kennedy, Sec. Chief** ✓ **W Queen** ✓ **E Reapsome** ✓ **N Bitmyer**	✓ **D Morgan, Sec. Chief** ✓ **S Ford** ✓ **M Dickerson** ❑ **J Smithson**	✓**C Needles** ✓**Eric Berwick** ✓**Ed Andrews** ✓**T Esh**

----- Meeting Agenda -----

Discussion Topic	Leader	Time
Audits ▪ Update on External ISO Audits ▪ Internal Audit Results ▪ AMRL On-site Inspection ▪ CCRL On-site Inspection	Bill G.	10 min
Customer Feedback ▪ Customer Satisfaction Index Project – update ▪ Customer Complaints ▪ Customer Rejections	Sherry J.	10 min
Process Performance and Product Conformity ▪ Measurement System Performance ▪ Performance on AMRL and CCRL Proficiency Tests ▪ Staffing ▪ Technician Training and Competency ▪ Equipment Calibration and Maintenance ▪ Facilities	Terry E Sherry J. Eric B. Ed. A.	
Corrective and Preventive Actions ▪ Analysis of CPARs ▪ Status of Open CPARS	Mike L.	
Actions Items from Previous Management Reviews (review items on action log)	Chris N.	
Changes to the Quality System ▪ Implemented Changes ▪ In progress Changes ▪ Proposed Changes	Bill G.	
Recommendations for Improvement	William S.	

[1]Adapted from the PENNDOT MTD Testing Laboratory format

Exhibit 2: Typical Procedure Describing How to Use the CPAR Form

DISCIPLINE 1: USE TEAM APPROACH

- ✓ Select internal and external team members
- ✓ Select a team champion (management member who will remove roadblocks)
- ✓ Select a team leader (member who directs efforts and takes responsibility for team)

DISCIPLINE 2: DESCRIBE THE PROBLEM

- ✓ Use terms understood by the customer
- ✓ Describe the change in pre-existing condition which caused the problem
- ✓ Express the condition in quantifiable terms

DISCIPLINE 3: DESCRIBE THE ROOT CAUSE

- ✓ Describe why the change in condition occurred, or identify the flaw in the system which allowed the pre-existing condition to go undetected
- ✓ Categorize the root cause, e.g.:

Material	Machines	Methods
Manpower	Maintenance	Mother Nature (Environment)

DISCIPLINE 4: IMPLEMENT CONTAINMENT PLAN

- ✓ Describe who, what, when and how you will capture and contain the defects now and prevent them from getting to customer
- ✓ Consider containment plan impact on:
  - Cost
  - Delivery
  - Inducement of other types of defects

DISCIPLINE 5: IMPLEMENT PERMANENT CORRECTIVE ACTION

- ✓ Describe who, what, when and how you will implement changes in material, manpower, methods, etc., to totally eliminate the root cause of the problem
- ✓ Consider permanent corrective action plan impact upon:
  - Inducing other types of defects
  - Elimination of containment activities (if corrective action plan works, containment activities should no longer be required)

DISCIPLINE 6: VERIFICATION OF CORRECTIVE ACTION

- ✓ Describe verification results in quantifiable terms (e.g., decreased defect occurrences to zero, etc.)
- ✓ Continue containment plan until permanent corrective actions are verified as being effective

DISCIPLINE 7: PREVENT RECURRENCE

- ✓ Describe the internal and/or external systemic changes that must be made to prevent the problem from recurring
- ✓ The team champion is responsible for taking these recommendations back to management and driving implementation

DISCIPLINE 8: CONGRATULATE YOUR TEAM

Exhibit 3: Typical CPAR Form[2]

Corrective and Preventive Action Report (CPAR) # _____

1. Describe Problem or Improvement Opportunity: Lab_____ Date_____ Initials ___
   Quality Manual Reference: _____ (Section # or QP # and section, if applicable)

Reviewed and Logged by Quality Manager: Initials _____ Date _____

2. Describe the cause as you see it: Lab_____ Date_____ Initials _____

3. Describe how to contain immediate problems: Lab_____ Date_____ Initials _____

4. Determine the root cause: Responsible person_____ Date____ Initials _____

5. Describe the permanent plan and date for completion: Responsible Person_____
Date_____ Signature _____

Anticipated Completion Date:

