Arizona Department of Transportation

Quality Assurance Program

Projects Utilizing Contractor Performed Acceptance

November 24, 2020

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The Arizona Department of Transportation has developed this Quality Assurance Program for Projects utilizing Contractor performed acceptance. This Program addresses how ADOT will deliver construction quality assurance when the Contractor, or an Independent Quality Firm hired by the Contractor, performs frontline Quality Acceptance inspection and testing with ADOT performing Owner Verification. It provides a systematic and consistent approach to achieving quality on these Projects through the implementation of Contractor Quality Control, Contractor Quality Acceptance, ADOT Owner Verification, ADOT Independent Assurance, and ADOT referee functions on a Project.

Sincerely,
Jesús A. Sandoval-Gil, MS, PhD, PE
State Materials Engineer

Please Note: Information pertaining to updates, changes to this document and reference materials being hyperlinked throughout the document should be included here.

Formal references may be included in this document as needed.

Approval

DocuSigned by: Jesus A Sandoval-Gil F9A6FBCB94A6460...	DocuSigned by: Ammon Heier FEF6E4414BAF4AE...
Signature	Signature
Jesús A. Sandoval-Gil, MS, PhD, PE	Ammon Heier, PE
Name	Name
State Materials Engineer	Area Engineer
Title	Title
ADOT	FHWA
Agency	Agency
11/24/2020	11/24/2020
Date	Date

Chapter 1

Scope

1.1 General

The Arizona Department of Transportation (ADOT) has developed this Quality Assurance Program (QAP) for Projects utilizing Contractor performed inspection and testing in the acceptance decision. This Program has been established to be compliant with the Code of Federal Regulations (CFR) 23 CFR 637, Subpart B – "Quality Assurance Procedure for Construction", Federal Highway Administration (FHWA) Technical Advisory 6120.3, and other guidance documents listed in Appendix A.

This Program provides our customers with products and services that meet mutually agreed upon requirements. The intent of this Program is to ensure all materials and workmanship incorporated into ADOT Projects satisfy specification requirements and to provide the highest degree of confidence in the reliability of tests and inspections for ADOT Projects. The purpose of this Program is to provide statewide consistency for Projects when the Contractor's test results are used in the acceptance decision, regardless of how the Project is funded. It presents requirements relating to Quality Acceptance (QA) procedures and Owner Verification (OV) procedures.

This Program is administered by the ADOT Materials Group Quality Assurance Section through the authority of the ADOT State Materials Engineer. Revisions to this Program will be issued by the ADOT Materials Group Quality Assurance Section through the authority of the ADOT State Materials Engineer. Any modification to this QAP requires review and approval by the ADOT Materials Group Quality Assurance Section through the authority of the ADOT State Materials Engineer and FHWA.

Appendix B shows the list of abbreviations and definitions used in this Program.

1.2 Program Components

This Program is comprised of two major components. These are the Acceptance Program and the Independent Assurance (IA) program. The Acceptance Program includes QA performed by the Contractor and OV performed by ADOT, or its designee. The Program allows the use of Contractor performed QA as part of the Acceptance Program, when Contractor QA test results are verified by ADOT's OV test results. The IA program consists of IA performed by ADOT, or its designee, to evaluate the equipment and personnel performing acceptance testing.

23 CFR 637, Subpart B defines quality control as: All contractor/vendor operational techniques and activities that are performed or conducted to fulfill the contract requirements. 23 CFR 637, Subpart B also allows for quality control, as defined in the CFR, sampling and testing results to be used as part of the acceptance decision. This Program differentiates Contractor QA from

Contractor Quality Control (QC). Within this Program, Contractor QC cannot be used as part of the Acceptance Program and is not subject to the IA program. Figure 1.2 shows the relationship between the different components of this QAP.

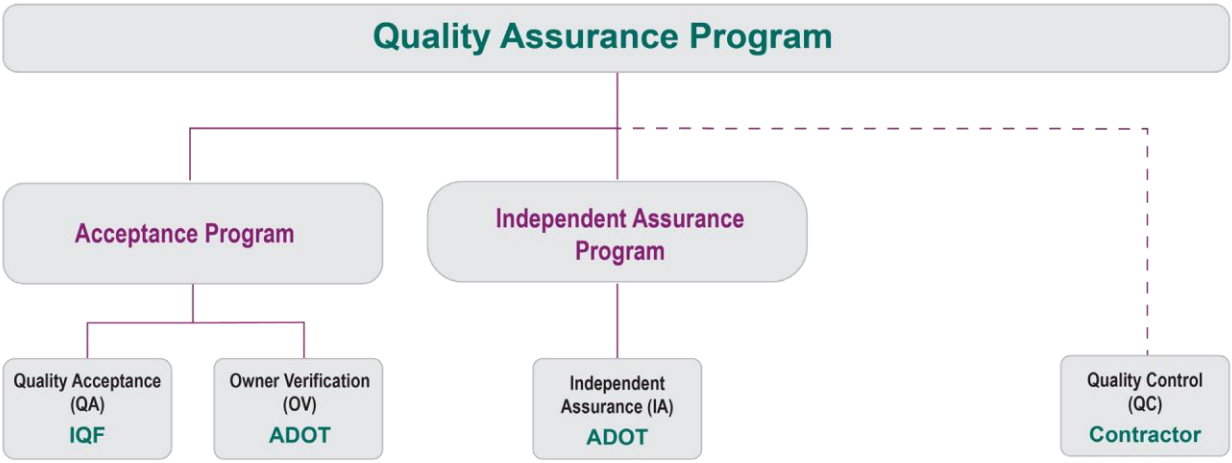

Figure 1.2: Components of this Quality Assurance Program

Chapter 2 addresses the Contractor QC and includes a brief description of the approach to QC. The Contract Documents will provide detailed QC requirements that shall be included in the Contractor's Construction Quality Management Plan (CQMP). Chapter 3 addresses the Acceptance Program and includes detailed Contractor QA requirements and the approach to ADOT OV. The Contract Documents will provide detailed Contractor QA requirements that shall be included in the CQMP. Chapter 4 provides detailed requirements for the ADOT IA program.

1.3 Construction Quality Management Plan

The Contractor shall create a CQMP that describes the policies, procedures, and staffing required to manage construction quality in accordance with the Contract Documents. The Contractor shall define all QC processes and procedures in the CQMP that will achieve compliance with the Contract Documents. The Contractor, or an Independent Quality Firm (IQF) hired by the Contractor, shall also define Contractor QA processes and procedures for both materials testing and comprehensive product inspection which will be used in acceptance decisions as described in this Program. The CQMP is required to be approved by ADOT prior to the start of any construction activities.

1.4 Owner Verification Testing and Inspection Plan

ADOT will develop an Owner Verification Testing and Inspection Plan (OVTIP) that describes the processes and procedures for ADOT to perform OV of the Contractor's QA inspection and testing. Detailed ADOT OV criteria are in section 3.11.

1.5 Conflict of Interest

There are six functions identified in the QAP, these functions and the responsible parties are shown below:

- Production; Contractor
- Quality Control; Contractor
- Quality Acceptance; Contractor, or Independent Quality Firm
- Owner Verification; ADOT, or Owner Verification Firm
- Independent Assurance; ADOT
- Referee; ADOT

To avoid a conflict of interest, each Contractor function shall be performed by separate groups or entities, and each ADOT function will be performed by separate ADOT groups. Production, Quality Control, and Quality Acceptance shall be separated by reporting structure, and any additional requirements of the Contract Documents. The OV, IA, and referee functions will only be performed by an ADOT group or an entity contracted directly by ADOT.

Chapter 2

Quality Control

2.1 General

The Contractor is responsible for the quality of the Work. Project quality will be enhanced through the daily efforts of all workers involved with the Work as described in the CQMP. The Contractor's entire workforce shall actively participate in quality efforts to minimize/eliminate re-Work.

The QC program shall be sufficient in scope to produce only Work compliant with the Contract Documents. The QC program shall also be sufficient in scope to avoid repeated discoveries of Nonconforming Work. Repeated discoveries of Nonconforming Work by the Contractor QA staff, the IQF, ADOT, or an excessive use of Engineering Judgment according to ADOT, will be considered a breakdown of the QC program. Corrective action shall be documented and implemented by the Contractor if there is a breakdown of the QC program. Corrective action may include the revision of existing QC procedures, addition of new QC procedures, re-training of QC personnel, removal and replacement of QC personnel, or other such actions necessary per ADOT, to restore the effectiveness of the QC program.

QC efforts are not part of the Acceptance Program.

2.2 Contractor's Quality Control Requirements

The Contractor's CQMP shall comply with the QC requirements of this Program and the Contract Documents.

Chapter 3

Acceptance Program

3.1 General

The Acceptance Program includes both the Contractor's QA and ADOT's OV functions. Regarding materials testing, Contractor QA test results are only allowed to be used in the acceptance decision if they are verified by ADOT's OV test results. Regarding workmanship and other inspection-driven features of the Work, Contractor QA inspection observations and conclusions shall only be used in the acceptance decision if the processes, procedures, and documentation, per the approved CQMP, are verified by ADOT's OV functions. Only Contractor QA performed per the approved CQMP may be used in any acceptance decisions.

