Quality Assurance Stewardship Review

Summary Report

2019 - 2023

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16. Abstract

The current program of Quality Assurance Stewardship Reviews was established by the Federal Highway Administration (FHWA) in fiscal year (FY) 2003 to assess agency quality assurance (QA) practices. By the end of 2017, all 52 State highway agencies (SHA) including Puerto Rico and the District of Columbia had undergone at least one review. This *Summary Report* summarizes the findings of the 17 SHA reviews completed in calendar years 2019 through 2023. Previous summaries of Quality Assurance Stewardship Reviews can be downloaded from the FHWA Pavement Publications – QA webpage.

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

The observations and findings from the Quality Assurance Stewardship Review program continue to play an important part in the FHWA's oversight role. These reviews of SHA QA programs allow the FHWA to identify and assess risks to the Federal-aid program. The reviews also provide an avenue to FHWA for the promotion and education of SHAs on new technologies.

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EXECUTIVE SUMMARY

A State highway agency's (SHA) quality assurance (QA) program is the process the SHA uses to determine whether it is obtaining the material or product that was specified. A considerable amount of Federal-aid construction funding is used on pavement and material activities. The Federal Highway Administration (FHWA) regulations for the QA program are found in 23 CFR 637 Subpart B. Proper implementation of this regulation helps ensure appropriate expenditure of Federal-aid funds. Additional information is provided in the Resources section of this *Summary Report*.

The current program of Quality Assurance Stewardship Reviews was established by the FHWA in fiscal year (FY) 2003 with the purpose of assessing SHA QA practices and verifying compliance with 23 CFR 637.205, 23 CFR 637.207, and 23 CFR 637.209. By the end of 2017, all 52 SHAs including Puerto Rico and the District of Columbia had undergone at least one review. This report summarizes the findings of the 17 reviews completed in calendar years 2019 through 2023. At the time of the review, 12 of these 17 SHAs were identified as using contractor test results in the acceptance decision in some portion of their QA program. This practice, while permissible under 23 CFR 637.207(a)(1)(ii), may increase the overall risk to the program and is the focus of part of the FHWA Quality Assurance assessment.

These reviews allow FHWA to identify and assess risks as part of Federal-aid program oversight. Some key trends include:

- The majority of SHAs reviewed were in overall compliance with 23 CFR 637.205, 23 CFR 637.207, and 23 CFR 637.209.
- The use of contractor test results in the acceptance decision without adequate validation has continued to be documented in the reviews.
- The Independent Assurance (IA) program for several SHAs needed strengthening. A few reviews indicated that SHAs using the system basis for IA were not submitting an annual report to the FHWA documenting their program as required in 23 CFR 637.207(a)(2)(iv). Also, a few SHAs needed to improve their IA system based approach to include split sampling or proficiency sampling as required in 23 CFR 637.207(a)(2)(ii).
- A few SHAs did not have operational controls and documented procedures to avoid potential conflicts of interest when consultants are used in multiple roles associated with the QA program by the SHA or contractors.[1]
- A few SHAs did not have clearly documented results from their laboratory qualification for acceptance testing.

The observations and findings identified opportunities for improvement relating to the SHAs' QA programs, and technical resources have been provided to assist States where requested.

Quality Assurance Stewardship Reviews provide technical resources and assistance to SHAs and the respective FHWA Division Offices to continuously improve their QA program.

[1] 23 CFR 637.209(c).

INTRODUCTION

Requirements for SHA sampling and testing programs have existed since the early 1960s. A considerable amount of Federal-aid construction funding is used on pavement and materials activities. Effective QA programs meeting 23 CFR 637 Subpart B will help ensure proper stewardship of the Federal-aid funding.

A major revision to the FHWA's sampling and testing regulations titled *Quality Assurance Procedures for Construction* was published on June 29, 1995, as 23 CFR 637 Subpart B. Amendments to this regulation were published on December 10, 2002 and September 24, 2007. The major revision in 1995 was made due to the need to improve the QA process as some SHAs implemented the use of contractor testing in the acceptance decision as noted when the Final Rule was published in the Federal Register.[2] Concerns about the process were found through several national reviews performed by FHWA in the early 1990s. The current regulations apply to Federal-aid highway projects on the National Highway System (NHS),[3] though most SHAs used the same QA program for projects off the NHS and for State funded projects. Five significant changes in the 1995 revision included:

- Requirement for all testing personnel and laboratories to be qualified using SHA procedures per 23 CFR 637.209.
- Requirement for the SHA's central laboratory to be accredited by the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program (AAP) or a comparable laboratory accreditation program per 23 CFR 637.209(a)(2).
- Provision of flexibility in sampling and testing by allowing the use of contractor test results in the overall SHA acceptance decision, provided certain checks and balances are in place per 23 CFR 637.207(a)(1)(ii).
- Allowance for consultants to be used in performing Independent Assurance (IA) or dispute resolution if their laboratories are accredited by the AASHTO Accreditation Program or a comparable laboratory accreditation program per 23 CFR 637.209(a)(3) and 23 CFR 637.209(a)(4).
- Allowance for SHAs to use a system approach to IA instead of establishing frequencies based on individual project quantities, provided certain reporting requirements are followed per 23 CFR 637.207(a)(2).

In FY 2003, the current program of Quality Assurance Stewardship Reviews was established with the purpose of assessing agency QA practices and verifying compliance with 23 CFR 637.205, 23 CFR 637.207, and 23 CFR 637.209.

More than half of SHAs use contractor test results in their acceptance decisions. The use of contractor testing may vary from collecting roadway surface profiles on new construction to performing extensive material testing on asphalt and portland cement concrete (PCC) pavements, making it difficult to assign a definite number of users of this approach.

[2] Federal Register, Volume 60, No. 125, pages 33712-33719.
[3] 23 CFR 637.201.

By the end of 2017, all 52 SHAs including Puerto Rico and the District of Columbia had at least one Quality Assurance Stewardship Review. Table 1 provides a listing of the SHAs and the year(s) of their review from the start of the program in 2003 through 2023. Thirty SHAs have had multiple reviews since 2003.

