



*Since 2003, the Federal Highway Administration has reviewed 37 State Highway Agencies' Quality Assurance Programs. This report summarizes the reviews from the 13 States – conducted from 2009 through 2012.*



U.S. Department  
of Transportation

**Federal Highway  
Administration**

## QUALITY ASSURANCE STEWARDSHIP REVIEW SUMMARY REPORT FOR FISCAL YEARS 2009 THROUGH 2012

### Title 23, Code of Federal Regulations, Part 637

#### §637.201 Purpose.

To prescribe policies, procedures, and guidelines to assure the quality of materials and construction in all Federal-aid highway projects on the National Highway System.

#### §637.203 Definitions.

**Acceptance program.** All factors that comprise the State transportation department's (STD) determination of the quality of the product as specified in the contract requirements. These factors include verification sampling, testing, and inspection and may include results of quality control sampling and testing.

**Independent assurance program...**

**Proficiency samples...**

**Qualified laboratories...**

**Qualified sampling and testing personnel...**

**Quality assurance...**

**Quality control...**

**Random sample...**

**Vendor...**

**Verification sampling and testing...**

### *Executive Summary*

A States Quality Assurance program is the process a State uses to determine whether they are obtaining the material that was specified. Fifty percent of the Federal-aid construction dollars are spent on materials. Therefore there is significant risk if States' Quality Assurance programs are inadequate. The FHWA publishes its requirements for Quality Assurance programs in 23 CFR 637. Proper implementation of this regulation helps assure proper expenditure of Federal-aid funds. These reviews are listed in the agency's Strategic Plan as part of the agency's on going stewardship activities. Quality Assurance Stewardship Reviews were conducted to determine the strengths and weaknesses in States' Quality Assurance (QA) Programs for construction. QA Programs included acceptance, independent assurance, technician qualification and laboratory qualification. Since 2003, QA Programs in 37 States have been reviewed. This report summarizes the reviews from the 13 States that were conducted from 2009 through 2012.

Five of the 13 States reviewed used contractor test results in the acceptance decision. In most States where contractor test results were used in the acceptance decision, *it was found that the States' systems for comparing test results between the contractor and State needed to be strengthened.* The major opportunities for improvement in this area included:

- Statistical comparison between the State & contractor results;
- State control of sampling locations;
- Verification of pavement smoothness data; and
- Custody of State verification samples.

Although the Independent Assurance Programs were generally well developed, there was one area noted in several States that needed improvement. This being the tolerances used for comparing test results needed to be reevaluated more frequently.

During this time, 2009-2013, there were two noteworthy trends.

- 1) States were increasingly using electronic materials management systems to effectively manage and analyze their large volumes of testing and inspection data.
- 2) The States were also increasing the use of data from National Transportation Product Evaluation Program (NTPEP) to approve manufactured products. NTPEP is an AASHTO effort to test and

evaluate common manufactured materials and provide results for use by all agencies. Both of these approaches are assisting States to continue assuring material quality in a time of flat or declining resources.

It is planned that the Quality Assurance Stewardship Reviews will continue. Additionally, there will be continued development and updating of resources based on these reviews in order to continuously improve the QA Program.

### *Background*

The regulation, 23 CFR 637, originally providing requirements for State sampling and testing programs were issued in the early 1960's. The regulations came about as a result of congressional investigations that uncovered fraud and poor sampling and testing procedures used by State personnel. There is significant risk since 50% of the Federal-aid construction dollars are spent on materials alone. Proper functioning quality assurance programs will help ensure proper stewardship of the Federal-aid dollars. Over the years the regulations have been revised a number of times. The latest revisions to FHWA's sampling and testing regulations titled, "Quality Assurance Procedures for Construction," were published on June 29, 1995, as Title 23, Code of Federal Regulations, Part 637 (23 CFR 637). This particular revision was made due to the need to improve the Quality assurance process as the states implemented the use of contractor testing in the acceptance decision. The concerns about the process were found through several national reviews that were performed in the early 1990s. *The five most significant changes in the regulation were as follows:*