Contractor QA shall be performed by Contractor staff or an IQF hired by the Contractor as defined in the Contract Documents. Only an independent group of Contractor staff may perform the Contractor QA role. The independent group of Contractor staff is subject to approval by ADOT. In this Program, it is assumed that the Contractor has hired an IQF to perform the Contractor QA function and that firm is led by a Construction Independent Quality Manager (CIQM). If the Contractor QA is being performed in-house, then the same requirements would apply to the Contractor's in-house Contractor QA team and their in-house Contractor QA manager.

3.2 Qualification of Personnel

All personnel performing sampling and testing shall meet the qualification requirements shown below for the appropriate field in which sampling and testing is being performed.

Soils and Aggregate	
<u>Field</u> Arizona Technical Testing Institute (ATTI) "Field" certification.	<u>Laboratory</u> Arizona Technical Testing Institute (ATTI) "Laboratory Soils/Aggregate" certification.
Asphaltic Concrete	
<u>Field</u> Arizona Technical Testing Institute (ATTI) "Field" certification.	<u>Laboratory</u> Arizona Technical Testing Institute (ATTI) "Asphalt" certification.
Concrete	
<u>Field</u> American Concrete Institute (ACI) "Concrete Field Testing Technician Grade I" certification.	<u>Laboratory</u> American Concrete Institute (ACI) "Concrete Strength Testing Technician" certification.

All personnel performing sampling and testing shall be supervised by an individual meeting the

requirements below for the appropriate field in which sampling and testing is being supervised.

Soils and Aggregate	
Field Arizona Technical Testing Institute (ATTI) "Field" certification plus one of (a) through (g) below	Laboratory Arizona Technical Testing Institute (ATTI) "Laboratory Soils/Aggregate" certification plus one of (a) through (g) below.
Asphaltic Concrete	
Field Arizona Technical Testing Institute (ATTI) "Field" certification plus one of (a) through (g) below.	Laboratory Arizona Technical Testing Institute (ATTI) "Asphalt" certification plus one of (a) through (g) below.
Concrete	
Field American Concrete Institute (ACI) "Concrete Field Testing Technician Grade I" certification plus one of (a) through (g) below.	Laboratory American Concrete Institute (ACI) "Concrete Strength Testing Technician" certification plus one of (a) through (g) below.

(a) Professional Engineer, registered in the State of Arizona, with one year of highway materials sampling and testing experience acceptable to ADOT.

(b) Engineer-In-Training, certified by the State of Arizona, with two years of highway materials sampling and testing experience acceptable to ADOT.

(c) Obtained a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology, Construction, or related field acceptable to ADOT; and with three years of highway materials sampling and testing experience acceptable to ADOT.

(d) Certified by the National Institute for Certification in Engineering Technologies (NICET) in the Construction Materials Testing field as an Engineering Technician (Level III) or higher in the appropriate subfield in which sampling and testing is being performed.

(e) Certified by NICET in the Transportation Engineering Technology field as an Engineering Technician (Level III) or higher in the Highway Materials subfield.

(f) Certified by NICET as a Certified Engineering Technologist, or higher, in Civil Engineering Technology with five years of highway materials sampling and testing experience acceptable to ADOT.

(g) An individual with eight years of highway materials sampling and testing, and construction, experience acceptable to ADOT.

In the absence of ATTI certification, individuals who currently possess active certification(s)

under another state's certification program may be allowed to perform Project activities that would normally be covered by ATTI certification as part of the acceptance decision on a provisional basis. This provisional status requires prior approval by ADOT on a case-by-case basis, and is only applicable to the individual Project. To request provisional approval, the following information shall be submitted to ADOT a minimum of 14 Days before the individual starts sampling and testing on the Project:

- Name of the individual.
- Name of the appropriately certified person who will be supervising the individual's Work.
- Description of the Work to be performed by the individual, including the type of sampling and testing the individual is expected to perform.
- List of applicable certifications currently held under another state's certification program and expiration dates.
- Differences between the other state certifications and the corresponding ATTI certifications.
- Description of how these differences will be managed to avoid errors.

Any authorized provisional approval will be in effect for a maximum of six (6) months from the time the individual begins working on the Project. By the time this six-month period has elapsed, the individual shall have obtained the appropriate ATTI certification(s) to be allowed to continue sampling and testing or materials related inspection on the Project. While in provisional status, such individuals shall be under the direct supervision of someone who has the appropriate ATTI certification(s). The IQF shall obtain this provisional approval from ADOT, document the certification status of these individuals, and ensure the individuals obtain the appropriate ATTI certification(s) within the time allotted. Individuals receiving provisional allowance to perform acceptance Work shall be observed by ADOT's IA program within the first 14 days from the time the individual begins sampling and testing on the Project.

Inspectors performing acceptance inspections on precast concrete Elements shall have Precast Concrete Institute (PCI) Level II certification.

Inspectors performing acceptance inspections on either Freeway Management System (FMS), lighting, or signals shall have both International Municipal Signal Association (IMSA) Traffic Signals Technician Level II and IMSA Fiber Optic Technician Level II certifications.

Inspectors accepting traffic control set ups shall have American Traffic Safety Services Association (ATSSA) Traffic Control Supervisor (TCS) certification.

Any person accepting asphaltic concrete binder shall have the National Binder Technician Certification (NBTC).

3.3 Qualification of Laboratories

All laboratories are required to be approved by ADOT prior to performing sampling and testing activities for an ADOT Project. The "ADOT System for the Evaluation of Testing Laboratories" details the requirements that laboratories shall satisfy in order to be considered for approval by ADOT. Laboratories which have been approved to perform sampling and testing activities on ADOT Projects are listed in the ADOT "Directory of Approved Materials Testing Laboratories". Included in that directory are the individual tests for which a laboratory has been approved. In addition to the R18 Quality Management System Criteria, laboratories performing sampling and testing activities for an ADOT Project under this Program shall also obtain American Association of State Highway and Transportation Officials (AASHTO) re:source accreditation for the following Quality Management Systems:

- C1077 (Aggregate)
- C1077 (Concrete)
- D3666 (Aggregate)
- D3666 (Asphalt Mixture)
- D3740 (Soil)
- E329 (Aggregate)
- E329 (Asphalt Mixture)
- E329 (Concrete)
- E329 (Soil)

Both AASHTO re:source accreditation and ADOT approval must be received for all test methods that are to be performed on an ADOT Project.

In this Program, laboratories are not required to participate in the ADOT Proficiency Sample Program. This is due to the already required AASHTO re:source and Cement and Concrete Reference Laboratory (CCRL) proficiency sample programs, as well as the ongoing ADOT verification per this Program.

3.3.1 ADOT Laboratory Inspection

All independent, Contractor, materials supplier, government, and other testing laboratories desiring to perform testing activities for ADOT shall submit to an ADOT inspection as specified in the "ADOT System for the Evaluation of Testing Laboratories". The inspection considers those elements of service that the respective laboratory proposes to offer to ADOT. This requirement includes laboratories submitting asphaltic concrete mix designs and those performing acceptance and referee testing for ADOT. A current (within 18 months) passing ADOT inspection is one of the initial and ongoing conditions required for, and to maintain, ADOT approval.

ADOT inspections include both an equipment inspection and a procedural inspection.

A written inspection report will be issued by ADOT to the laboratory that has been inspected. The laboratory shall provide ADOT with satisfactory responses to the noted deficiencies within 30 days of the report issuance. The responses shall provide satisfactory evidence that all significant deficiencies were corrected or that corrective action is in progress. The laboratory's inspection and responses will be considered when evaluating ADOT eligibility.

3.3.1.1 ADOT Laboratory Equipment Inspection

The equipment inspection will consist of checking dimensional, calibration, and specification conformance of all apparatus and equipment required by the test procedures contained in "ADOT's Materials Testing Manual", and in other applicable specifications. Equipment related documentation, required by AASHTO R18, is also checked during this inspection. This inspection is not a calibration service for non-ADOT laboratories. Any equipment found unacceptable shall be repaired, properly calibrated, or removed from service at the expense of the owner laboratory. Laboratory facilities will also be checked for compliance with applicable standards, such as, proper temperature and humidity control. Documentation of the calibration and verification of equipment used in field testing which is not available during the inspection will be reviewed for compliance with applicable requirements.

3.3.1.2 ADOT Procedural Inspection

The procedural inspection serves as a tool to evaluate the performance of laboratory technicians when performing tests in accordance with the "ADOT Materials Testing Manual" or other applicable specifications. ADOT, AASHTO, and American Society for Testing and Materials (ASTM) test methods referenced in the "ADOT Materials Testing Manual" will be observed. If ADOT's test methods deviate from those given in a similar AASHTO or ASTM procedure, ADOT's Materials Testing Manual will govern.

The inspection formats will generally conform to the techniques employed by AASHTO re:source and the CCRL, as appropriate. When a departure from the requirements of a test method is observed by the inspectors, they will point it out to the laboratory personnel so that immediate corrections can be made if possible. The inspectors will present a summary of their findings and identify deficiencies requiring corrective action at an informal exit review where any deficiencies discovered can be discussed openly. It is requested that the laboratory manager and supervising engineer be present at the exit review.

3.4 Qualification of Equipment

All equipment used by any technician shall be in the active inventory of an AASHTO accredited and ADOT approved laboratory. Actual calibration records for each specific inventory item shall be current and provided upon request. All equipment and apparatus shall be inspected and found acceptable. All equipment and apparatus shall be maintained in good working order.