This *Summary Report* provides an overview of the Quality Assurance Stewardship Review program and a compilation of the findings and observations from the 17 individual SHA reviews completed in calendar years 2019 through 2023. Previous summaries of Quality Assurance Stewardship Reviews are available on the FHWA Pavement Publications – QA webpage.

Table 1. SHAs with Quality Assurance Stewardship Reviews since 2003.

State Highway Agency	Calendar Year(s) of Review
Alabama	2009, 2020
Alaska	2016
Arizona	2009
Arkansas	2016
California	2004, 2011, 2023
Colorado	2003, 2018
Connecticut	2005, 2018
Delaware	2007
District of Columbia	2016
Florida	2010
Georgia	2004, 2009, 2023
Hawaii	2009, 2020
Idaho	2008, 2018
Illinois	2013
Indiana	2008, 2015,* 2021
Iowa	2012
Kansas	2008, 2019
Kentucky	2014
Louisiana	2013
Maine	2003, 2013
Maryland	2004, 2013
Massachusetts	2014
Michigan	2012, 2021
Minnesota	2005, 2018
Mississippi	2009
Missouri	2003, 2012
Montana	2015
Nebraska	2006, 2019
Nevada	2006, 2018
New Hampshire	2010, 2023
New Jersey	2015
New Mexico	2007, 2018
New York	2004, 2010
North Carolina	2004, 2022
North Dakota	2017
Ohio	2011
Oklahoma	2003, 2008, 2023
Oregon	2005, 2022
Pennsylvania	2006, 2019
Puerto Rico	2017
Rhode Island	2008, 2022
South Carolina	2007, 2014
South Dakota	2013
Tennessee	2016
Texas	2011, 2021
Utah	2010, 2021
Vermont	2016
Virginia	2006, 2017
Washington	2011
West Virginia	2014
Wisconsin	2006, 2016
Wyoming	2007, 2022

* Asphalt mixture review only.

OBJECTIVE AND SCOPE

The Quality Assurance Stewardship Reviews evaluated the SHAs' QA program practices and procedures and ascertained the status of the SHAs' implementation of and compliance with QA regulations 23 CFR 637.205, 23 CFR 637.207, and 23 CFR 637.209. Each review examined the entire QA program in that State, except for the 2015 review in Indiana.

Typically, four Quality Assurance Stewardship Reviews have been conducted in each of the years, 2003 through 2023, as shown in figure 1. Twelve of the 17 SHA reviews completed in 2019 through 2023 identified the use of contractor test results in the acceptance decision in some portion of their QA program at the time of the review.

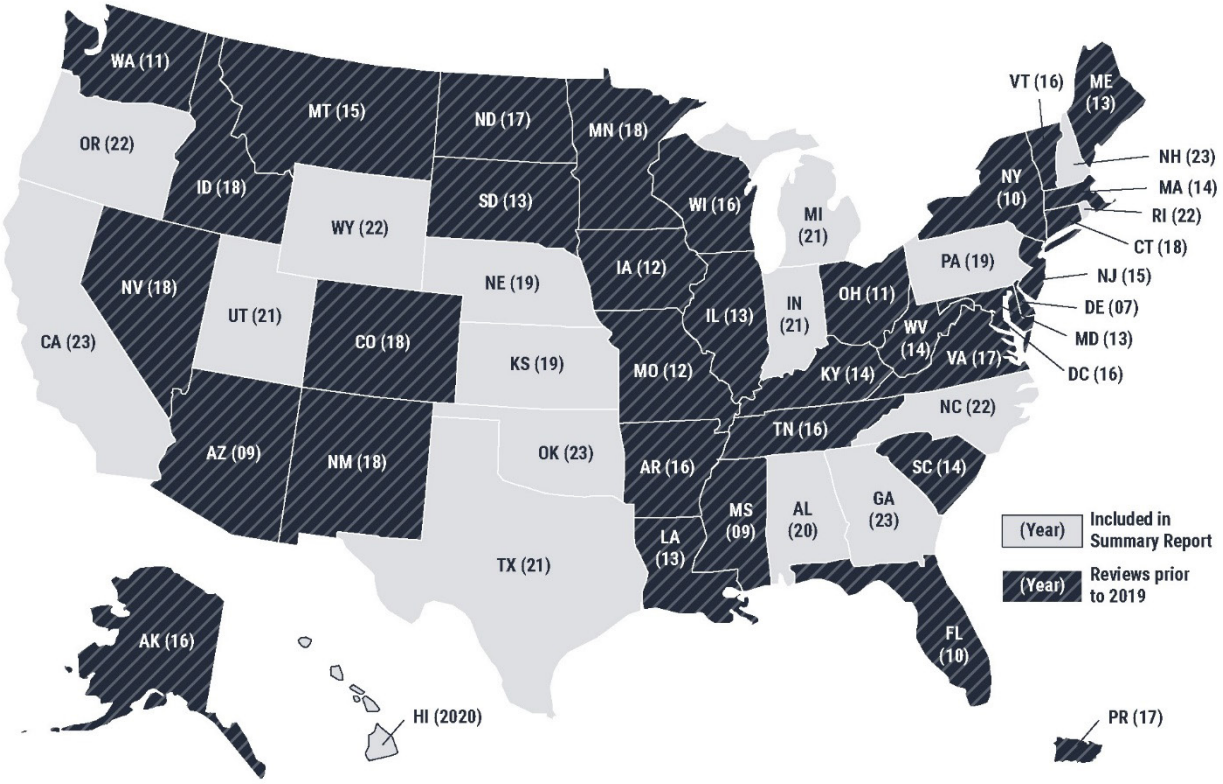

Figure 1. Most recent Quality Assurance Stewardship Reviews by calendar year.

REVIEW PROCEDURES

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

Prior to the review, a QA review guide was provided to the SHA to help define the existing QA program. The Division Office and SHA provided the QA program, specifications, and other related documents to the FHWA review team before the onsite visit. Entrance conferences were held, as appropriate, with key FHWA Division Office and SHA personnel to explain the evaluation and process. Closeout meetings were held with the Division and SHA personnel to share information obtained from the review.