6. Solution verified by Quality Section: QA Responsible Person _____Date_____
Signature_____

[2] Adapted from the PENNDOT MTD Testing Laboratory format

Exhibit 4: Typical Document Control Procedure[3]

4.2.1 General

The Quality Management System documentation shall consist of a Quality Manual that includes and or references the Policies and Procedures of the organization as they relate to the Quality Management System. It also includes the Quality Policy and objectives, work instructions which provide directions and guidance for the execution of critical tasks, forms which are used to provide a systematic method for recording specific information needed to document activities or the results of activities and the records required by ISO 9001:2000. Further, the Quality Management System documentation shall include and or reference those documents needed by the organization to ensure the effective planning, operation and control of processes.

4.2.2 Quality Manual

Our Quality Manual defines the quality management system for the Construction Unit and the scope of our organization is to ensure that roads and bridges designed by the PENNDOT design organizations are built according to specifications. Therefore, design is excluded from the scope of this quality management system because this function is the responsibility of others by department-mandated procedures. This Quality Manual includes and or references Policies and Procedures, work instructions which provide directions and guidance for the execution of critical tasks, and forms. On an annual basis, a general overview of this manual and ISO operating procedures are presented to the construction unit staff. The Quality Manual also contains a description of the sequences and interactions of the processes included in the Quality Management System. It should be noted that although design and maintenance are not the primary responsibility of the Construction Unit, there are interfaces with design and maintenance that are currently established and we plan to expand interaction between these units in the future. Interactions are described in section 4.1 of this manual.

4.2.3 Control of documents

The Master copy of all Quality System documentation shall be maintained electronically under the supervision of the Management Representative. Employees shall check any hardcopy Quality System document against the electronic Master to ensure it is the latest version. Any documents for the Quality Management System shall be reviewed for adequacy and approved prior to issue. At least annually, an agenda item for Management Review shall be a discussion of the need for review and updating of documents. If updates are necessary, such documents shall be re-approved before reissuing. Documents of external origin such as federal, state, and county publications (e.g. Pub 408), regulations, or Standards (e.g. AASHTO) are identified and controlled in each sub-unit to ensure that the proper versions of the documents are used. Any documents (forms) created for district use only will be stored and controlled within our LAN system J:Drive.

The creation, revision, and distribution of the Quality Manual, Work Instructions, and Forms are the responsibility of the Management Representative. The Assistant Executive - Construction Unit or the Management Representative shall approve all changes to the Quality Manual. The Table of Contents of the Quality Manual shows the latest revision date of each section so users can verify they have the correct revision. The most recent version of each document in the Work Instructions and Forms file will have a revision date. Any user of hard copy documentation shall check the master listing maintained on the computer master to ensure the hard copy document is the applicable version. Each sub-unit head shall hold the master copy of each document type for their area, identifying the current revision status to ensure applicable documents are available at points of use. Each sub-unit head is responsible for reviewing documents pertaining to their specific work function to verify current issue for use during the last quarter of the year and report on the status at the last management review meeting of the year. If uncontrolled copies are issued, they shall be clearly identified. Obsolete documents retained for legal or knowledge preservation purposes shall be suitably identified.

Changes to internal documents may be recommended by any employee and forwarded to the document owner for review and action. The document owner is responsible to control the new issues and revisions and to assure proper approvals and distribution, and to assure obsolete documents are removed. A Document Ownership Chart [see Appendix A that follows] shall be maintained by the appropriate sub-unit head who shall least annually conduct a review of documents to ensure that documents remain legible, identifiable, and retrievable. These documents are listed in appendix A of this clause.

4.2.4 Control of records

Quality records that demonstrate conformance to specified requirements shall be stored for future reference. Quality records are identified in the list below [see Appendix B that follows] and shall be controlled by the document owner and retained for the length of time specified by the sub-unit or others, as appropriate.

Issues relating to protection, retention time and disposition of quality records shall be discussed at least annually in Management Review and appropriate and actions, if any, shall be recorded and instituted. Retention times are noted for each area in appendix B to this section.