All equipment and apparatus shall be inspected, calibrated, and verified per the requirements of this Program, and the requirements of ADOT's "Equipment Calibration and Verification" document located in the "ADOT Material Testing Manual".

Inspection of equipment and apparatus shall be performed by either:

- An AASHTO accredited laboratory that has been approved by ADOT, or:
- An individual or company who, as a business, performs inspection and calibration of sampling and testing equipment.

Inspections and calibrations shall be performed in accordance with established ADOT, AASHTO, ASTM, and National Institute of Standards and Technology (NIST) specifications. Proper calibration equipment that is traceable to NIST standards shall be used.

3.5 Quantities of Material and Work Elements

The IQF shall continuously track and record the quantities of all materials and Work Elements incorporated into the Project. The IQF shall also continuously track and record the number of all samples and tests performed on the Project. Monthly, the IQF shall reconcile their accepted quantities with the quantities of all materials and Work Elements incorporated into the Project. Monthly, the IQF shall submit a detailed report to ADOT that, at a minimum, includes:

- The total (current month and Project total to date) number of samples and tests performed, the total (current month and Project total to date) number of required samples and tests, the total (current month and Project total to date) quantity of material incorporated into the project, the minimum sampling frequency, unit of measurement, and the sampling point, all for each individual combination of: specification section, material, type of test required, and Material Code. An example of one of these combinations is shown below:

Spec.	Mat.	Mat. Code	Type Code	Type of Test	Samp. Point	Min Samp. Freq.	Unit of Meas.	Quant. this Month	Tests Req. This Month	Tests Perf. This Month	Total Quant. to Date	Total Tests Req. to Date	Total Tests Perf. to Date
501	Bedding Material for Concrete Pipe	BM	CP	Compaction	In-Place	One per 50 Cubic Yards	Cubic Yards	#	#	#	#	#	#

- The total quantities (current month and Project total to date) of each and every Work Element incorporated into the Project. For this report, these Work Elements are individual bid items typically found on ADOT projects, and any additional, or more detailed, Project specific items.

ADOT will use the report to verify the compliance of both the IQF and ADOT testing

frequencies. The CQMP shall define how the IQF will accurately track, record, and report the quantities of all materials and Work Elements incorporated into the Project. At the beginning of the Project, and included in the CQMP, the IQF shall submit the formats and detailed examples of the report listed above to ADOT, for ADOT's review and approval.

3.6 Sampling and Testing

This section provides requirements for acceptance sampling and testing.

3.6.1 Types and Uses

Sampling is either random or fixed, depending on whether the location was selected randomly (random) or if a specific location was subjectively identified (fixed). Sampling is also either independent or dependent, based on whether the location was independently selected (independent) or whether it is based on the location of another sample, e.g. a split sample (dependent). Only ADOT and IQF samples selected randomly and independently shall be used to meet the acceptance testing minimum frequency requirements of the sampling Guide Schedule. This includes both the items shown in Appendix D, as well as any Project specific sampling and testing frequency requirements. A failing IQF random independent test requires both a passing fixed test at the original failing location and an additional passing random independent test within the unit or quantity of material being accepted.

The IQF shall perform additional fixed tests when the quality of material is questionable. If these additional fixed tests fail, they shall be addressed in the same manner as a failing random independent test. Fixed tests do not count towards meeting the Guide Schedule testing frequencies.

A comparison process for performing and analyzing split samples between ADOT and IQF is required during the initial implementation of, and throughout, this Program to ensure that ADOT and IQF equipment and testing procedures are in alignment. ADOT will determine how many and which type of tests will be used during this comparison process. These test results will be analyzed by ADOT and shared with the IQF to assure laboratory and technician test results compare favorably. This process will help provide initial alignment of the ADOT and IQF laboratories and testing procedures. The IQF shall commit the resources and sample material necessary to accommodate splitting alignment activities described in the Program. When the allowable variation limits in Appendix C of this Program are exceeded, corrective actions for either or both parties will be identified and incorporated as appropriate.

Split samples may also be performed throughout the life of the Project to investigate non-validating material categories and to verify or realign testing equipment and personnel.

3.6.2 Frequencies, Labeling, and Representative Quantities

The quality of materials and construction incorporated into the Project are controlled by

acceptance sampling, acceptance testing, and acceptance inspection activities. Acceptance test results and acceptance inspection results shall be accepted based on compliance with the specifications and the Contract Documents. The IQF shall randomly sample at prescribed frequencies, based on the sampling Guide Schedule, that meet or exceed those presented in the Appendix D. The Project's sampling Guide Schedule shall be published in the CQMP.

The IQF's sampling Guide Schedule shall apply to sampling frequencies only for acceptance sampling and testing. It shall indicate the material type to be sampled, the controlling specification(s), the frequency of sampling, the location where sampling will occur, the testing to be performed, and the acceptance criteria. The IQF's acceptance samples shall be obtained randomly. The Contractor and IQF shall use the Material Codes as shown in Appendix E. All Material Codes and material types to be used on the Project shall be included in the CQMP. The Contractor or IQF may request to modify Material Codes or material types based on specific Project needs. This request is subject to ADOT's approval. ADOT may alter the Material Codes in Appendix E at any time to accommodate the separation of materials into appropriate categories for statistical validation or verification. The IQF shall also label samples and sample tickets in accordance with the example sample ticket in Appendix E. At the beginning of the Project, and included in the CQMP, the IQF shall submit the formats and detailed examples of sample tickets to be used to ADOT, for ADOT's approval.

Every IQF sample is a representative sample that represents quality of a larger quantity of material or Element of Work. The test result for each individual test performed shall be applied to the larger quantity of material or Work that the individual test result represents. This applies to all sampling and testing per the Guide Schedule, as well as any sampling, testing, or activities with required frequencies, identified in the CQMP or Contract Documents.

The CQMP shall define the methodology that is used by the IQF to define the specific quantity of material or Work that each representative sample represents from the larger quantity of material or Work.

This includes, but is not limited to materials that are sampled on a time designated lot basis. The CQMP shall define the methodology to estimate the relationship between the production quantity and the time required to produce such quantity. This relationship is required for the IQF to determine the recommended number of acceptance samples. The CQMP shall also define how the sampling times are determined, and quantity of material each sample represents.

3.6.3 Notification

Every week, the Contractor shall update and provide the IQF and ADOT with an accurate rolling 3 week look ahead schedule consistent with the current complete Project schedule. This complete Project schedule is often referred to as the Project's complete critical path method schedule. The look ahead schedule shall include all offsite fabrication activities, all offsite inspection activities, and all offsite sampling and testing activates. The look ahead schedule

shall also include all onsite fabrication activities, all onsite inspection activities, and all onsite sampling and testing activities.

Every day, the Contractor shall provide the IQF and ADOT with an accurate and complete hourly schedule, for any and all sampling and testing that will occur the following day. All sampling and testing requires at a minimum one complete business day notification. The hourly schedule shall include all offsite inspection, sampling, and testing activities. The hourly schedule shall include all onsite inspection, sampling, and testing activities.

3.7 Status of Material Quality

All material incorporated into the Project shall adhere to the Contract Documents. If material is to remain incorporated into the Project that does not adhere to the Contract Documents, Engineering Judgment shall be utilized and properly documented, or the Nonconformance Report (NCR) process shall be completed by the Contractor.

With regard to ADOT and IQF test results, there are multiple possible combinations of passing and failing results. The following describes the process that shall be followed based on the different possible combinations:

3.7.1 Both the IQF and ADOT test results are within specification limits. The material represented by the samples is considered acceptable and may be left in place.

3.7.2 The IQF test results are outside of the specification limits (No ADOT test result or ADOT test results are within the specification limits). The material may be accepted and left in place only if one of the following occurs:

3.7.2.1 The NCR process is completed by the Contractor.

3.7.2.2 The IQF test result indicates reasonable conformance with specification requirements and the IQF exercises Engineering Judgment to accept the material.

3.7.2.3 The IQF test results do not indicate reasonable conformance with specification requirements. The material shall be removed, reworked, or repaired. The failing IQF test result is replaced by two additional IQF passing test results. The first additional passing test shall be a fixed IQF test at the same location as the original failing sample, and the second sample shall be a random independent IQF test within the quantity of material that the initial failing test represented.

Random independent test results representing material prior to any replacement, rework, or repair will be excluded from new statistical analyses.

3.7.3 The IQF test results are within the specification limits and the ADOT test results are outside of specification limits. The material may be accepted and left in place only if one of the following occurs:

3.7.3.1 The NCR process is completed by the Contractor.

3.7.3.2 The ADOT test result indicates reasonable conformance with the specification requirements and both the IQF exercises Engineering Judgment to accept the material and ADOT concurs with the acceptance of the material based on the IQF's Engineering Judgment.

3.7.3.3 ADOT test results do not indicate reasonable conformance with specification requirement in ADOT's Sole Discretion:

The material shall be removed, reworked, or repaired. The failing ADOT test result is addressed with two additional passing IQF test results. The first additional sample shall be an IQF fixed test at the same location as the original ADOT failing sample, and the second sample shall be a new IQF random sample within the quantity of material that the initial failing ADOT sample represented (the test shall not be any previous IQF test result). Any failing IQF test results during this process shall initiate the start of the process in Section 3.7.2 "The IQF test results are outside of the specification limits (No ADOT test result or ADOT test results are within the specification limits)…". ADOT may conduct an additional tests or samples at any time during this process. Any failing ADOT test result shall require two new additional IQF test results (Section 3.7.3.3 starts from the beginning for each failing result).