The Quality Assurance Stewardship Reviews included:

- Planning, scheduling, and coordinating the review via emails and phone calls.
- Interviews with SHA headquarters, region/district, and field office personnel in addition to FHWA personnel.
- Reviews of SHA policy and procedure documents including implementation strategies and office records where applicable.
- Visits to construction projects to assess field practices, including discussions with contractor quality control (QC) staff as appropriate.
- Identification of program strengths, opportunities for program improvements, and suggested practices for consideration.
  - Program strengths were areas where the SHA QA program employed effective processes and procedures to evaluate materials and minimize program risks.
  - Opportunities for improvement represented significant concerns about the SHA QA program and its implementation. These opportunities for improvement should be addressed in partnership between the FHWA Division Office and the SHA and are tracked by the FHWA Division Office and Headquarters.
  - Suggested processes and procedures that could help an SHA reduce its materials acceptance risks.
- Completion of a final report, which was provided to the FHWA Division Office.

OBSERVATIONS AND FINDINGS

Introduction

The observations and findings discussed in this *Summary Report* were derived from the 17 Quality Assurance Stewardship Reviews completed between 2019 and 2023.

Overall Compliance with 23 CFR 637 Subpart B from the Recent Quality Assurance Stewardship Reviews

As noted earlier in this *Summary Report*, the Quality Assurance Stewardship Reviews evaluated the SHAs' QA program practices and procedures and ascertained the status of the SHAs' implementation of and compliance with QA regulations 23 CFR 637.205, 23 CFR 637.207, and 23 CFR 637.209. These findings were listed in the Opportunities for Improvement section of the individual SHA reports. The findings listed here will not be repeated in the Opportunities for Improvement section of this report.

Observations and findings related to compliance with 23 CFR 637.205, 23 CFR 637.207, and 23 CFR 637.209 included:

- Some SHAs were not verifying contractor-collected test data (e.g., pavement smoothness, concrete pavement, structural concrete strength). A majority of the State reviews that noted the use of contractor test results in the acceptance decision had this finding, with most of the findings related to pavement smoothness (23 CFR 637.207(a)(1)(ii)(B)).
- A few SHAs were using the system basis for their IA but were not submitting an annual report to the FHWA documenting their program as required in 23 CFR 637.207(a)(2)(iv).
- A few SHAs needed to ensure potential conflicts of interest were avoided when using a consultant for acceptance sampling and testing as required in 23 CFR 637.209(c).
- One SHA needed to document that third-party laboratories used for dispute resolution must be accredited (and not just certified by the SHA) as required in 23 CFR 637.209(a)(4).
- A few SHAs were noted as needing to strengthen and formalize laboratory qualification procedures to ensure there is clear documentation when a testing laboratory is approved for acceptance testing as required in 23 CFR 637.209(a)(1).
- A few SHAs needed to improve their IA system based approach to include split sampling or proficiency sampling as required in 23 CFR 637.207(a)(2)(ii).

Noncompliance items were noted to both the respective SHA and FHWA Division Office to bring practices into compliance.

Program Strengths from the Recent Quality Assurance Stewardship Reviews

As discussed previously in this *Summary Report*, program strengths were areas where the SHA QA program employed effective processes and procedures to evaluate materials and minimize program risks.

Quality Assurance Program

Almost all 17 reviews specifically noted consistent use of one QA program for SHA-administered projects (including projects on or off the NHS and with or without Federal

funding). A single SHA review noted multiple systems used by an SHA. Using the same QA program may lower the risk to the Federal-aid program as QA program personnel are more likely to consistently apply the QA requirements on a project, regardless of funding source or highway system.

To reduce confusion and risk, a majority of the SHAs also used the same QA program for local public agency projects that used Federal-aid highway funds.

Almost all the SHAs conducted regular meetings (ranging from monthly to annually) to discuss changes or issues in the QA program. This provided an opportunity for training and background information to be provided to field personnel and a venue for feedback from the field on the application of QA program elements.

Acceptance

For SHAs using contractor's tests in the acceptance decision, data validation using statistical tests allows the SHA to determine if both the contractor's test results and the State's verification test results are from the same population.[4] One of the SHAs was using the statistical F- and t-tests[5] in verifying[6] contractor test results.

Alternative Contracting Methods (ACM), such as Design-Build (D-B), Construction Manager / General Contractor (CM/GC), Construction Manager at Risk (CMAR), and Alternate Technical Concepts (ATC), have been used to accelerate project delivery, encourage the deployment of innovation, and minimize the potential for unforeseen delays and cost overruns. The use of these methods has become increasingly popular in highway construction during the years covered by this *Summary Report*, but these methods can create some risks in the QA program. In 2012, FHWA issued a Tech Brief related to this topic (see Resources section of this *Summary Report*). Alternative contracting methods were included in most of the SHA reviews with D-B noted as the most common approach. These reviews noted that most of the SHAs were effectively applying their standard QA program on these types of projects or had a standard QA program for D-B projects.

In recent years, FHWA has provided training and technical support on the use of the percent within limits (PWL) specifications. PWL is a quality measure that provides a powerful tool to characterize the quality of the material considering both the average and variability of the material properties.[4] A majority of the SHAs reviewed were using PWL for acceptance and payment.

Federal regulation at 23 CFR 637.205(e) requires that "[a]ll samples used for quality control and verification sampling and testing shall be random samples." Random numbers were commonly used by the SHAs reviewed to generate sampling locations. Most of the SHAs consistently used random sampling procedures and applications. A majority of States used an SHA-developed spreadsheet or computer program as a practice to generate and document their random number practice with one review noting the use of a smartphone voice assistant to generate random numbers.