- 1 • Required all testing personnel and laboratories to be qualified using State procedures.
- 2 • Required the State's central laboratory to become accredited by the AASHTO Accreditation Program or a comparable program.
- 3 • Provided flexibility in sampling and testing by allowing the use of Contractor test results in the overall State acceptance decision, provided certain checks and balances were in place.
- 4 • Allowed consultants to be used in performing Dispute Resolution or Independent Assurance (IA) if their laboratories have been accredited by the AASHTO Accreditation Program or a comparable program.
- 5 • Allowed States to use a system approach to IA instead of establishing frequencies based on individual project quantities, provided certain reporting requirements were followed.

Several parts of the revised regulations had implementation dates of June 29, 2000. In FY 2003, the current program of Quality Assurance Stewardship Reviews was established. After the first year of these reviews were completed in FY 2003, concerns were expressed over the use of contractor supplied test results used in the acceptance decision. The concerns centered on cases of fraud as they related to proper validation of contractor test

results. Thirty-one (31) States are currently using contractor testing results in the acceptance decision.

Because of the large number of States that were using contractor test results and the concerns over the implementation of that provision, the scope of the reviews were adjusted in 2004 to focus on States that used contractor tests results in the acceptance decision. Twenty-five (25) of the 37 States reviewed since 2003 use contractor test results in the acceptance decision. From 2003 through 2008 20 of the 23 States that were reviewed used contractor tests in the acceptance decision. However, for this period 2009-2012 only 5 of the 13 States reviewed used contractor tests in the acceptance decision. The majority of the remaining States do not use contractor tests in the acceptance decision.

### State QA Programs

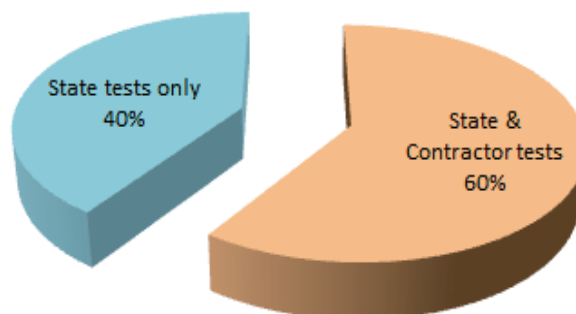


Figure 1. Breakdown of State QA Programs

### *Objective and Scope*

This activity reviewed the States' QA Program practices and procedures, and ascertained the status of the States' implementation of the QA regulation, 23 CFR 637. Each review examined the entire QA Program in that State. These reviews are included in the Performance Year 2014 FHWA Strategic Implementation Plan and are listed in the National Program Stewardship and Oversight Plan under the Headquarter/Resource Center Recurring and Required Reviews.