Random independent test results representing material prior to any replacement, rework, or repair will be excluded from new statistical analyses.

3.7.4 Both the IQF and ADOT test results are outside of the specification limits. The material may accepted and left in place if one of the following occurs:

3.7.4.1 The NCR process is completed by the Contractor.

3.7.4.2 The IQF and ADOT test result indicates reasonable conformance with the specification requirements and both:

The IQF exercises Engineering Judgment to accept the material (the IQF must exercise Engineering Judgment on both the IQF and ADOT results)

and ADOT concurs with the acceptance of the material based on the IQF's Engineering Judgment.

3.7.4.3 The ADOT test result indicates reasonable conformance with the specification requirements and the IQF test results do not indicate reasonable conformance with specification requirements:

The material shall be removed, reworked, or repaired. The failing IQF test result is replaced by two additional IQF passing test results. The first additional passing test shall be a fixed IQF test at the same location as the original failing sample, and the second sample shall be a random independent IQF test within the quantity of material that the initial failing test represented.

Random independent test results representing material prior to any replacement, rework, or repair will be excluded from new statistical analyses.

3.7.4.4 The IQF test result indicates reasonable conformance with the specification requirements and the ADOT test results do not indicate reasonable conformance with specification requirements in ADOT's Sole Discretion:

The IQF exercises Engineering Judgment to accept the failing IQF test result material.

The material shall be removed, reworked, or repaired. The failing ADOT test result is addressed with two additional passing IQF test results. The first additional sample shall be an IQF fixed test at the same location as the original ADOT failing sample, and the second sample shall be a new IQF random sample within the quantity of material that the initial failing ADOT sample represented (the test shall not be any previous IQF test result). Any failing IQF test results during this process shall initiate the start of the process Section 3.7.2 "The IQF test results are outside of the specification limits (No ADOT test result or ADOT test results are within the specification limits)…". ADOT may conduct an additional tests or samples at any time during this process. Any failing ADOT test result shall require two new additional IQF test results (Section 3.7.4.4 starts from the beginning for each failing result).

Random independent test results representing material prior to any replacement, rework, or repair will be excluded from new statistical analyses.

3.7.4.5 The IQF and ADOT test results do not indicate reasonable conformance with specification requirements in ADOT's Sole Discretion:

The material shall be removed, reworked, or repaired. The failing IQF test result is replaced by two additional IQF passing test results. The first additional passing test shall be a fixed IQF test at the same location as the original failing sample, and the second sample shall be a random independent IQF test within the quantity of material that the initial failing test represented.

All random independent test results representing material prior to any replacement, rework, or repair will be excluded from new statistical analyses.

3.8 Engineering Judgment

The use of Engineering Judgment is part of the Acceptance Program and the IQF needs the ability to render decisions in the field regarding the quality of Work performed. Engineering Judgment is accepting any testing result or Work that does not adhere to the Contract Documents. The CQMP shall list any specific Element / characteristic of Work or test attribute that the IQF will be allowed to exercise Engineering Judgment on when accepting test results or Work. ADOT recognizes that the IQF is a section of the Contractor's team working with the Contractor to check for, and determine, compliance with the Contract Documents. ADOT also recognizes that the IQF should be afforded the opportunity, in concert with their independent role, to render Engineering Judgment with respect to appropriate documents for inspection and testing provided that the following criteria are met:

- Engineering Judgment will only be made by the CIQM and / or ADOT. Authority for Engineering Judgment may be delegated with the approval of ADOT.
- Engineering Judgment will be made by a Professional Engineer in the State of Arizona.
- Engineering Judgment to accept material or Work failing to meet the Contract Documents will never be applied solely to promote "partnering" or to help the Contractor. The Project schedule will not be a consideration with respect to the quality delivery of the Project.
- Engineering Judgment to accept materials or Work failing to meet specification requirements will be applied only in cases that will otherwise meet the intent of the design or in cases where the rejection of material would compromise the quality of a more significant item (e.g. by rejecting a load of concrete a structural Element is subject to a cold joint).
- Engineering Judgment will only be applied to individual test results or specific Elements of Work. Patterns of failure will not be accepted and shall be considered a breakdown in QC program. Recurring use of Engineering Judgment for the same plan or specification deviation shall result in process corrections to

the construction operations to assure material and Work is conforming Contract Documents. Engineering Judgment cannot be used to widen a specification requirement on a continuing basis.

- The individual exercising Engineering Judgment will apply good engineering practices to ensure the quality of accepted material. This may include performing additional tests, an engineering analysis, etc. and will be justified and documented in the Engineering Judgment log.
- Engineering Judgment will be technically sound and justified in the Engineering Judgment log. Engineering Judgment will only utilize localized conditions. Engineering Judgment will not be utilized to waive specifications for conditions that have Project wide implications. The acceptance of material or Work not meeting the Contract Documents in a single instance, at a specific location, will not become a Project wide decision. Each situation will be judged on the merits of its unique characteristics.
- ADOT may, at any time, remove or limit Engineering Judgment authority from any CIQM, or person delegated by the CIQM, if his/her Engineering Judgment is inappropriately exercised, as determined by ADOT.
- ADOT and FHWA have oversight agreements in place that requires specific documentation relating to Nonconforming Work that may remain in place. Any application of Engineering Judgment will be accompanied by appropriate documentation as defined in the CQMP.
- The IQF is encouraged but not required to consult with ADOT prior to making acceptance decisions based on Engineering Judgment.
- IQF personnel shall not be pressured by the Contractor to exercise Engineering Judgment. Nor shall IQF personnel be placed under duress in making their acceptance determinations.

Any of the IQF's acceptance decisions that utilize Engineering Judgment may be rejected by ADOT. ADOT may exercise Engineering Judgment at its Sole Discretion.

3.9 Referee Testing

While expected to occur very rarely, disputes over specific IQF and ADOT test results may be resolved, in a reliable, unbiased manner by referee testing and evaluation performed by ADOT's Materials Group or an independent third-party testing laboratory as appointed by ADOT's Materials Group. The decision by ADOT, or its designee, is final. Referee testing is solely an owner function. Referee testing shall only be allowed when it is specified in the Contract Documents.

The Contractor shall pay for the referee testing of IQF test results. The party whose original test results do not compare with the referee testing results will pay for the referee testing of ADOT test results.

3.10 Additional Quality Acceptance Requirements

The CQMP shall comply with the requirements in the Contract Documents and this Program.

Monthly, and on a day of the month determined by ADOT, the IQF shall submit to ADOT a certification form. The certification form shall certify that all Elements of Work incorporated in the Project adheres to the Contract Documents. It shall also certify that the monthly Contractor payment amounts whether based on quantities or percent complete is accurate. At the beginning of the Project, and included in the CQMP, the IQF shall submit the format and detailed example of the IQF monthly certification form to ADOT, for ADOT's review and approval. The IQF monthly certification form shall be professionally signed and sealed by the CIQM. The form shall clearly certify that:

- Work incorporated into the Project adheres to the Contract Documents, unless specifically listed on the certification form.
- The IQF is compliant with certification, calibration, and accreditation requirements of the CQMP.
- Work was sampled, tested, inspected, and accepted per the approved CQMP.
- Quantities represented in Contractor's monthly payment request are accurate
- Percentages represented in Contractor's monthly payment request are accurate.

"Certificates of Compliance" and "Certificates of Analysis" are required for certain materials prior to their incorporation into the Project. Certificates shall adhere to the requirements of section 106.05 ADOT Standard Specifications and ADOT's "Series 1000 Certificates". At a minimum, all items listed in Figure 3 of "Series 1000 Certificates" and the items requiring certificates per Appendix D, shall require certificates. The Project specific sampling and testing Guide Schedule shall reflect the specific items or components, in addition to those in Appendix D, that are to be accepted based by certification. The CQMP shall define a clear and detailed process defining how the IQF will accurately track, record, and report the acceptance of materials based on certificates and how they accurately will match the certificates to all materials being accepted. Monthly, the IQF shall submit a detailed report to ADOT that, at a minimum, includes:

- The total quantities (current month and Project total to date) of items incorporated into the Project that require certificates of compliance or certificates of analysis, for each individual: Work Element, and Guide Schedule combination of specification and material.
- The total quantities (current month and Project total to date) of items

incorporated into the Project that require certificates of compliance or certificates of analysis, for each individual: Work Element, and Guide Schedule combination of specification and material, that a certificate of compliance or certificate of analysis was received.

- Each individual certification for that month, ordered by Work Element, and Guide Schedule combination of specification and material.

At the beginning of the Project, and included in the CQMP, the IQF shall submit the formats and detailed examples of all items listed above to ADOT, for ADOT's review and approval.

The IQF shall ensure and monthly certify that the Project is compliant with the "Buy America" requirements of 23 CFR 635.410. The CQMP shall define a clear and detailed process defining how the IQF will accurately track, record, and report the compliance with the "Buy America" requirements. Monthly, the IQF shall submit a detailed report to ADOT that clearly demonstrates and justifies compliance with the "Buy America" requirements.