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[4] Grogg, M. and A. Espinoza-Luque. 2023. *Documenting FHWA Quality Assurance Assessment 2022: Summary Report*. FHWA-HIF-23-021. Washington, DC: Federal Highway Administration. Accessed February 9, 2024.
[5] The *F*-test provides a method for comparing the variances (standard deviations squared, σ^2) of two sets of data by assessing the size of the ratio of the variances. The *t*-test provides a method for comparing the means of two independent data sets and is used to assess the degree of difference in the means.
[6] 23 CFR 637.207(a)(1)(ii)(B).

Pavement Smoothness

For decades, the FHWA has used pavement smoothness as an indicator of pavement performance of the NHS and suggested smoother pavement practices. Most of the SHAs reviewed used the International Roughness Index (IRI) to quantify pavement smoothness when measured by an inertial profiler while one SHA used a similar index known as Ride Number (RN). Inertial profilers allow efficient measurement, reduce traffic disruption, and are compatible with network-level pavement smoothness reporting. Profile Index (PI), as measured by a profilograph or calculated from the measured profile, was reported as being used by a few SHAs, primarily on PCC pavements.

Properly qualified[7] profiling equipment and operators are used to minimize the risk for pavement smoothness incentive programs. All the reviews noted that SHAs used profiler equipment certification and operator certification as part of their QA program for pavement smoothness. Almost all SHAs used contractor-collected quality control pavement smoothness data. As noted previously in this report many of these SHAs were not using agency verification while others were properly verifying the contractor's quality control test data. The remaining SHAs used SHA-collected data only.

PCC

PCC is a material used by SHAs both in structural and pavement applications. Examples of precast concrete items observed during the SHA reviews are shown in figures 2 and 3.

Most SHAs were recognized for requiring a project-level PCC QC plan to be submitted by the contractor before PCC production. The purpose of the QC plan is to measure those quality characteristics and to inspect those activities that impact the production at a time when corrective action can be taken to prevent appreciable nonconforming material from being incorporated into the project.[8] Figure 4 shows the preparation for QC field testing required by a QC plan.

Several SHAs required PCC ready-mix plants to be certified by the National Ready Mixed Concrete Association (NRMCA). Several SHAs also used NRMCA certification for transit mix trucks. The remaining SHAs either certified the plants themselves or required self-certification by the contractor or concrete producer. Certified plants and delivery trucks reduce the risk for the production and delivery of noncompliant ready-mix concrete.

Multiple new technologies were being implemented in the PCC area during the review period. Most reviews contained voluntary practice suggestions for SHAs to investigate or implement technologies such as optimized gradation, magnetic imaging tomography scanning (MIT Scan), or surface resistivity. Adoption of these technologies allows for improved concrete structure and pavement performance at a lower life-cycle cost. A majority of the SHAs reviewed had adopted one or more of these technologies and others were exploring or piloting these technologies.

[7] 23 CFR 637.207(a)(1)(ii)(A).
[8] Burati, J., R. Weed, C. Hughes, and H. Hill. 2002. *Optimal Procedures for Quality Assurance Specifications*. FHWA-RD-02-095. Washington, DC: Federal Highway Administration.

Figure 2. Precast concrete noise wall panels.

Figure 3. Precast concrete bridge deck panels.

Figure 4. Testing plastic concrete at the project level.

Asphalt Mixtures and Pavements

Asphalt mixtures are widely used for both new and rehabilitated pavement applications (see figure 5). Generally, asphalt mixtures have become more complicated over the years as production has moved from hot-mix asphalt produced with virgin aggregates mixed with neat asphalt binder to asphalt paving mixtures that now include recycled materials, production by-products, polymer modifiers, warm-mix additives, and so on.

Figure 5. Asphalt overlay placement.

All reviewed SHAs used performance-graded (PG) binders (see figure 6). A few SHAs added specifications such as Multiple Stress Creep Recovery requirements or delta Tc on 40-hour pressure aging vessel (PAV) materials. The use of this binder grading improves the consideration of climatic, stress, and strain effects in the asphalt binder selection process. Most SHAs used polymer-modified asphalt binders in at least some applications, and a few SHAs used recycled tire rubber in their asphalt mixtures.

Figure 6. Contractor technician sampling asphalt binder.

All the SHAs reviewed specified asphalt binder using either:

- AASHTO M 320, *Standard Specification for Performance-Graded Asphalt*, with or without additional PG-plus tests.
- AASHTO M 332, *Standard Specification for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test*.

Superpave volumetric mixture design evaluated how asphalt mixtures will consolidate to ensure there is sufficient space for the binder to provide long-term durability and sufficient aggregate structure to resist densification and plastic deformation by traffic in the field.[9] All 17 SHAs reviewed predominantly used the Superpave volumetric mixture design with a Superpave gyratory compactor, although individual SHAs had their own gyratory or used Marshall mix design for certain mixtures.

[9] Federal Highway Administration (FHWA). 2010. *Superpave Mix Design and Gyratory Compaction Levels*. Tech Brief. FHWA-HIF-11-031. Washington, DC: Federal Highway Administration.

Warm-mix asphalt (WMA) technologies can reduce energy consumption and emissions, provide better compaction on the road, produce a paving mix that can be hauled for longer distances, and extend the paving season by allowing paving at lower temperatures.[10] All SHAs reviewed reported having a permissive WMA specification where it is the contractor's option to use WMA. WMA usage was reported to be as high as 98 percent of an SHA's annual asphalt mixture production.

In the sustainability area, "the FHWA supports and promotes the use of recycled highway materials in pavement construction in an effort to preserve the natural environment, reduce waste, and provide cost effective material for constructing highways. In fact, the primary objective is to encourage the use of recycled materials in the construction of highways to the maximum economical and practical extent possible with equal or improved performance. As part of the FHWA recycled materials policy, the FHWA actively promotes asphalt pavement recycling and technology."[11] All SHAs reported recycling existing asphalt pavements to produce reclaimed asphalt pavement (RAP) as shown in figure 7, and then incorporating the RAP into their asphalt mixture. The reported rate of RAP usage by SHAs varied from 15 to 30 percent.

Figure 7. Contractor RAP stockpile and processing.