## 31 States use Contractor test results in the Acceptance Decision

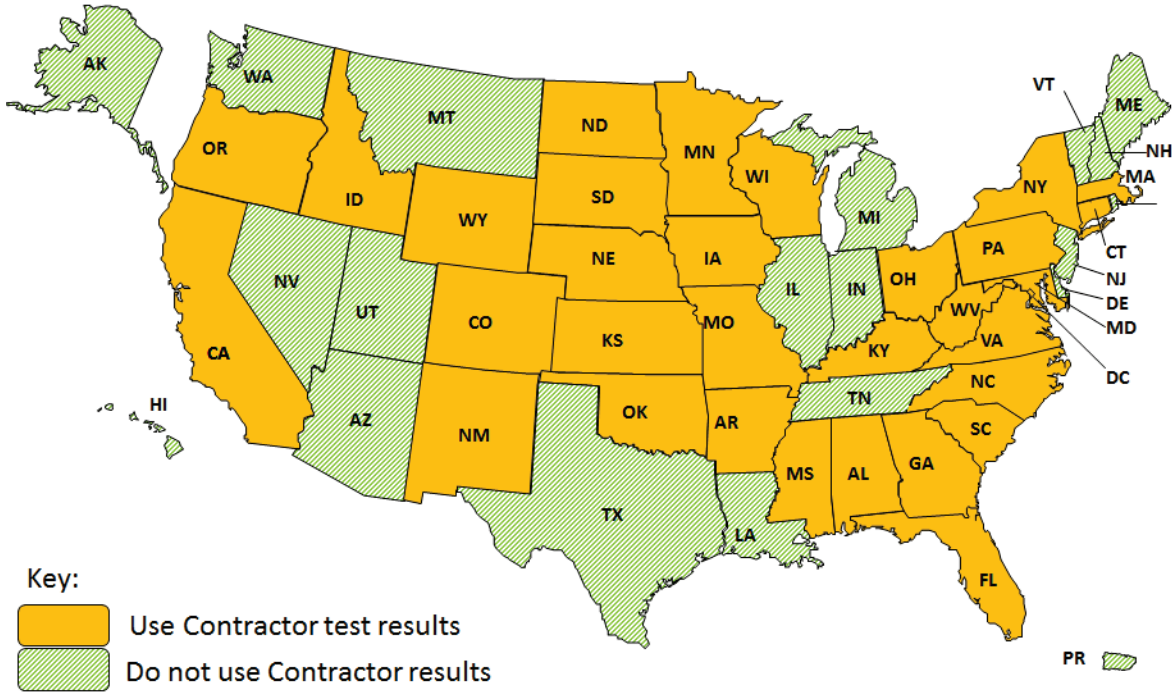


Figure 2. Summary of test results used in State Acceptance

Typically, four stewardship reviews have been conducted each Fiscal Year since 2003 as shown on the following map. This report documented the 13 reviews completed between 2009 and 2012. Five of these 13 States used contractor test results in the acceptance decision; see Table 1 and Figure 3. The map does not reflect “follow-up” visits.



## *Review Procedures*

The Quality Assurance Stewardship Reviews were a joint effort involving the State personnel along with FHWA personnel from Headquarters, Resource Center, and the Federal-aid Division Offices. Materials practices involving the regulation were examined at the State's headquarters, region/district, and construction project level. The stewardship reviews included:

1. Interviews with State headquarters, region/district and field office personnel and FHWA personnel;
2. Reviews of State policy and procedure documents including implementation strategies and office records where applicable;
3. Visits to construction projects to assess field practices as appropriate; and
4. Identification of best practices and opportunities for program improvements.

Entrance conferences were held, as appropriate, with key FHWA Division Office and State personnel to explain the assessment and process. Closeout meetings were held with the Division and State offices to share information obtained from the assessment.



Review team on Chicago project that used 100% recycled materials.



Review team conducting QA training.

## *Observations and Findings*

This “*state-of-the-practice*” report documents the reviews completed on 13 States during FY 2009 through FY 2012. The report documents the significant best practices and opportunities for improvement. “Significant” defined as a major issue or an issue being document in multiple State assessments. The best practices and opportunities for improvement are further subdivided as appropriate by the Quality Assurance categories of Acceptance, Independent Assurance, Technician Qualification, and Laboratory Qualification.

Best Practices Areas of Opportunity



## 1. Best Practices

### a. Acceptance

- (1) Verification of Contractor Test Data. Several States are using statistical evaluations to verify that contractor test results are similar to the States' results. Typically a statistical test call the F test compares the variance of the contractor tests to the standard deviation of the State's tests. In addition a statistical test called the t test is used to compare the States tests to the contractor's tests using sample size mean and variance of each sample set. Verification that State and contractor test results represent the same material population is critical when contractor test results are used in the acceptance decision.



- (2) Sample Security. Several States allow contractors to transport cores for testing asphalt density and separate asphalt mix box samples. However, appropriately, they use security tape on the box samples that indicates tampering if removed (figure left). The cores are shipped in plastic totes or coolers that have numbered security tags to prevent tampering.