At the beginning of the Project, and included in the CQMP, the IQF shall submit the format and detailed example of the report listed above to ADOT, for ADOT's review and approval.

Unless addressed elsewhere in the Contract Documents, the IQF shall adhere to all inspection, sampling, testing, and acceptance criteria addressed in ADOT's Practice and Procedure Directives (PPD) Manual. A list of ADOT's current PPD's can be found online under "ADOT's Construction and Materials Manuals."

3.11 ADOT Owner Verification Requirements

ADOT, or its designee, will perform OV functions to verify IQF inspections, test results and conclusions.

For materials testing, verification will be achieved through comparisons between IQF test results and ADOT test results, or the observation of IQF test performances. To verify IQF test results, ADOT's testing will be programmatically performed at the levels shown in Appendix F, Owner Verification Levels of Testing Verification, subject to Project specific recommendations or changes made by ADOT. The different levels correspond to different verification requirements of this Program.

For workmanship and inspection activities, ADOT will verify that the IQF is performing the inspection procedures adequately and that the IQF is documenting the results in accordance with the CQMP. In addition to real-time evaluations, ADOT will also conduct audits to verify the Contractor's compliance with the approved CQMP.

ADOT will develop a comprehensive OVTIP for the Project. ADOT's OVTIP will include internal procedures used by ADOT to ensure that the IQF's frontline acceptance activities are performed

in accordance with the approved CQMP and to verify the IQF's adherence to the CQMP. ADOT will complete the development of the OVTIP in parallel with approval of Contractor's CQMP.

The OVTIP will address following items:

- Methods and procedures that define the authority and responsibility for the administration of the OVTIP.
- Procedures for overseeing the inspection of the Work and procedures for overseeing the IQF's overall compliance with the CQMP and Contract Documents.
- Procedures to ensure that the education, training, and certification of personnel performing OV activities are achieved and maintained.
- Procedures to oversee the status and disposition of any identified Nonconforming Work or any item or process that does not conform to the Contract Documents.
- Measures to ensure that ADOT tools, gauges, instruments, and other measuring and testing devices used in activities affecting quality are properly maintained, controlled, calibrated, certified, and adjusted at specified periods to maintain accuracy within industry standards.
- A system of planned and periodic audits of Contractor's CQMP to determine adherence to and the effectiveness of the CQMP. Audit results will be documented, reviewed, and sent to the Contractor. Follow-up action, including re-audit of deficient areas following corrective action, will be taken where needed.
- A system of planned and periodic audits to determine adherence to and the effectiveness of the OVTIP. Audit results will be documented and reviewed. Follow-up action, including re-audit of deficient areas following corrective action, will be taken where needed.
- Procedures for performing periodic inspections of Work and periodic inspections the IQF inspectors to verify that the Work and IQF are in compliance with the Contract Documents. The procedure will identify a target oversight inspection frequency and methods for performing verification inspections for IQF inspectors.
- Procedures on how ADOT's material sampling and testing will be performed. This includes the process for generating random test locations, tracking material samples, processing material samples, review and approval of test records, and tracking compliance with material testing frequency.
- Procedures for reviewing IQF and ADOT test results for compliance with mutually agreed upon processes and naming conventions to ensure data integrity for accurate statistical analyses.
- Procedures for verifying that only tests performed by qualified IQF testing personnel are submitted to ADOT.
- Procedures for auditing of QC and IQF records, documentation, procedures, and

processes to verify compliance with the Contract Documents and approved CQMP.

- Procedures for reviewing Portland cement concrete mix designs and hot-mix asphaltic concrete mix designs.
- Target frequencies for the independent sampling and testing that are to be conducted as a part of OV. The initial target frequency may include a higher frequency of testing at the beginning of the Project and may be adjusted, as appropriate, throughout the Project, based on: the observed consistency of the product, the statistical comparison between ADOT and IQF test results, and ADOT's engineering determinations.
- Procedures for ensuring that ADOT testing is performed at the frequencies stipulated in the OVTIP.
- Identification of the platform and data structure of the data management system that will be used to collect, store, and retrieve ADOT test result data.
- Identification of a strategy to coordinate test result data communication between the IQF and ADOT.
- Procedures for performing statistical analyses in compliance with procedures outlined in this Program.
- Procedures for satisfying System Basis IA obligations of this Program.
- The parameters and guidelines used to accept any statistically non-validating material.

3.12 Validation and Verification

IQF sampling, testing, and inspection results are only valid if verification is achieved by ADOT.

Prior to beginning construction, a Project specific risk analysis will be conducted and each material testing procedure expected to be performed by the IQF, and verified by ADOT, will be assigned an ADOT materials testing verification level of 1, 2, or 3. In general, test results that have a stronger correlation with material performance and Elements of construction with greater residual risk to ADOT will utilize a more vigorous verification approach. Test results that do not have a strong correlation to performance and Elements of construction with lower residual risk to ADOT will utilize a less vigorous verification approach. Appendix F lists the programmatic ADOT levels of verification associated with each test method. ADOT may change these verification levels based on specific Project needs. The IQF and Contractor shall comply with any verification levels changed from Appendix F. The IQF shall adhere to the data transfer requirements of Appendix H. Proper and efficient data transfer between the IQF and ADOT is required as part of the Program. Prior to any verification by ADOT, and included in the CQMP, data transfer formats and processes must be submitted by the IQF, and approved by ADOT prior to the start of construction activities.

3.12.1 Level 1 - Statistical Validation and Verification

When test procedures are performed in the context of construction Elements with high ADOT residual risk, those procedures that are considered primary indicators of performance are assigned materials verification Level 1. For Level 1 procedures, the ADOT testing frequency will be approximately 10%, but not less than 5%, of the IQF's testing frequency. At a minimum, ADOT will perform three tests per quarter per analysis category with at least nine IQF test results.

For Level 1 test procedures, verification is achieved by ADOT through regular and frequent test result validation. Validation involves statistical analyses using test result comparison packages that have been prepared for specific materials during specific time frames. The F-test is used to determine if the ADOT and IQF data population variances are equal, and the t-test is used to determine if their means are equal. From the F- and t- tests, p-values ranging from 0 to 1 are calculated. Appendix F establishes the critical p-value, known as alpha (α), or "Level of Significance", for each material type. When the calculated p-value is above the alpha (α) value shown in appropriate category of Appendix F, the IQF test data has been statistically validated.

Statistical analysis will be reported utilizing only data sets from within a defined time frame. The effective ADOT testing volume for a Level 1 test procedure is intended to represent approximately ten percent (10%) of the respective IQF testing volume; however, this percentage may vary.

Where IQF test data validation is achieved, ADOT will document that the IQF test results have been verified for the given analysis category. Where ADOT test data validation is not achieved, ADOT and the IQF shall jointly investigate the source of the non-validation event.

If the joint investigation finds the quality requirements of the Project have been met, ADOT and the IQF will take the necessary steps to bring the material category into a verified status. It will be ADOT's discretion as to if the IQF test results are valid in these cases, and how they will document the verification.

If the joint investigation finds the quality requirements of the Project have not been met, ADOT and the IQF will use Engineering Judgment or the NCR process to address the quality requirements and take the necessary steps to bring the material category into a verified status.

3.12.2 Level 2 - Independent Verification

When test procedures are performed in the context of construction Elements with high ADOT residual risk, those procedures that are only considered secondary indicators of performance are assigned materials verification Level 2. Test procedures may also be assigned verification Level 2 when testing is performed in the context of construction Elements with lower residual ADOT risk. For Level 2 procedures, the ADOT testing is generally conducted at least once per quarter depending on the IQF's testing frequency and ADOT's residual risk. In some cases, low IQF test frequencies and the timing of construction operations may affect ADOT's ability to conduct Level 2 testing as planned. Depending on actual circumstances, when Level 2 testing

cannot be conducted as planned, compensatory testing will be conducted at the next practical opportunity. At a minimum, ADOT will perform at least one test per quarter if the IQF has more than 10 tests.

For Level 2 test procedures, verification is achieved by ADOT by obtaining independent ADOT samples and comparing ADOT test results with the corresponding IQF test results. Test result verification is accomplished on a quarterly basis or as dictated by actual construction operations and schedule. If the IQF test results cannot be verified, ADOT and the IQF shall jointly investigate the root cause and bring it back into verification status.

3.12.3 Level 3 - Observation Verification

When test procedures are performed in the context of construction Elements with low ADOT residual risk, or when test procedures will be conducted very infrequently, these procedures are assigned materials verification Level 3. ADOT's OV will be performed through observation of the IQF's test performance once per Project.

For Level 3 test procedures, verification is achieved by ADOT observing the IQF performing the specific test methods. This type verification will occur once per test method, unless otherwise determined necessary by ADOT. If the test procedure cannot be verified, ADOT and the IQF shall jointly investigate the root cause and bring it back into verification status.

3.13 FHWA Reporting

ADOT will submit both quarterly reports, as well as a final certification package, to FHWA.

3.13.1 Quarterly Reports

ADOT will submit quarterly reports to FHWA to demonstrate compliance with this Program. The reporting period for specific pay items or materials is dependent on the pace of construction, the number of tests performed in each analysis category, the time period of the sampling, and the specification and quality requirements.

The FHWA quarterly report will address the following areas:

- Statistical analysis and verification results.
- Non-validation investigations.
- Split sample test results.
- Engineering Judgment log.
- Nonconformance log.
- Certifications and Buy America log.