[10] Federal Highway Administration (FHWA). 2020. "EDC-1 Innovations." Webpage. Washington, DC: Federal Highway Administration. Accessed January 2, 2024.
[11] Federal Highway Administration. 2020. "Asphalt Pavement Recycling with Reclaimed Asphalt Pavement (RAP)." Webpage. Washington, DC: Federal Highway Administration. Accessed March 2024.

To improve resistance to moisture-induced damage, most SHAs voluntarily used AASHTO T 283, *Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage*, to determine the moisture susceptibility of the mixture design. Some SHAs have made modifications to this procedure based on their experiences and on mixture performance in their State. Additionally, several SHAs were using AASHTO T 324, *Standard Method of Test for Hamburg Wheel-Track Testing of Compacted Asphalt Mixtures*.

To improve longitudinal joint performance, about half of the SHAs have a longitudinal joint density specification. Another SHA was using an adhesive to improve joint performance.

For rutting resistance, moisture damage, and mixture durability, several of the SHAs were using the Hamburg wheel-track test (HWTT) (see figure 8) while additional SHAs were piloting its use. A few SHAs were using an Asphalt Pavement Analyzer (APA) (see figure 9) in addition to or instead of the HWTT.

Figure 8. HWTT on compacted asphalt mixture sample.

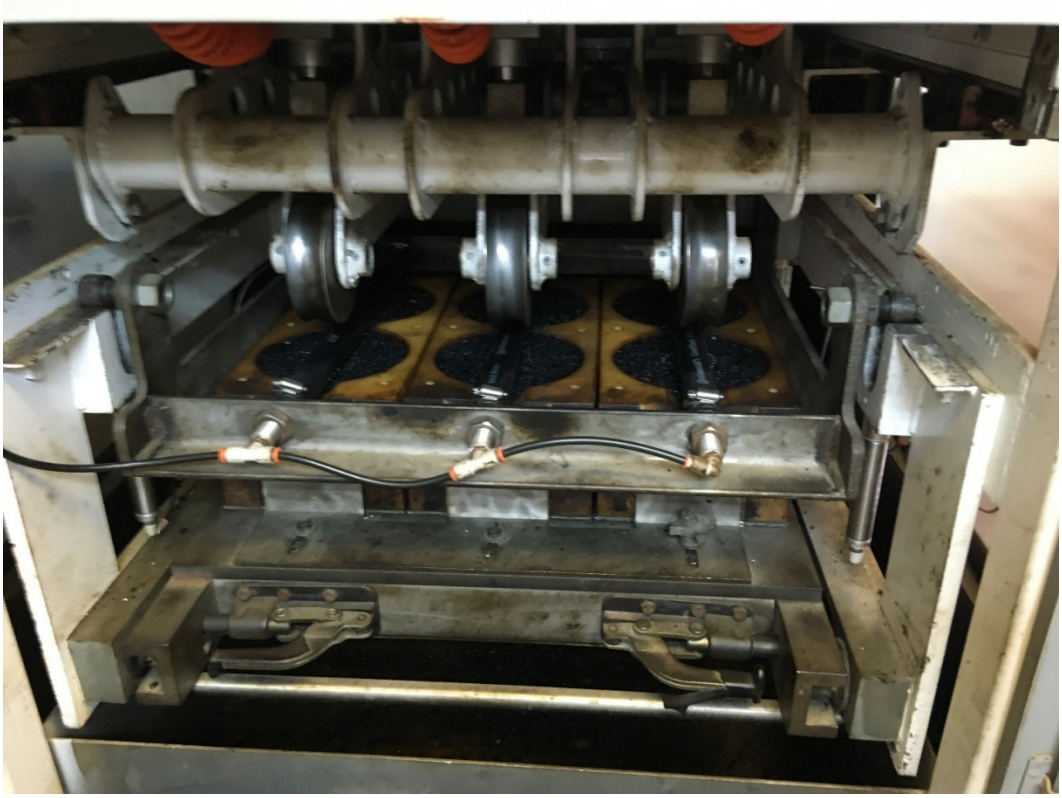

Figure 9. Asphalt pavement analyzer.

Several of the SHAs were noted for their processes to determine, verify, and use aggregate specific gravity data in the evaluation of asphalt mixture properties. These controls reduce the risk of contractors manipulating the volumetric properties of the asphalt mixture, which could affect the pavement performance.

All SHAs had the contractor perform the mixture design with verification by the SHA. The verification varied with some SHAs doing laboratory testing of the asphalt component materials and mixtures while others only performed a paper review of the contractor's submission. Agencies may reduce their risk by conducting more robust mixture verification during the mix design process or test strip construction.

Most of the 17 SHAs required a project-level QC plan by the contractor on asphalt mixture paving projects. The purpose of the QC plan is to measure those quality characteristics and to inspect those activities that impact the production at a time when corrective action can be taken to prevent appreciable nonconforming material from being incorporated into the project.[12]

Sampling location for the asphalt mixture was almost equally split between SHAs that required sampling loose mix behind the paver or from the windrow in front of the paver (figure 10) and SHAs that sampled the asphalt mixture from the truck or at the plant (figure 11). Sampling at the paver is the location that most closely represents final in-place material properties. A few SHAs allowed for sampling at either of these locations.

[12] Burati, J., R. Weed, C. Hughes, and H. Hill. 2002. *Optimal Procedures for Quality Assurance Specifications*. FHWA-RD-02-095. Washington, DC: Federal Highway Administration.

Figure 10. Sampling asphalt mixture from the windrow in front of the paver.

Figure 11. Sampling asphalt mixture from a truck at the plant.

Balanced Mix Design (BMD) is described as an "asphalt mix design using performance tests on appropriately conditioned specimens that address multiple modes of distress taking into consideration mix aging, traffic, climate, and location within the pavement structure."[13] A majority of the SHAs reviewed had implemented or were piloting BMD-related performance testing. Testing included the HWTT, APA, indirect tension asphalt cracking test (IDEAL-CT), and indirect tension asphalt rutting test (IDEAL-RT).

