

TechBrief

The Construction and Materials Quality Assurance Program is an integrated, national effort to improve the effectiveness of the State acceptance of materials both in the inspection, sampling and testing. The program is designed to provide tools and guidance in implementing Quality Assurance programs. The program is designed to provide tools and guidance in implementing Quality Assurance programs.



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INDEPENDENT ASSURANCE PROGRAMS

This Technical Brief provides information regarding independent assurance as it relates to activities for the evaluation of the sampling and testing procedures used in a materials and quality acceptance program.

Introduction

23 CFR 637 defines an Independent Assurance Program as: Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program.

An Independent Assurance Program ensures the sampling and testing is performed correctly and 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.

Qualified sampling and testing personnel, other than those performing the verification and quality control (QC) sampling and testing, should perform the Independent Assurance (IA) tests. Likewise, equipment other than that used for verification and QC should be used for IA sampling and testing. By regulation IA sampling and testing is conducted by agency personnel or an accredited laboratory designated by the agency.

The regulation requires IA specifically be designed to include testing performed on project produced materials. Since the testing of project produced materials are tested in multiple locations and by multiple personnel it is necessary to have some assurance the testing is being performed accurately. Manufactured products are typically tested in the State's central laboratory or by a designated consultant laboratory. Testing in the central laboratory is considered to be covered by the laboratories accreditation and participation in proficiency testing.

Background

In the early sixties Congressional investigation uncovered improper testing and fraud in some of the federally funded highway projects. To address the issue of improper testing a separate sampling and testing program was developed. The program was operated by personnel different than project personnel on different equipment. The samples were split with project personnel and the test results were compared. In addition, testing procedures were also observed. This was done to ensure sampling procedures were performed correctly and equipment stayed in calibration. In later rewrites of the regulation this program became the Independent Assurance program.

Scope

The regulation, 23 CFR 637, only covers projects that are on the National Highway System (NHS). The regulation requires testing personnel that perform any verification testing or QC testing used in the acceptance decision be covered by an IA program regardless of the agency, including a local agency or a toll authority administering a project.

Some States have IA testing personnel perform other duties such as: (1) instructing other testers, (2) obtaining samples for the verification of manufactured products,(3) obtaining samples of aggregate, cement, binder samples at production facilities for purposes other than IA, (4) inspecting precast or other facilities. Even though these functions are a necessary part of an overall Quality Assurance (QA) program they will not be discussed in this Tech Brief since the purpose of this Tech Brief is to discuss the IA functions as defined in the regulation.

Regulation 23 CFR 637

The text of the entire regulation can be found at this website:

http://www.access.gpo.gov/nara/cfr/waisidx_03/23cfr637_03.html

The following is a summary of the elements of the IA program:

1. Establish IA sampling and testing frequencies;
2. Evaluate testing equipment by using one or more of the following: calibration checks, split samples, or proficiency samples.
3. Evaluate testing personnel by observations and results from testing split samples or proficiency samples.
4. Prompt comparison and documentation of test results obtained by the tester being evaluated and the IA tester.
5. Develop guidelines including tolerance limits for the comparison of test results.

6. Provide an annual report to the FHWA when the system approach is used.

The rest of the Tech Brief will discuss best practices for each of the above requirements.

System versus Project Approach

The Independent Assurance Program can be set up on a project basis, which is the traditional approach, or on a system basis. The difference in the two approaches is the basis of the frequency of testing (cover all projects versus cover all personnel).

Some States have moved away from having testing personnel on all projects and are moving toward centralizing testing away from the project level. As this occurs testers may perform testing on several projects and it becomes more efficient to have a frequency based on the testers instead of projects quantities. In addition, the project approach does not always include all the testing personnel.

As States have moved toward the system approach they have also incorporated the IA program results as part of the technician qualification program.

Frequency of Independent Assurance Testing

Project Approach - The State establishes the frequency for the IA testing based on the testing frequency performed on the project or on a time frequency on a project. Typically, the States use a frequency of 10 percent of the verification/acceptance testing. For example if the verification testing is performed at the rate of 1 per 500 tons the IA frequency would be 1 per 5000 tons.