Each sub-unit defines methods used for the identification, collection, indexing, access, filing, storage, maintenance and disposition of quality records include suitable identification of the contents of files or electronic media or storage boxes.

[3]Adapted from the PENNDOT Engineering District 10-0 Construction Unit format

1. APPENDIX A: DOCUMENT OWNERSHIP CHART

The following is a list of documents referenced in the QMS procedures for individual areas throughout the construction unit. (Note: The classification of documents indicated below is for information only. Documents may be used in various places throughout the Construction Unit.)

TOP MANAGEMENT

Customer Service Index Survey and Results HACS
After Action Review Minutes
Legislative Contact Report
Customer Complainant System (Electronic) Organizational Chart Job Descriptions
District Dashboard (Electronic)

MANAGEMENT REPRESENTATIVE

ISO 9001:2000 Standard District 10 ISO Quality Manual

MATERIALS

Bulletin #15 Approved Construction Materials Bulletin #14 Approved Aggregate Producers
Bulletin #41 Approved Bituminous Asphalt Producers Bulletin #42 Approved Concrete Producers
ASTM Specifications
AASHTO Specifications
Maintenance Manual
PTM Pennsylvania Test Methods Manual
Bulletin #27 Bituminous Concrete Mixtures, Design Procedures

GEOTECHNICAL

Pennsylvania Publication 293 Pennsylvania Design Manual 4
AASHTO LRFD Bridge Design Specifications Geotechnical Engineering Report Project Specific Foundation Report Project

CONSULTANT AGREEMENT PENNDOT Publication #93

LABOR CONTRACT COMPLIANCE

PENNDOT Labor Compliance Manual

STRUCTURAL CONTROL

Structural Welding Code
Bridge Standards
Bridge Coating Inspection Manual

FIELD OPERATIONS

Project Office Manual (P.O.M.)
Publication 408 Specifications
Contract Documents Including Special Provisions Roadway/Bridge/Traffic Control Standards Project Plans
Cross Sections
Project Partnering Meeting Minutes (If applicable)

2. APPENDIX B: QUALITY MANAGEMENT SYSTEM FORMS/RECORDS INDEX

Note: The classification of forms indicated below is for information only. Forms may be used in various places throughout the Construction Unit.

MATERIALS: minimum five (5) year retention for all quality records

District Forms – Equipment Calibrations CS-430 Notification of Inspection

CS-458A Report of Compressive Strength of Portland Cement Concrete 4/99 CS-616 Request for Plant Substitution CS-4171 Certification of Compliance 1/02 CS-4211 Table of Contents 10/95

CS-4211A Material Test Results10/95 CS-4211B Project Summary 10/95 CS-4211C Summary and Moisture Record 1/96 CS-4337 Annual Inspection of Transit Truck Mixers 1/96 CS-4337A Summary Producers Transit Truck Mixers 9/78 TR-430A Aggregate Source Evaluation Report 1/96 TR-447 Sample Identification 9/93 TR-455 Disposition of Failed Materials 8/95 TR-459 Air Content of Hardened Concrete TR-465 Daily Bituminous Mixture Certification 1/96

TR-498 Bituminous Concrete Plant Inspection Report 12/97 TR-4109 Portland Cement Concrete Plant Report 1/96 TR-4126A Aggregate

GEOTECHNICAL: minimum seven (7) year retention on all quality forms District Form-In-House Design Request Form

TR-4247 Method for Calculation of Moisture Density Relationship 1/96 TR-4276A Nuclear Method Compaction Density Report 5/92

LABOR CONTRACT COMPLIANCE: minimum seven (7) year retention

CS-4339R Request for Subcontractor Approval 1/03

EO-16 MBE/WBE Subcontractor and Supplier Solicitation Sheet 9/99 EO-32 MBE/WBE Subcontractor and Supplier Commitment Sheet 12/97 EO-364 Trainee Enrollment Form

EO-365 Highway Contractor Training Report 10/94

EO-380 PENNDOT Schedule of DBE Participation "Attachment A" EO-400 Highway Contractors Monthly EEO Report 5/02 EO-402 Monthly DBE Status Report 12/97 EO-403 Contracts and Subcontracts Awarded 5/96 FHWA-1022 Notice (Poster) 6/90