One of the initiatives under FHWA's Every Day Counts (EDC) Round 6 is the Targeted Overlay Pavement Solutions (TOPS). Pavement overlays represent a significant portion of highway infrastructure dollars. State and local highway agencies can maximize this investment and help ensure safer, longer-lasting roadways by employing innovative overlay procedures that will improve pavement performance, lessen traffic impacts, and reduce the cost of pavement ownership.[14] Most of the 17 SHAs employed one or more of the overlay solutions (e.g., stone matrix asphalt (SMA), crack attenuating mix (CAM), open-graded friction course (OGFC)) featured in TOPS.

A few SHAs required the use of a material transfer vehicle to provide a more constant supply of asphalt material to the paver and reduce material and temperature segregation.

Manufactured Materials

Manufactured materials play a key role in the construction of Federal-aid highway projects by SHAs. All reviewed SHAs had published lists for SHA-qualified products, which are accessible on the internet.

The AASHTO Product Evaluation and Audit Solutions (formerly known as the National Transportation Product Evaluation Program (NTPEP)) is a voluntary AASHTO program that tests select manufactured materials and audits quality procedures at certain production facilities. All of the SHAs were using this program as part of their material approval process. A few of the SHAs were identified as active participants in the program participating in the technical committees and product evaluations.

Independent Assurance

Federal regulation at 23 CFR 637.203 defines an IA program as "activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program" (see Resources section of this *Summary Report* for additional information). An IA program ensures that the sampling and testing are performed correctly and that the testing equipment used in the program is operating correctly and remains calibrated. It involves a separate and distinct schedule of sampling, testing, and observation.[15]

SHAs have options under the regulation regarding the approach they take for IA.[16] The IA program can be set up on a project basis or on a system basis. The difference between the two approaches is the basis of the frequency of testing (cover all projects versus cover all personnel).

[13] West, R., C. Rodezno, F. Leiva, and F. Yin. *2018 NCHRP Project 20-07/Task 406 Development of a Framework for Balanced Mix Design*. Washington, DC: Transportation Research Board.
[14] Federal Highway Administration. 2023. "EDC-6 Innovations (2021-2022)." Webpage. Washington, DC: Federal Highway Administration. Accessed January 2, 2024.
[15] 23 CFR 637.207(a)(2).
[16] 23 CFR 637.207(a)(2).

Some SHAs implemented a hybrid method using both project and system approaches in their IA program. Figure 12 provides the breakdown of the IA approach used by the 17 SHAs reviewed.

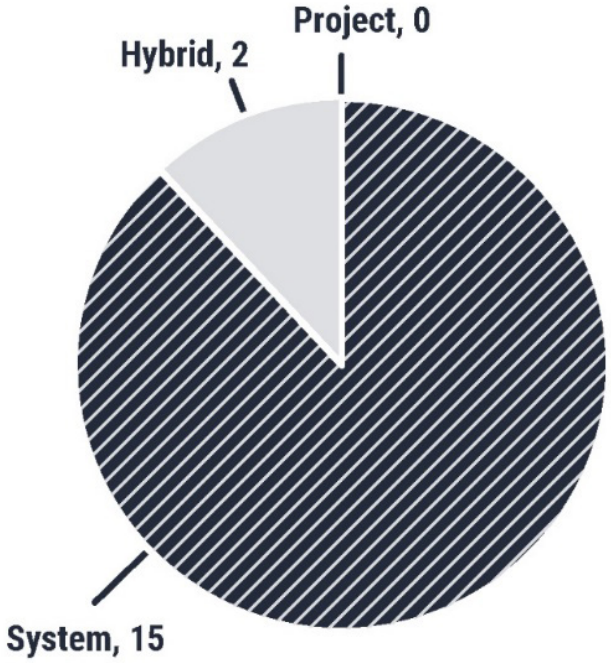

Figure 12. Distribution of SHAs approach to IA at the time of the 17 State reviews.

The IA program is a key requirement[17] to reduce the risk to construction quality. A few SHAs that used the system approach were using proficiency testing or rodeos to efficiently meet the IA requirements[18] (see figure 13), while a few were testing technicians twice a year to reduce the IA program risk.

[17] 23 CFR 637.207(a)(2).
[18] 23 CFR 637.207(a)(2).

Figure 13. SHA district laboratory used for IA evaluation of technicians.

Technicians Qualifications

Federal regulation at 23 CFR 637.209(b) requires that all sampling and testing data used in the acceptance decision or the IA program be executed by qualified sampling and testing personnel. While the details of the qualification are left to the SHAs, FHWA provides guidance in its "Non-regulatory Supplement for 23 CFR Part 637 Subpart B—Quality Assurance Procedures for Construction" (see Resources section of this *Summary Report* for additional information).

Most SHAs use 5 years as the maximum length of technician certification, which is in accord with FHWA's recommendation.[19] Several of the SHAs used a shorter period (2 or 3 years) for all or some of their maximum length of technician certification.

Laboratory Qualifications

Like technician qualifications, 23 CFR 637.209(a)(1) requires that all contractor, vendor, and SHA testing used in the acceptance decision be performed by qualified laboratories. Among the program strengths noted in the laboratory qualification area were:

- All the reports noted that the central laboratory was accredited by the AAP.
- A few SHAs had district or regional laboratories that were also accredited in whole or in part by the AAP. The accreditation of district or regional laboratories increased confidence in testing results and provided a backup for central laboratory testing.

[19] See Resources section of *Summary Report* for Non-regulatory Supplement NS 23 CFR § 637B, "Quality Assurance Procedures for Construction," Item 3.d.5.

- A majority of the SHAs reviewed required that contractor or consultant laboratories that performed certain functions (such as asphalt mix design) be accredited by the AAP which improved the confidence in the test results.
- Several of the SHAs required a formal review of the field laboratories by SHA personnel before they were qualified. SHAs that conducted more robust field laboratory reviews reduced the risk of equipment bias in the test results.