System Approach - An alternative method to basing frequency on project testing frequencies is to base the IA frequency on a time basis for all testers and equipment. In this case, the personnel and equipment would be verified on a "system" basis. The purpose is to cover all the testers and equipment over a period of a year. While States strive to reach all testers, it is not always possible. States typically set a goal of reaching 90% of the active testers. Active testers are defined as those testers that are performing testing in a given year, in most States this is a subset that is smaller than all "qualified" testers since some qualified personnel may have retired, move to other jobs or resigned. The system approach can be a more effective means of performing IA since it ensures that most testers are reviewed and that the same testers are not continually reviewed.

One challenge is to determine the active testers. For States that have an electronic materials management system it is very easy to determine the active testers since these systems indicate who is performing a given test. The IA testers will run reports periodically (monthly) to

determine the testers that need to be reviewed. For those States that do not have an electronic materials management system it becomes more challenging to determine the active testers. A good practice under these circumstances is to require the project personnel to identify the personnel that are going to perform testing, state, consultant, and contractor, at the beginning of the project along with any changes to the IA personnel. The IA testers will then know the active testers along with the testers that they have already been reviewed and will thus know the testers that need to be reviewed in the future.

Mixed Approach - It is permissible to separate the verification of equipment and personnel, i.e., one method to check equipment is to require a calibration and inspection frequency. Personnel can be checked by sending out proficiency samples. It is permissible to use a mixed approach, i.e. where some test procedures and or some testers are covered by a project approach where the remaining procedures are covered by a system approach.

Equipment and Personnel

Testing equipment may be evaluated by using one or more of the following: calibration checks, split samples, or proficiency samples.

Testing personnel may be evaluated by observations and split samples or proficiency samples.

The typical approach for performing IA is to check equipment and personnel at the same time. This is performed by IA personnel visiting a job site to observe the sampling and testing on site and to also test a split of the sample on site with equipment the IA personnel brought or to take the split to another laboratory for testing. When the test results are compared it checks both the equipment and tester. If a set of samples do not compare further analysis is required to determine if the source of the error is in procedure or equipment.

Some States send out proficiency samples to district, other subsidiary laboratories as well as consultants and contractors. Some of these States develop their own samples, while others require the laboratories to subscribe to the AASHTO Materials Reference proficiency samples. Proficiency samples are a way to address equipment and test procedures. Some States are preparing enough proficiency samples for all the active testers. In cases where all the testers are covered by the proficiency samples additional IA work would only need to review those that did not compare. If the proficiency program did not cover all the testers additional IA work would also be required.

Another method that covers just the equipment is performed by frequent standardization and or calibration. The frequency for standardization and/or calibration differs by equipment due to the unique nature of each testing device. AASHTO R-18 and some of the test procedures contain a frequency for standardization/calibration of the testing equipment. However, if standardization/calibration is the only check on the equipment (no split samples or proficiency samples) the standardization/calibration should probably be run frequently.

As some States move toward the system approach the States are checking testers in a central location. This allows the IA inspectors to cover numerous testers at one time. This has worked especially effectively in States where the projects and or laboratories are spread across a large geographic area. The States that use this approach are also including this data for requalification of testing personnel. When this approach is used the equipment needs to also be covered by standardization/calibration, split sample or proficiency sample testing.

Some States will suspend and/or revoke a technician's qualification/certification for repeated poor performance on IA evaluations. These are in addition to suspensions and/or revocation due to fraudulent activities. Some States will also perform testing on 3 way split-samples. In this approach one split is tested by project personnel, one split is tested by the contractor personnel and the third split is tested by the IA personnel. This is typically performed at the beginning of production to ensure that all testing personnel and equipment are performing correctly.

Prompt Comparison and Documentation

It is essential the IA Program compare results and detect deficiencies in State or contractor testing procedures in a timely manner. This improves the reliability of sampling and testing. The timely comparison of data may be restricted by the resources of an agency including personnel, facilities, and geographical constraints. These resource needs must be considered in an agency program.