Monthly, the IQF shall submit all data, results, investigations, results, and logs listed above to

ADOT, on the day of the month directed by ADOT. At the beginning of the Project, and included in the CQMP, the IQF shall submit the formats and detailed examples of all items listed above to ADOT, for ADOT's Sole Discretion review and approval.

3.13.2 Final Certification of Material Incorporated to the Project

The IQF shall submit a final certification package to ADOT. The final certification package shall include:

- A signed and professionally sealed letter from the CIQM certifying that all sampling, testing, acceptance activities, acceptance documentation, and the Work adheres to this Program, the Contract Documents, and all required Federal Regulations (exceptions per the bullet below).

- An organized and detail report of any and all sampling, testing, acceptance activities, acceptance documentation, and Work that does not adhere to this Program, the Contract Documents, and all required Federal Regulations.

- An organized and detailed report summarizing the total quantities, required number of samples, required number of tests, number of samples taken, and number of tests performed for each combination (per the Guide Schedule) of: specification, material, and type of test(s) required; that is incorporated into the Project.

- An organized and detailed report summarizing: (1) all materials, and their corresponding quantities, incorporated into the Project that required certificates of compliance or certificates of analysis, and (2) the total quantity of each material incorporated into the Project that have documented certificates of compliance or certificates of analysis as part of the quality records.

At the beginning of the Project, and included in the CQMP, the IQF shall submit the formats and detailed examples of all items listed above to ADOT, for ADOT's Sole Discretion review and approval.

ADOT will submit a separate final materials certification package to FHWA that certifies ADOT's compliance with the Program. The final materials certification report will include:

- A certification letter certifying that all ADOT sampling, testing, and acceptance activities were performed in accordance with this Program.
- A summary of the total number of ADOT samples and tests.
- A summary of the statistical analysis and verification results.

Chapter 4

Independent Assurance Program

4.1 General

23 CFR 637, Subpart B requires the implementation of an IA program. ADOT, or its designee, will implement the IA program as described in this section.

The IA program evaluates the sampling/testing personnel and testing equipment used in acceptance of materials. The CFR allows observations, split sample results, and proficiency sample results as means of evaluating testing personnel within the state's IA program. The IA program allows for the inclusion of calibration checks, split sample results, and proficiency sample results for evaluating acceptance testing equipment. The IA program does not directly determine the acceptability of materials but evaluates all personnel and equipment involved in the acceptance decision.

4.2 ADOT Independent Assurance for Sampling and Testing Personnel

The Program will utilize a "System Basis" IA which is based on evaluating and verifying satisfactory performance by the individuals performing acceptance sampling and testing, and the equipment utilized, for a twelve-month period. The IA program in this Program will be implemented as follows:

Each ADOT and IQF individual who will perform acceptance sampling and testing in the field shall be observed and evaluated on a System Basis, in which ADOT IA personnel verify that sampling and testing is being conducted properly in accordance with the appropriate test methods. Except as approved, in writing, by ADOT in its Sole Discretion, such evaluation shall occur within 30 days of initial service on the Project and every 12 months thereafter.

Each ADOT and IQF individual who will perform acceptance sampling and testing in the laboratory shall be evaluated on a System Basis, in which ADOT IA personnel verify that sampling and testing is being conducted properly in accordance with the appropriate test methods. Except as approved, in writing, by ADOT in its Sole Discretion, such evaluation shall occur within 30 days of initial service and every 12 months thereafter.

ADOT and the IQF shall track the qualification status of all their respective technicians and proactively request and schedule all evaluations. Following the end of each calendar year, ADOT will submit a report to the FHWA documenting activities of the IA "System Basis" program for the Project. The report will include the following information:

- Names and number of technicians performing acceptance sampling and testing the Project.

- Number of such technicians evaluated by the IA program.
- Number of such technicians that had deviations, as determined by the evaluation.
- Summary of how the deviations were addressed, along with any potential systematic solutions to recurring deficiencies.
- Goals for the upcoming twelve-month period.

Test methods requiring IA sampling and testing are shown in Appendix G.

Appendix A

Federal Regulations and Guidance:

FEDERAL-AID POLICY GUIDE
October 5, 1995, Transmittal 14

23 CFR 637B
OPI: HNG-23

SUBCHAPTER G - ENGINEERING AND TRAFFIC OPERATIONS
PART 637 - CONSTRUCTION INSPECTION AND APPROVAL

Subpart A - [Reserved]

Subpart B - Quality Assurance Procedures for Construction

Sec.
637.201 Purpose.
637.203 Definitions.
637.205 Policy.
637.207 Quality assurance program.
637.209 Laboratory and sampling and testing personnel qualifications.

Appendix A to Subpart B-Guide Letter of Certification by State Engineer

Authority: 23 U.S.C. 109, 114, and 315; 49 CFR 1.48(b).
Source: 51 FR 40417, Nov. 7, 1986, unless otherwise noted.

Subpart A-[Reserved]

Subpart B-Quality Assurance Procedures for Construction

Sec. 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

Sec. 637.203 Definitions.

(a) Acceptance program. All factors that comprise the State highway agency's (SHA) 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.

(b) Independent assurance samples and tests. Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program. Test procedures used in the acceptance program which are performed in the SHA's central laboratory would not be covered by an independent assurance program.

(c) Proficiency samples. Homogeneous samples that are distributed and tested by two or more laboratories. The test results are compared to assure that the laboratories are obtaining the same results.

(d) Qualified laboratories. Laboratories that are capable as defined by appropriate programs established by each SHA. As a minimum, the qualification program shall include provisions for checking test equipment and the laboratory shall keep records of calibration checks.

(e) Qualified sampling and testing personnel. Personnel who are capable as defined by appropriate programs established by each SHA.

(f) Quality assurance. All those planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality.

(g) Quality control. All contractor/vendor operational techniques and activities that are performed or conducted to fulfill the contract requirements.

(h) Random sample. A sample drawn from a lot in which each increment in the lot has an equal probability of being chosen.

(I) Vendor. A supplier of project-produced material that is not the contractor.

(j) Verification sampling and testing. Sampling and testing performed to validate the quality of the product.

Sec. 637.205 Policy.

(a) Quality assurance program. Each SHA shall develop a quality assurance program which will assure that the materials and workmanship incorporated into each Federal-aid highway construction project on the NHS are in conformity with the requirements of the approved plans and specifications, including approved changes. The program must meet the criteria in Sec. 637.207, and be approved by the FHWA.

(b) SHA capabilities. The SHA shall maintain an adequate, qualified staff to administer its quality assurance program. The State shall also maintain a central laboratory. The State's central laboratory shall meet the requirements in Sec. 637.209(a)(2).

(c) Independent assurance program. Independent assurance samples and tests or other procedures shall be performed by qualified sampling and testing personnel employed by the SHA or its designated agent.

(d) Verification sampling and testing. The verification sampling and testing are to be performed by qualified testing personnel employed by the SHA or its designated agent, excluding the contractor and vendor.

(e) Random samples. All samples used for quality control and verification sampling and testing shall be random samples.

Sec. 637.207 Sampling and testing program.

(a) Each SHA's quality assurance program shall provide for an acceptance program and an independent assurance (IA) program consisting of the following:

(1) Acceptance program.

(I) Each SHA's acceptance program shall consist of the following:

(A) Frequency guide schedules for verification sampling and testing which will give general guidance to personnel responsible for the program and allow adaptation to specific project conditions and needs.

(B) Identification of the specific location in the construction or production operation at which verification sampling and testing is to be accomplished. Identification of the specific attributes to be inspected which reflect the quality of the finished product.

(ii) Quality control sampling and testing results may be used as part of the acceptance decision provided that:

(A) The sampling and testing has been performed by qualified laboratories and qualified sampling and testing personnel.

(B) The quality of the material has been validated by the verification testing and sampling. The verification sampling shall be performed on samples that are taken independently of the quality control samples.

(c) The quality control sampling and testing is evaluated by an IA program.

(iii) If the results from the quality control sampling and testing are used in the acceptance program, the SHA shall establish a dispute resolution system. The dispute resolution system shall address the resolution of discrepancies occurring between the verification sampling and

testing and the quality control sampling and testing. The dispute resolution system may be administered entirely within the SHA.

(2) The IA program shall evaluate the qualified sampling and testing personnel and the testing equipment. The program shall cover sampling procedures, testing procedures, and testing equipment. Each IA program shall include a schedule of frequency for IA evaluation. The schedule may be established based on either a project basis or a system basis. The frequency can be based on either a unit of production or on a unit of time.

(I) The testing equipment shall be evaluated by using one or more of the following: Calibration checks, split samples, or proficiency samples.

(ii) Testing personnel shall be evaluated by observations and split samples or proficiency samples.

(iii) A prompt comparison and documentation shall be made of test results obtained by the tester being evaluated and the IA tester. The SHA shall develop guidelines including tolerance limits for the comparison of test results.

(iv) If the SHA uses the system approach to the IA program, the SHA shall provide an annual report to the FHWA summarizing the results of the IA program.

(3) The preparation of a materials certification, conforming in substance to Appendix A of this subpart, shall be submitted to the FHWA Division Administrator for each construction project which is subject to FHWA construction oversight activities.

(b) [Reserved]

Sec. 637.209 Laboratory and sampling and testing personnel qualifications.