Records and Data Management

A comprehensive and accessible database of material test results can support a comprehensive QA program. Several of the SHAs reviewed used AASHTO SiteManager or AASHTOWare Project to collect and store material test results. Some SHAs used it more extensively than others, allowing the analysis of test results to update specification limits or comparison testing tolerances. The remaining SHAs reviewed used commercial programs or systems developed internally that accomplished a similar function for collecting and storing test results so that they could be analyzed. Several of the SHAs reviewed restricted the entry of test results in their system to qualified technicians, which reduced the risk of testing and data entry by unqualified personnel.

The preparation of a materials certificate and its submission to the FHWA Division Administrator is required by 23 CFR 637.207(a)(3) for each construction project on the NHS that is subject to FHWA construction oversight activities. Several of the SHAs followed this approach more widely by preparing materials certificates on all Federal-aid or all State-funded projects.

Opportunities for Improvement from the Recent Quality Assurance Stewardship Reviews

In addition to the regulatory requirements cited in the Overall Compliance with 23 CFR 637 Subpart B from the Recent Quality Assurance Stewardship Reviews section of this report, some other non-regulatory items were deemed high-risk and listed as Opportunities for Improvement in the individual State reports.

Quality Assurance Program

During the reviews, it was suggested that a few SHAs develop or improve their documented procedures or practices for random sampling. Random sampling is required by 23 CFR 637.205(e) and prevents conscious or unconscious bias in obtaining samples.

The review of one of the SHAs noted that multiple current operating procedures did not match the current written procedures and the two should be brought into alignment.

Acceptance

Many SHAs use contractor resources to transport or store samples. A few of the SHAs had potential security issues with samples that were obtained, stored, or transported by contractor personnel. Proper sample security must be provided to ensure the integrity of the samples.[20]

[20] The verification sampling and testing are to be performed by qualified testing personnel employed by the STD or its designated agent, excluding the contractor and vendor. 23 CFR 637.205(d).

In the asphalt mixture and pavement area, multiple items were noted across the 17 reviewed SHAs as opportunities for improvement. Items noted in the reports included:

- A few SHA reviews noted issues with the determination, verification, or use of aggregate specific gravity in asphalt mixtures. This creates issues with accurately calculating mixture volumetric properties such as voids in mineral aggregate (VMA) and effective asphalt content.
- Ignition furnaces were used by most of the SHAs as a method of determining asphalt binder content. When using this method, proper determination of correction factors directly impacts the test result. A majority of the SHAs were noted as having issues with the correction factor being used for ignition furnaces, using the same correction factor for multiple ignition furnaces, or using contractor-reported correction factors. Typical technologies used by SHAs for determining asphalt binder content are shown in figures 14 through 17.

Figure 14. Typical ignition furnace used by an SHA to determine asphalt binder content.

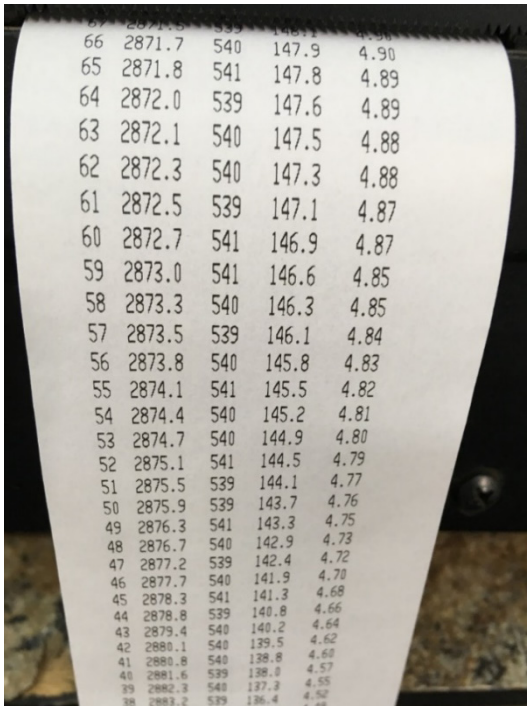

Figure 15. Example of an ignition furnace automated printout.

Figure 16. Centrifuge extractor with solvent applied over the loose asphalt mixture.

Figure 17. Automated extractor and distillation unit used by an SHA.

Technician Qualifications

A few SHAs needed to improve their technician qualification program with either the inclusion of significant testing (e.g., nuclear density for soil and aggregate) in their technician qualification program or formal classroom training, a written examination, and a demonstration of testing proficiency as recommended in "Non-regulatory Supplement for 23 CFR Part 637 Subpart B—Quality Assurance Procedures for Construction" (see Resources section of this *Summary Report)*.

Effective Practice Suggestions from the Recent Quality Assurance Stewardship Reviews

Effective practice suggestions were based on processes and procedures that were observed in prior reviews of other SHAs and could help an SHA reduce their materials acceptance risks and improve the efficiency of their quality assurance program. SHAs were encouraged to consider the practices as resources allowed. Some of these processes and procedures were developed or refined during the time of the subject reviews. Trends from the 17 reviews are summarized below:

- Several SHAs were encouraged to improve the documentation of their QA program for clarity.
- Most SHAs were encouraged to improve their IA program through items such as increased IA testing, updating the IA testing comparison tolerances, and improved IA reporting and analysis. Improvements to an IA program increase confidence in the sampling and testing results.

- Most SHAs were encouraged to improve their random sampling and sample security practices. Random sampling is required by 23 CFR 637.205(e) and prevents conscious or unconscious bias in obtaining samples.
- Several of the SHAs were encouraged to consider the use of PWL in their acceptance procedures, while a few of the SHAs that used this approach were urged to reexamine the pay factors they were employing to see if they balanced the risk between the agency and the contractor appropriately. PWL is a quality measure that provides a powerful tool to characterize the quality of the material considering both the average and variability of the material properties.[21]
- Almost all SHAs using contractor test results in the acceptance decision were encouraged to reduce their risk by strengthening the validation of contractor test results and improving specifications.
- In the PCC area, it was noted during some of these reviews that implementing a concrete surface resistivity test for PCC mixtures could improve PCC durability. Several SHAs were encouraged to consider optimized gradation (e.g., Tarantula Curve Method) in the proportioning of aggregates for PCC mixtures for improved quality.
- About half of the SHAs received suggested improvements to their technician or laboratory qualification practices to improve sampling and testing quality and confidence in the results.