- (3) Sampling Hot Mix Asphalt (HMA). Many States sample loose HMA from behind the paver where the final “in-place” properties are evaluated (figure right). This ensures that the sample includes the as-placed material and reduces the potential of plant personnel biasing the sampling process.



There can also be additional efficiencies with the use of State personnel.

- (4) Electronic Materials Management Systems. States are making progress in electronic management of materials data. Several States are using the AASHTO Site Manager software; additionally some States have either an in-house developed system or a third-party developed system. The creation of these databases has allowed the States to examine their specification limits more easily and ultimately will allow analysis of data to create performance-related specifications.
- (5) Pavement Smoothness Requirements. Several States have adopted or are implementing the use of inertial profilers for specifying and measuring roadway smoothness. Using these profilers increases measurement efficiency, can reduce traffic control requirements, and allows for compatibility with network level pavement smoothness data.
- (6) Standardization of Smoothness Measurement. Several States are calibrating their smoothness measurement devices at a test facility. The calibration process includes the recordation of the filter settings used at the time of certification. In addition, several States are certifying operators of smoothness measuring devices. States need accurate smoothness data to ensure proper and equitable payment for smoothness.
- (7) National Transportation Product Evaluation Program (NTPEP). The NTPEP is an AASHTO program which tests select manufactured materials. A number of States are moving toward expanded use of the NTPEP program. States are specifying that materials need to be tested by NTPEP before the material is considered for approval. The results of the program can be used as part of a State’s approved products list program. The NTPEP program use resulted in increased assurance of product quality and more efficient use of State personnel.

- (8) Field Communication. Most States hold monthly or quarterly meetings between headquarters, district, and regional materials engineers to discuss materials quality issues. This is a good forum for ensuring consistency of interpretation of specifications, test procedures and policy. These meetings also ensure that issues with specifications are identified and addressed in a timely manner.
- (9) Longitudinal Joints. Several States have developed specifications to improve density of HMA at the longitudinal joints in order to avoid premature joint failure and extend overall pavement life.
- (10) HMA Performance-Related Testing. Several States are moving toward the use of the Hamburg wheel-track test (HWT) in the acceptance of asphalt mixes. Performance tests are being used such as the HWT screen for rutting, or tests other performance issues prior to material production.

**b. Independent Assurance**

- (1) Annual Reports. Several States have developed comprehensive annual IA reports which include the number of certified technicians, the number of active technicians, the number of technicians that were covered by the IA program, the number of IA reports that had deficiencies, and an analysis of the deficiencies along with the potential systemic solutions to reoccurring deficiencies.

**c. Laboratory and Technician Qualification**

- (1) Accreditation of District/Region Laboratories. Several of the States are requiring their district/region laboratories (in addition to the central laboratory) to be accredited by the AASHTO Accreditation Program. Requiring additional qualification of the State's laboratories reduces the chances of having test results successfully questioned in disputes.
- (2) Calibration of Gyratory Compactors. Most States have procedures to ensure that the internal angle of gyration on Superpave gyratory compactors is being properly checked. States are also moving toward checking the gyratory molds with the three point bore gauge to improve consistency and comparability of asphalt material test results.
- (3) Laboratory Accreditation for Mix Designs. Some States are requiring laboratories that perform mix designs to be accredited

by the AASHTO Accreditation program. This requirement supports the overall quality of the laboratories and improves confidence in the resulting mix designs.

- (4) Proficiency Programs. Several States have developed internal materials proficiency sample programs to verify qualification of laboratories and or technicians. States are also using the proficiency samples that are prepared by the AASHTO Material Reference Laboratory. Participation in proficiency programs is an effective way to evaluate the testing practices of laboratories and technicians.