(a) Laboratories.

(1) After June 29, 2000, all contractor, vendor, and SHA testing used in the acceptance decision shall be performed by qualified laboratories.

(2) After June 30, 1997, each SHA shall have its central laboratory accredited by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.

(3) After June 29, 2000, any non-SHA designated laboratory which performs IA sampling and testing shall be accredited in the testing to be performed by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.

(4) After June 29, 2000, any non-SHA laboratory that is used in dispute resolution sampling and testing shall be accredited in the testing to be performed by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.

(b) Sampling and testing personnel. After June 29, 2000,all sampling and testing data to be used in the acceptance decision or the IA program shall be executed by qualified sampling and testing personnel.

(c) Conflict of interest. In order to avoid an appearance of a conflict of interest, any qualified non-SHA laboratory shall perform only one of the following types of testing on the same project: Verification testing, quality control testing, IA testing, or dispute resolution testing.

Appendix A to Subpart B - Guide Letter of Certification by State Engineer

Date
Project No.

This is to certify that:

The results of the tests used in the acceptance program indicate that the materials incorporated in the construction work, and the construction operations controlled by sampling and testing, were in conformity with the approved plans and specifications. (The following sentence should be added if the IA testing frequencies are based on project quantities. All independent assurance samples and tests are within tolerance limits of the samples and tests that are used in the acceptance program.)

Exceptions to the plans and specifications are explained on the back hereof (or on attached sheet).

Director of SHA Laboratory or other appropriate SHA Official.

Formerly Federal-aid Policy Guide Non-Regulatory Supplement NS 23 CFR, Part 637B, July 19, 2006, Transmittal 36

See Order 1321.1C FHWA Directives Management

1. **POLICY (23 CFR 637.205).** The Division Administrator shall provide appropriate oversight to ensure that the State's quality assurance program is being implemented as approved. At a minimum the oversight should cover:

    a. Materials sampling and testing issues,

    b. Construction inspection issues covering the specific attributes which reflect the quality of the finished product, and

    c. State capabilities - maintaining an adequate, qualified staff to administer the quality assurance program and qualified laboratories.

2. **QUALITY ASSURANCE PROGRAM (23 CFR 637.207)**

    a. The State's acceptance program should provide a reasonable level of inspection to adequately assess the specific attributes which reflect the quality of the finished product. Acceptance inspection should include inspection of the component materials at the time of placement or installation, as well as the workmanship and quality of the finished product.

    b. Samples used in the acceptance decision should be taken as close as possible to where the material is incorporated into the project.

    c. The State should retain control of the verification sampling locations and timing until immediately prior to sampling.

    d. Sampling and testing frequencies may vary from State to State as the quality and uniformity of the material varies. The State may reduce its testing frequency for materials with a history of accurate, uniform test results that consistently meet specification requirements. The rate of testing should be higher on newly developed material sources, sources with questionable quality, sources with a wide range of test results, and sources with failing test results.

    e. When contractor's tests are used in the acceptance decision and the State and contractor test results do not compare, the frequency of verification testing should be increased.

f. The State should obtain the contractor's test data as soon as it is available, no later than 24 hours after sampling is completed. The State's test results should not be given to the contractor until after the contractor results are received.

g. The State should review the contractor's source documentation as part of the State's quality assurance program.

h. Test results should not be discarded unless it is known that the sampling or testing was flawed. It may be appropriate to perform additional testing when the quality of the material is in question. However, in cases where additional tests are performed, the acceptance and pay criteria need to be adjusted to account for the additional test results.

i. If project materials are used in the Independent Assurance (IA) program, the IA samples should be split samples when possible, or in close proximity to the same location as the samples used in the acceptance decision.

j. Observation of sampling and testing procedures should be included as part of an IA system to evaluate sampling and testing personnel and ensure that test procedures are performed correctly.

k. When using the project approach for IA, the frequency should be approximately 10 percent of the frequency of the tests used in the acceptance decision.

l. When using the system approach for IA, each inspector should be covered once or twice a year.

m. The State is encouraged to develop a Qualified Products List for manufactured materials.

n. The State is encouraged to perform a risk analysis when developing an acceptance program for manufactured items. When performing a risk analysis, the State should consider the use of the product, safety, cost, and historical quality of the product.

o. The State should consider the data from the National Transportation Product Evaluation Program (NTPEP) when developing qualified product lists. See http://www.ntpep.org/.

p. The State is encouraged to report the evaluation of new products to the American Association of State Highway and Transportation Officials Product Evaluation List (APEL). See http://apel.transportation.org/.

q. The State should consider visual inspection and/or the manufacturer's certification as a basis for accepting small quantities of non-critical material.

3. **LABORATORY AND SAMPLING AND TESTING PERSONNEL QUALIFICATION (23 CFR 637.209)**

a. All test procedures used in the acceptance decision should be in the scope of accreditation for the States central laboratory.

b. The National Cooperation for Laboratory Accreditation (NACLA) "Recognition Procedure" and the National Institute of Standards and Technology (NIST) Interagency Report 7012 (NISTIR 7012), "Technical Requirements for Construction Materials Testing", is the criteria required for the approval of comparable laboratory accreditation programs as indicated in a Notice in the Federal Register on September 22, 2004. The accreditation bodies will be evaluated against the NACLA Recognition Procedure and the Technical Requirements for Construction Materials Testing, and they must be recognized by NACLA with the Technical Requirements for Construction Materials Testing listed within its scope before the accreditation bodies will be approved by the Federal Highway Administration (FHWA). To meet the quality assurance requirements in 23 CFR 637.209(a)(2), (3), and (4), the laboratories' scope of accreditation must indicate that the laboratory was assessed according to the requirements in NISTIR 7012. The NACLA Recognition Procedure is available at http://www.nacla.net/Pdf/Evaluation%20Procedure%20RevA.pdf. The Technical Requirements for Construction Materials Testing is available at http://ts.nist.gov/ts/htdocs/210/gsig/pubs/ir7012.pdf.

c. The following should be used as guidance for reviewing and revising laboratory qualification programs for non-accredited laboratories that provide test results and information used in the acceptance decision:

1. **Personnel**

a. **Supervisors**. Supervisors of testing personnel should have a minimum of 3 years experience in testing of highway construction materials.

b. **Technicians**. Guidance for technician qualification programs is listed in paragraph 3d.

2. **Documentation**. State DOT's should develop test procedures and/or test manuals referencing standard testing procedures. These procedures should also cover handling, identification, conditioning, storage, retention and disposal of test samples.

3. **Proficiency In Testing**. Testing personnel should be routinely evaluated by observations and split samples or proficiency samples.

4. **Frequency of Assessments**

   a. Laboratory assessments should be made on a 3- to 5-year cycle.

   b. Data from the IA program along with observations during IA tests should be used as part of the ongoing evaluation of the laboratory.

d. The following should be used as guidance for reviewing and revising a technician qualification program:

1. Formal training of personnel including all sampling and testing procedures with instructions on the importance of proper procedures and the significance of test results.

2. Hands-on training to demonstrate proficiency of all sampling and testing to be performed.

3. A period of on-the-job training with a qualified individual to assure familiarity with State DOT procedures.

4. A written examination and demonstrated proficiency of the various sampling and testing methods.

5. Requalification at 3- to 5-year intervals (data from the IA program can be used as one element of requalification).

6. A documented process for retraining or removing personnel that perform the sampling and testing procedures incorrectly.

7. The following are not appropriate criteria for achieving or maintaining qualification status: Grandfathering, the acceptance of a Professional Engineer or Engineer-in-Training certificate, or lifetime qualification.

4. **MATERIALS CERTIFICATE (23 CFR 637 APPENDIX A).** The intent of the material certification is to ensure that the quality of all materials incorporated into the project is in conformance with the plans and specifications, thus ensuring a service life equivalent to the design life. Any material represented by an acceptance test that does not meet the criteria contained in the plans and specifications is considered an exception.

Exceptions should be investigated to determine if in fact the material is in reasonably close conformity with the plans and specifications.

Use of Contractor Test Results in the Acceptance Decision, Recommended Quality Measures, and the Identification of Contractor/Department Risks

T 6120.3

August 9, 2004

Par.

1. **What is the purpose of this Technical Advisory?** This Technical Advisory provides guidance and recommendations for the use and validation of contractor's test results for acceptance, the use of quality measures, and the identification of contractor and department risks.

2. **Does this Technical Advisory supersede other Federal Highway Administration (FHWA) guidance?** Yes. This Technical Advisory supersedes previous guidance provided in the following:

a. *Memorandum from Director, Office of Engineering, to Regional Administrators,* "INFORMATION: Quality Assurance Procedures for Construction - 23 CFR 637 - Sampling for Verification Testing," March 28, 1997.

b. *Memorandum from Chief, Highway Operations Division, to Regional Administrators, Division Administrators, Federal Lands Highway Program Administrator,* "INFORMATION: Quality Assurance Guide Specification and Implementation Manual for Quality Assurance," August 2, 1996.

3. **What is FHWA's policy on the use of contractor's quality control test results for acceptance?** The FHWA policy on the use of contractor's quality control test results for acceptance requires validation of all data not generated by the State transportation department (STD) or its designated agent if used in the acceptance decision. The requirements are codified in Title 23 Code of Federal Regulations Part 637 Subpart B (23 CFR 637B), located at http://www.access.gpo.gov/nara/cfr/waisidx_03/23cfr637_03.html. (Note that the use of STD is in line with 23 CFR 637 B, as of April 1, 2003. In this Technical Advisory, all references to State Highway Agency (SHA) or "agency" have been replaced with STD or "department.")