Deviations from the established tolerances will require an engineering audit of the respective sampling and testing procedures, and the equipment used. When comparison of QC and verification data reveals significant differences in test values, the variables involved should be evaluated by the IA personnel to determine whether further testing and investigation is needed to establish the source of the discrepancy.

Corrective actions should be incorporated as appropriate under the direction of IA personnel.

Tolerances for Comparison of Test Results

A common place to start in establishing comparison tolerances are the D2S limits in the published test procedures. However, as States reduce the options in published test procedures and as testers become more proficient, the tolerances should be reduced. When split samples are used, the materials and sampling variability are eliminated from the analysis and only the variability due to the testing procedures and the equipment are included.

The comparison of split sample test results should be based on established deviation values or tolerances that are representative of the testing procedures and materials used. AASHTO and ASTM have published precision statements for some test methods. However, many of these procedures have multiple methods and or options inside the procedure. In order to reduce

testing variability most States have specified the particular options within the test procedures. Therefore the agency should develop Independent Assurance tolerances based on their specific options that the State is requiring. Care must be taken when historical data are used in establishing these limits to ascertain that the data are not biased; i.e., they were obtained in a random manner and that all test results have been reported. Otherwise, the variability may be underestimated and the limits too restrictive.

Many States distribute proficiency samples to their district laboratories. This data can be analyzed to determine IA tolerances. The formula for D2S is $D2S = 2\sqrt{2}(1S)$ where

1S = the standard deviation of the results .

Established tolerances should be periodically evaluated and modified to ensure that the goals of IA are being met; that is, it assures the reliability of contractor and agency test results. Some States are evaluating their tolerance every year. As a minimum the tolerances should be evaluated every 5 years.

In situations where multiple split tests are performed on a project a paired t-test can also be used to analyze data.

Annual Reports

The regulation requires those States that use a system approach to prepare and submit an annual report to the FHWA Division Office.

The annual report should include the following information: the number of certified technicians, the number of active technicians, the number of technicians covered by the IA program, the number of IA reports that had deviations, and a summary of how the deviations were addressed along with the potential systematic solutions to reoccurring deficiencies.

Alternate Approach

One State is statistically analyzing State and Contractor data in an innovative manner to accomplish both verification and IA.

An example of this approach is shown in Figure 1. In this approach the contractor performs sampling and testing at the rate of 4 samples per lot. The State takes verification samples, at the beginning of production; a minimum of 4 samples are taken the first week of production and at least 1 per lot. The State's verification samples are taken at the plant by contractor personnel under the direction of the State personnel. The verification samples are split and one split is given to the contractor. Analysis is performed in two ways. First, for IA, the split results are compared using IA comparison tolerances. In the figure below; IA1 is compared to the contractor split of that sample, sample 4 of lot 1. For validation, the State verification

samples are made independent by removing the corresponding contractor splits. In the figure below samples 1, 2, 3 from lot 1; samples 1, 2, 4 from lot 2; samples 1, 2, 3 from lot 3; and samples 1, 3, 4 from lot 4 are compared to the State's IA1, IA2, IA3, and IA4 with the F& t tests.