## 2. Opportunities for Improvement

### a. Acceptance

- (1) Use of Contractor Test Results. In most States it was found that the States' validation system needed to be strengthened. The following items were noted:
  - (a) Use of a statistical comparison. It was noted in some States that a statistical comparison was not being performed between the contractor's results and the State's results. The comparison was being based solely on a one vs. one comparison of results. This method of verification is very weak and will only detect severe problems with contractor test results. The strongest statistical method is the F test which compares the variances of the contractor's and State test results and t test which compares the States tests to the contractor's tests using sample size mean and variance of each sample set.
  - (b) Control of contractor supplied data. A need to control the documentation for contractor supplied test results was noted in some States. In some cases the State is not receiving the documentation until three days after the paving. Some States also do not require the contractors to retain the source documentation for the required three years and are not periodically reviewing the records. The States should be reviewing source documentation, requiring proper retention of documents and require the submission of test results the next day and before the State supplies their results.
  - (c) Control of sampling location. It was noted in several States that the time and or location of sampling was

being made known to the contractor. In some cases the random numbers for the sample locations are being given to the contractors for the entire project at the beginning of the project or at the beginning of the day for the entire day. The State must control the sampling location and timing, limit the pre-notification of sampling, and limit the ability of the contractor to modify sampling locations. Also, sampling behind the paver can avoid prior knowledge of the location and sampling times to the plant operators.

- (d) Security of samples. There have been issues with the security of the retained sample (samples potentially used for dispute resolution or backup samples) being in the possession of the contractor. The possession and storage of retained samples should be taken immediately by the State. Manipulation of the samples or replacement with known passing material could potentially occur when the contractor takes possession of these samples.
- (e) Lack of verification of pavement smoothness data. States need to provide independent verification of contractor supplied data quality.
- (f) Lack of random sampling. All QC sampling used in the acceptance decision and verification sampling and testing must be random. Random sample locations are critical to ensuring that the test results are representative of the entire lot of material.

(2) Hot Mix Asphalt (HMA)

- (a) Several States did not include volumetric properties as part of the acceptance decision for HMA mix and should move towards using volumetric properties. Volumetric properties provide a better relationship to pavement performance compared to the aggregate gradation specifications that some states use.
- (b) The maximum theoretical density of the mixture needs to be verified at the start of production and throughout production. The values can change with differences in gradation and binder content. The maximum theoretical density is an important parameter in calculating asphalt mixture volumetric properties and in-place density measurements from roadway cores.

- (c) States should take HMA mixture samples behind the paver to insure that the samples include all potential for segregation. Behind the paver sampling provides material that best represents the final in-place material.

(3) Other Acceptance Issues

- (a) States need to develop comprehensive electronic materials management systems to include all data and to allow continuous analysis of specifications in order to improve their specifications based on the actual results obtained within the State.
- (b) Absolute Average Deviation or other inefficient quality measures are being used for acceptance and pay adjustments. States should move toward a more robust statistical system such as Percent Within Limits (PWL) for specifications. These more robust statistical systems better identify variations in material quality and are more balanced in the assignment of risk between the agency and the contractor.
- (c) States should move toward larger lot sizes (7- 20 samples) to reduce risks for both the State and contractors. Very small lot sizes increase the acceptance risks and very large lot sizes (> 30) will not allow defective materials to be identified toward the end of the lot.
- (d) When establishing qualified products lists States should take advantage of the data that is available through the testing that is performed on some manufactured items by the National Transportation Product Evaluation Program (NTPEP). The NTPEP program can result in increased assurance of product quality with more efficient use of State personnel
- (e) States should calibrate their smoothness measurement devices at a test facility. The calibration process should include the recordation of the filter settings used at the time of certification. Reliable data is critical as States include pay adjustments for pavement smoothness.



**b. Independent Assurance**

- (1) Tolerances. States should review their tolerances used to compare test results. In some instances tolerances were developed in the early 1970s and have not been thoroughly examined since then. In many cases the testing variability has decreased due to certification programs and improvements to test procedures. Therefore, the tolerances may be too large and actual testing differences are not being identified.

**c. Technician Qualification**

- (1) Requalification. Requalification programs for technicians should be developed for all sampling or testing programs. This should include technicians that are testing soils, sampling asphalt mixtures and sampling cores. Trained and qualified technicians are vital to ensuring that test results represent the materials on a project.