[21] Grogg, M. and A. Espinoza-Luque. 2023. *Documenting FHWA Quality Assurance Assessment 2022: Summary Report*. FHWA-HIF-23-021. Washington, DC: Federal Highway Administration.

CONCLUSION

Observations and findings from the Quality Assurance Stewardship Review program continue to play an important part in the FHWA's oversight role. These reviews of SHA QA programs allow the FHWA to identify and assess risks to the Federal-aid program. Key trends identified in the reviews included:

- The majority of SHAs reviewed were in overall compliance with 23 CFR 637.205, 23 CFR 637.207, and 23 CFR 637.209.
- The use of contractor test results in the acceptance decision without adequate validation has continued to be documented in the reviews.
- The IA program for several SHAs needed strengthening. A few reviews indicated that SHAs that were using the system basis for IA were not submitting an annual report to the FHWA documenting their program as required in 23 CFR 637.207(a)(2)(iv). Also, a few SHAs needed to improve their IA system based approach to include split sampling or proficiency sampling as required in 23 CFR 637.207(a)(2)(ii).
- A few SHAs did not have operational controls and documented procedures to avoid potential conflicts of interest when consultants are used in multiple roles associated with the QA program by the SHA or contractors.[22]
- A few SHAs did not have clearly documented results from their laboratory qualification for acceptance testing.

The reviews also provide an avenue for the FHWA to identify benefits and implementation practices of new technologies. Featured new technologies included:

- Performance Engineered Mixtures (PEM) are designed to provide the tools for agencies to specify and contractors to deliver concrete mixtures that reliably and sustainably meet the needs for concrete infrastructure.
- BMD-related testing such as the HWTT, APA, IDEAL-CT, and IDEAL-RT.
- TOPS-related technologies such as SMA, CAM, and OGFC.
- Increased use of recycled materials.

The observations and findings identified opportunities for improvement relating to the SHAs' QA programs and technical resources have been provided to assist States where requested.

In addition to the program-level Quality Assurance Stewardship Reviews discussed in this *Summary Report*, FHWA Division Offices conduct more focused process reviews and oversight activities, often supported by the FHWA Resource Center and Headquarters. These additional oversight activities often cover some of the same topics as these Quality Assurance Stewardship Reviews and provide additional follow-up on findings and suggestions.

Continuing the Quality Assurance Stewardship Reviews will improve the quality of materials on Federal-Aid highway projects by the:

[22] 23 CFR 637.209(c).

- Identification of program risks and initiation of program improvements.
- Identification of effective practices and new technologies.
- Successful implementation of new practices and technologies identified in follow-up reviews.
- Training opportunities for FHWA Division personnel.

These Quality Assurance Stewardship Reviews provide technical resources and assistance to SHAs and the respective FHWA Division Offices to continuously improve their QA program.

RESOURCES

The following resources are available for use by SHAs when implementing policies and practices to address the opportunities for improvement identified in the Quality Assurance Stewardship Reviews:

American Association of State Highway and Transportation Officials (AASHTO). 2022. *Standard Practice for Acceptance Sampling Plans for Highway Construction*. AASHTO Standard Recommended Practice R 9-05. Washington, DC: AASHTO.

Code of Federal Regulations (CFR). 2013. "Quality Assurance Procedures for Construction." *Code of Federal Regulations*. 23 CFR § 637B. Accessed January 2, 2024.

Federal Highway Administration (FHWA). 2002. *Optimal Procedures for Quality Assurance Specifications*. FHWA-RD-02-095. Washington, DC: FHWA.

Federal Highway Administration (FHWA). 2004. *Evaluation of Procedures for Quality Assurance Specifications*. FHWA-HRT-04-046. Washington, DC: FHWA.

Federal Highway Administration (FHWA). 2004. "Use of Contractor Test Results in the Acceptance Decision, Recommended Quality Measures, and the Identification of Contractor/Department Risks." Technical Advisory 6120.3. Webpage. Washington, DC: FHWA. Accessed January 2, 2024.

Federal Highway Administration (FHWA). 2006. "Chapter 1 I—Questions and Answers on the Quality Assurance Regulation (23 CFR 637)." *Materials Notebook*. Webpage. Washington, DC: FHWA. Accessed January 2, 2024.

Federal Highway Administration (FHWA). 2006. "Quality Assurance." Non-regulatory Supplement NS 23 CFR § 637B. Webpage. Washington, DC: FHWA. Accessed January 2, 2024.

Federal Highway Administration (FHWA). 2011. *Independent Assurance Programs*. FHWA-HIF-12-001. Washington, DC: FHWA.

Federal Highway Administration (FHWA). 2012. *Construction Quality Assurance for Design Build Highway Projects*. FHWA-HRT-12-039. Washington, DC: FHWA.

Federal Highway Administration (FHWA). 2013. *Acceptance of Non-Structural Precast Elements*. Tech Brief. FHWA-HIF-13-045. Washington, DC: FHWA.

Federal Highway Administration (FHWA). 2017a. "Chapter 1 IV - Quality Assurance Stewardship Review." *Materials Notebook*. Washington, DC: FHWA. Accessed January 2, 2024.

Federal Highway Administration (FHWA). 2017b. "Materials Quality Assurance." Webpage. Washington, DC: FHWA. Accessed January 2, 2024.

Federal Highway Administration (FHWA). 2017c. "Quality Assurance Stewardship Activities." Webpage. Washington, DC: FHWA. Accessed January 2, 2024.

Grogg, M. and A. Espinoza-Luque. 2023. *Documenting FHWA Quality Assurance Assessment 2022: Summary Report*. FHWA-HIF-23-021. Washington, DC: Federal Highway Administration.

National Highway Institute (NHI). 2020. *Quality Assurance for Highway Construction Projects.* FHWA-NHI-131141. Vienna, VA: NHI.