FHWA-1391 Construction EEO Report 3/92

LLC-25 Payroll Certification for Public Works Projects 3/98 OFCCP-1420 Equal Employment Opportunity is the Law OSHA-3165 Job Safety and Health Protection (Poster) LP-744 Pennsylvania Human Relations Act (Poster)

WH 347 Contractor's and Subcontractor's Payroll Statement 11/98 WH 1321 Notice to Employees 1/86

FIELD OPERATIONS: minimum seven (7) year retention on all quality forms

CS-111 Sub-Contractor/Supplier Request for Estimate Monitoring 11/94 CS-472 Concrete Inspector's Daily Record Book 5/96 CS-4333 Field Inspector's Diary 10/94 CS-4334 Master Diary 1/92

CS-4346 Items Quantity Book 12/91 D-428 Surveyor's Notebook 2/72

CS-4345 Borrow and/or Waste Agreement D-412A Computation of Earthwork 9/86 CS-4136 Punchlist

CS-4137 Final Inspection 1/03

CS-4138 Acceptance Certificate 8/01 FHWA-1446A Construction Inspection Report FHWA-1446B Final Acceptance Report 12/73

Exhibit 5: Cpk Examples for Asphalt Content

Asphalt Content in Job Mix Formula
Specification: 6.0 ± 0.4

Date	Data Set 1	Data Set 2	Data Set 3
7/1/2005	6.1	6.3	6.1
7/1/2005	6.0	6.2	5.7
7/2/2005	5.8	6.0	5.6
7/2/2005	5.8	6.0	5.8
7/3/2005	6.0	6.2	6.3
7/3/2005	5.9	6.1	6.0
7/5/2005	6.1	6.3	6.0
7/5/2005	6.0	6.2	6.2
7/6/2005	5.9	6.1	5.7
7/7/2005	5.9	6.1	5.6
7/7/2005	6.0	6.2	6.3
7/8/2005	6.0	6.2	6.0
7/9/2005	6.0	6.2	6.1
7/11/2005	5.9	6.1	6.4
7/11/2005	6.1	6.3	6.0
7/12/2005	6.0	6.2	6.1
7/12/2005	6.0	6.2	5.8
7/13/2005	5.8	6.0	6.0
7/14/2005	6.0	6.2	5.9
7/14/2005	5.9	6.1	5.7
7/15/2005	6.0	6.2	6.0
7/16/2005	6.0	6.2	5.9
Sum	131.2	135.6	131.2
Average	5.96	6.16	5.96
Standard Deviation	0.090	0.090	0.226
CPK	**1.34**	**0.87**	**0.54**

Cpk is a statistic used to monitor improvement. The most valid comparisons to make are those made of a specific Cpk over time. Goals set for Cpk can be of value to drive continuous improvement. Management review of Cpk is often a catalyst for improvement. Cpks of higher then 1.00 indicate more predictable process performance; Cpks of less than 1 indicate processes with less predictability. The calculation of Cpk is often automatically included in process control software as a means to compare routine process variation to the long-term process average. The Cpk is the minimum value calculated from the following:

$$Cpl = \frac{\overline{X} - LSL}{3\sigma} \qquad \text{or} \qquad Cpu = \frac{USL - \overline{X}}{3\sigma}$$

Bibliography

1. ISO 9001-2000, "Quality Management Systems Requirements", available at www.iso.org, Copyright: 2000 by International Organization for Standardization, Geneva, Switzerland.

2. Federal Highway Administration Technical Advisory T-6120.3, "Use of contractor test results in acceptance decisions", August 9, 2004, retrieved from http://www.fhwa.dot.gov/legsregs/directives/techadvs/t61203.htm

3. Federal Highway Administration "Construction Program Management and Inspection Guide", available from FHA Office of Asset Management, 400 7th Street, SW, HIAM-1, Washington, D.C., 20590

4. "ISO 9001:2000 Interpretative Guide for the Design and Construction Project Team", available from the American Society for Quality (ASQ) at www.asq.org, Copyright: 2003 by ASQ, Milwaukee, Wisconsin (ISBN 0-87389-601-7)

5. "Hot-Mix Asphalt Paving Handbook: 2000", US Army Corps of Engineers, 2nd edition, (ISBN 0-0135314)