*Status of Other Quality Assurance Activities*

SPECRISK software is a tool to assist in the development of statistically valid quality assurance specifications. SPECRISK allows agencies to evaluate PWL specifications and criteria for construction materials acceptance. In addition, agencies can better understand the risk allocation for the specification approaches being considered. A new version of SPECRISK software has been developed to run on Windows 7 and to make the program more user friendly. The new version is being tested and should be released during 2014.

***Conclusion***

The observations and findings from the reviews have resulted in ***numerous and significant opportunities for improvement relating to the States' Quality Assurance Programs.*** Opportunities for improvement have been documented and resources have been provided to assist States with implementation. The Quality Assurance Stewardship Reviews plans to continue with these efforts. Additionally, there will be continued development and updating of resources in order to continuously improve the QA Program.

### *Available Resources*

The following resources are currently available for assistance in dealing with issues raised in this report. These resources can be used by States when implementing policies and practices to address the opportunities for improvement.

1. The guideline for these reviews is available on the FHWA Pavements web site at <http://www.fhwa.dot.gov/pavement/materials/qareview.cfm>
2. "23 CFR Part 637," Subpart B - Quality Assurance Procedures for Construction, Federal Highway Administration, *Federal Register*, Washington, DC published on June 29, 1995, and amended on December 10, 2002, and September 24, 2007, <http://www.gpo.gov/fdsys/pkg/CFR-2013-title23-vol1/xml/CFR-2013-title23-vol1-part637.xml>
3. Non-regulatory supplement for 23 CFR Part 637, Subpart B - Quality Assurance Procedures for Construction, Federal Highway Administration. The non-regulatory supplement was updated on July 19, 2006. <http://www.fhwa.dot.gov/pavement/0637bsup.cfm>
4. Technical Advisory 6120.3, "Use of Contractor Test Results in the Acceptance Decision, Recommended Quality Measures, and the Identification of Contractor/Department Risks", Federal Highway Administration, August 9, 2004. <http://www.fhwa.dot.gov/construction/t61203.cfm>
5. Frequently asked questions (FAQ) on the Quality Assurance Regulation. The FAQs were updated on November 26, 2006. <http://www.fhwa.dot.gov/pavement/materials/qanda637.cfm>
6. "Optimal Procedures for Quality Assurance Specifications", *Publication No. FHWA-RD-02-095*, Federal Highway Administration, Washington, DC, April 2003, [http://www.fhwa.dot.gov/pavement/pub\\_details.cfm?id=89](http://www.fhwa.dot.gov/pavement/pub_details.cfm?id=89)
7. "Evaluation of Procedures for Quality Assurance Specifications", *Publication No. FHWA-HRT-04-046*, Federal Highway Administration, Washington, DC, October 2004, [http://www.fhwa.dot.gov/pavement/pub\\_details.cfm?id=367](http://www.fhwa.dot.gov/pavement/pub_details.cfm?id=367)
8. AASHTO Standard Recommended Practice R 9-05 (2009), "Acceptance Sampling Plans for Highway Construction" has been published in the 2005 AASHTO Standards. This guide will assist the States in developing specifications.
9. Tech Brief, "Independent Assurance Programs", *Publication No. FHWA-HIF-12-001*, Federal Highway Administration, Washington, DC, October 2011, <http://www.fhwa.dot.gov/pavement/materials/hif12001.pdf>

10. Tech Brief, “Acceptance of Non-Structural Precast Elements”, Publication No. FHWA-HIF-13-045, Federal Highway Administration, Washington, DC, June 2013, <http://www.fhwa.dot.gov/pavement/materials/hif13045.pdf>
11. Tech Brief, “Construction Quality Assurance for Design Build Projects”, Publication No. FHWA-HRT-12-039, Federal Highway Administration, Washington, DC, April 2012, <http://www.fhwa.dot.gov/publications/research/infrastructure/12039/12039.pdf>
12. NHI Course 134064 – “Transportation Construction Quality Assurance” is available in a 2 or 3 day version.