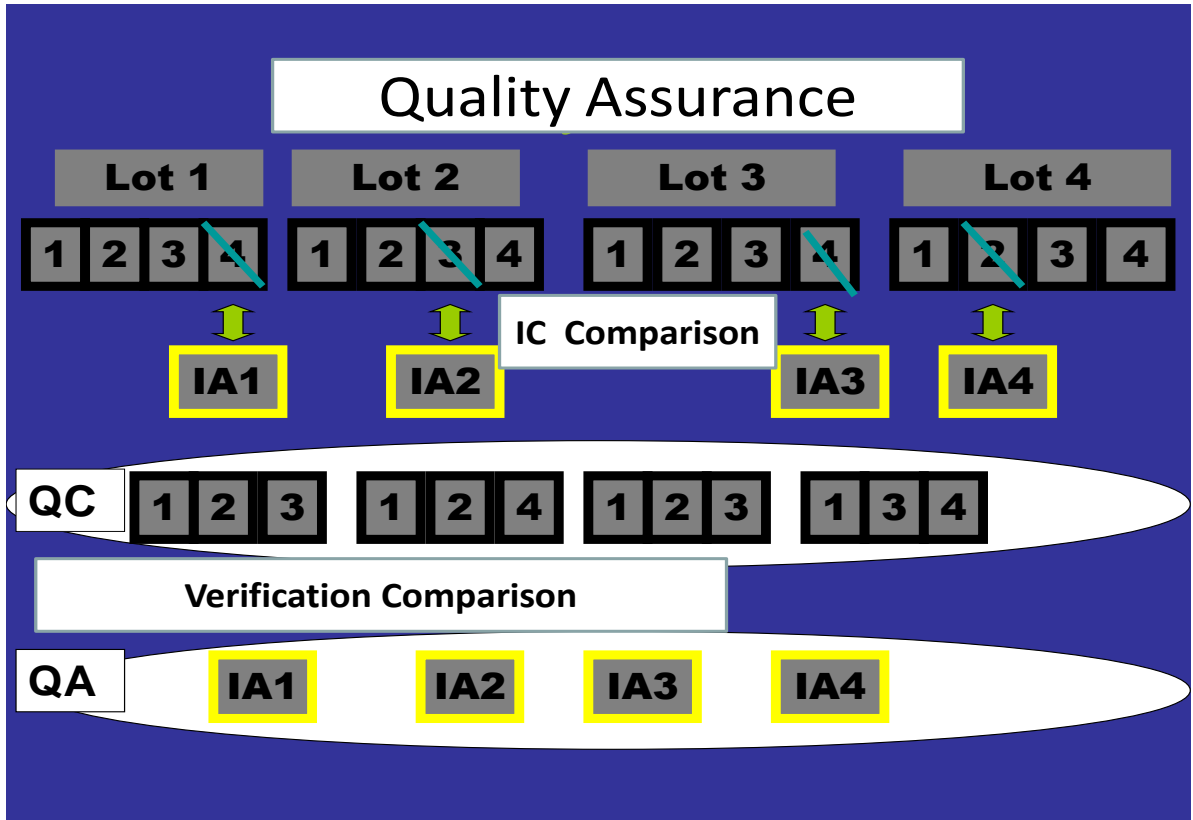


Figure 1. Example of Alternate Approach.

Conclusion - Commonly Noted Areas of Concern

- Test results from the IA program should only be compared to split test results or results from others testing the same set of proficiency samples.
- IA results are not to be used in the acceptance decision.
- IA should be based on split samples or proficiency samples not independent samples so that data can be compared without material variability.
- All tests that are performed in the field to determine the final acceptability of the materials should be covered by the IA program.

- All technicians that are performing testing that is used in the acceptance decision need to be covered by the IA program.
- Observation of sampling and testing procedures should be included as part of an IA system to evaluate sampling and testing personnel and ensure that testing and sampling procedures are performed correctly.

Further Information:

- "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.access.gpo.gov/nara/cfr/waisidx_03/23cfr637_03.html
- 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/legsregs/directives/fapg/0637bsup.htm>
- Frequently asked questions (FAQ) on the Quality Assurance Regulation. The FAQs were updated on November 26, 2006. <http://www.fhwa.dot.gov/pavement/materials/matnote11.cfm - qaa>
- AASHTO Standard Practice R 44, "Independent Assurance Programs" has been published in the 2007 AASHTO Standards. This guide will assist the States in developing Independent Assurance Programs
- NHI Course 134042, "Materials Control and Acceptance –Quality Assurance." The course is four days long and covers the basic essentials of QA. A two-day version of the course is also available. http://www.nhi.fhwa.dot.gov/training/brows_catalog.aspx
- NHI Course 134064 – "Transportation Construction Quality Assurance"

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