4. **Is there any existing FHWA guidance regarding 23 CFR 637B, the use of quality measures, and the identification of contractor and department risks?** Yes. Existing FHWA guidance is provided in the following:

a. *FHWA Materials Notebook: Chapter 1 - Materials Sampling and Testing* 23 CFR 637, "23 CFR 637 ACTION: Final Rule and Questions & Answers on the Regulation," https://www.fhwa.dot.gov/pavement/materials_notebook/1sec1.htm.

b. *Publication No. FHWA-RD-02-095* "Optimal Procedures for Quality Assurance Specifications" (see paragraph 18b), http://www.tfhrc.gov/pavement/pccp/pubs/02095/.

c. *Memorandum from Chief, Highway Operations Division, to Resource Center Directors, Division Administrators,* "INFORMATION: Laboratory Qualification," October 9, 1998, https://www.fhwa.dot.gov/pavement/labqual.htm.

d. *Memorandum from Chief, Highway Operations Division, to Resource Center Directors, Division Administrators, Acting Federal Lands Highway Program Administrator,* "INFORMATION: Technician Qualification," July 17, 1998, https://www.fhwa.dot.gov/pavement/techqual.htm.

5. **What is the background on quality assurance and quality assurance specifications?**

a. One of the fundamental concepts in quality assurance (QA) specifications is the separation of the functions of quality control (QC) and acceptance. In QA specifications, the contractor is responsible for the QC and the STD is responsible for obtaining and conducting verification tests and making the acceptance decision. Although QA is a combination of QC and acceptance, the separation of these two functions is important.

b. Due to the evolutionary nature of QA specifications, QC and acceptance functions often have been combined or intermingled. This has been a major source of confusion. The intermingling of QC and acceptance can be traced to the first statistically based specifications that were used at a time when STDs had technicians at the contractor's materials plants. The STD technicians did testing and determined when the product was acceptable. Contractors rarely did their own QC testing, and they often made changes to the process when necessary based on the STD's test results. Although QC was often recognized as a separate item from acceptance, in reality, little separation occurred.

c. With the downsizing that took place within many STDs in the 1990s, inspection and testing personnel positions were reduced significantly and many technicians were removed from the contractors' materials plants. Although STDs often took it upon themselves to control most aspects of production and construction, reductions in staff made it more important to assign QC where it rightfully belonged so the STD could focus on acceptance testing and inspection. This resulted in the contractor having to conduct the QC tests and the STD examining options for requiring more of its functions to be undertaken by the contractor. Many STDs found ways to include contractor test results in the acceptance decision, and some have questioned why the regulations prohibit the contractor from conducting acceptance testing.

d. The Federal regulations on sampling and testing of materials for construction appear in 23 CFR 637B (see paragraph 18a). These regulations were revised on June 29, 1995. This revision included clarification on the use of contractor test results in an acceptance program. The regulations most recent revision occurred in the *Federal Register* on December 10, 2002.

e. Further evolution of QA specifications has introduced the use of incentive/disincentive provisions and pay adjustment systems that utilize pay factors to adjust the amount paid to a contractor based on the level of quality of the product provided. Several different statistical quality measures were developed and used in order to determine this level of quality. Some examples of quality measures are: percent within limits, percent defective, average deviation, average absolute deviation, conformal index, and moving average. Some of these quality measures have been implemented without fully

understanding how they apply to acceptance or whether they conform to sound statistical principles.

f. Statistical QA specifications and acceptance procedures have been implemented without fully understanding the risks involved to both the STD and the contractor. The acceptable level of STD risk and contractor risk is a subjective decision that often varies between departments. It is estimated that few departments have developed and evaluated the risk levels associated with their acceptance plans.

g. State planning and research pooled fund study SPR-2(199) "Optimal Acceptance Procedures for Statistical Construction Specifications" was conducted in order to investigate the current use of QA specifications and provide recommendations for statistically sound QA procedures and balancing of risks. The pooled fund study was administered by FHWA and the results provided in publication no. FHWA-RD-02-095, "Optimal Procedures for Quality Assurance Specifications" (see paragraph 18b). This publication provides a guide for developing new or modifying existing acceptance plans and QA specifications.

6. **Where can I find definitions for the terms used within this Technical Advisory?** The definitions for terms used in this Technical Advisory are taken from the following sources (listed in order of precedence), unless otherwise specified:

a. 23 CFR 637 (see paragraph 18a).

b. AASHTO R10 (see paragraph 18e).

c. Transportation Research Board (TRB) Circular (see paragraph 18f).

7. **Do any of the terms need additional explanation?** Some additional explanations of terms are provided below:

a. **Difference Two-Sigma Limit (D2S Limit).** The D2S method compares the contractor and department results from a single split sample. The D2S Limit indicates the maximum acceptable difference between two test results obtained on test portions of the same material (and thus, applies only to split samples), and it is provided for single and multi-laboratory situations. It represents the difference between two individual test results that has approximately a five percent chance of being exceeded if the tests are actually from the same population. The value provided by this procedure is contained in many AASHTO and American Society of Testing and Materials (ASTM) test procedures and is typically listed in the precision and bias statement as "Acceptable Range of Two Test Results" at the end of each test procedure.

b. ***F*-test.** 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 hypothesis is that the department's tests and the contractor's tests are from the same population and the variability of the two data sets are equal. The intent is to determine whether the differences in the variability of the contractor's tests and the department's tests are larger than might be expected by chance if they came from the same population. The calculated *F*-value is then compared to the critical value (F_{crit}) obtained from a table of *F*-values at a chosen level of significance (α). The *F*-test can be used to compare either an equal or unequal number of contractor vs. department sample sizes.

c. **Operating Characteristics (OC) Curves**

(1) OC curves for statistical tests. OC curves can be developed to indicate the probability of rejecting a hypothesis. This type of curve shows the relation between the probability of rejecting a hypothesis that a sample belongs to a given population with a given characteristic and the actual population value of that characteristic. OC curves can also be developed to show either the probability of not detecting a difference, or detecting a difference, versus the actual difference between the two populations being compared. There are also OC curves available to provide guidance regarding the number of tests needed to achieve a certain probability of detecting a given difference when one actually exists. OC curves that plot the probability of detecting a difference are sometimes called power curves because they plot the power of the statistical test procedure to detect a given difference.

(2) OC curves for acceptance plans. OC curves can also be a graphical representation of an acceptance plan that shows a relationship between the actual quality of a lot and either (a) the probability of its acceptance (for accept/reject acceptance plans), or (b) the probability of its acceptance at various pay levels for acceptance plans that include pay adjustment provisions.

d. **Paired *t*-test.** The paired *t*-test compares contractor and department results from an equal number of split samples. When it is desirable to compare more than one pair of split sample test results, the *t*-test for paired measurements can be used. This test uses the differences between pairs of tests and determines whether the average difference is statistically different from zero. Thus, it is the difference within pairs, not between pairs, that is being tested. The calculated *t*-value is compared to the critical value (t_{crit}) obtained from a table of *t*-values at a specified level of significance and with n-1 degrees of freedom (see *t*-test in paragraph 7e).

e. ***t*-test**

(1) 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. The null hypothesis is that the department's tests and the contractor's tests are from the same population, and the means of the two data sets are equal. The desire is to determine whether it is reasonable to assume that the contractor's tests came from the same population as the department's tests. The *t*-test can be used to compare either an equal or unequal number of contractor vs. department sample sizes.

(2) Since the values used for the *t*-test are dependent upon whether or not the variances are assumed equal for the two data sets, it is necessary to test the variances (*F*-test) before the means (*t*-test). If it is determined that the variances are assumed to be equal ($F<F_{crit}$), then the *t*-test is conducted based on the two sample sets using a pooled estimate for the variance and pooled degrees of freedom. If the sample variances are determined to be different ($F\geq F_{crit}$), then the *t*-test is conducted using the individual sample variances, the individual sample sizes, and the effective degrees of freedom. The calculated *t*-value is compared to the critical value (t_{crit}) obtained from a table of *t*-values at a specified level of significance.

8. **What are the requirements for the use of independent samples?** The regulation 23 CFR 637B requires the use of independent samples for verification sampling and testing in the acceptance program. In order to be considered independent, each sample must contain independent information reflecting all sources of variability associated with the material, process, sampling, and testing in the test results. This does not prevent split samples from being used in the acceptance decision if the data is used properly to provide validation of independent data (see paragraph 13). Some clarification of using contractor performed sampling for verification sampling and for use in the acceptance decision is found in paragraphs 9 through 13.

9. **Who is required to perform verification sampling and testing?**

a. The regulation requires STD personnel or their representatives to perform the verification sampling and testing. The regulation also specifically indicates that verification sampling and testing cannot be performed by contractor employees. However, there are situations where labor regulations, hazardous conditions, and liability issues may dictate some contractor involvement in verification sampling. In these situations, the involvement of contractor personnel should be limited so that they are not deemed to be in control of the sampling.

(1) The STD can use the services of the contractor's personnel to assist in obtaining independent verification samples when the following requirements are adhered to:

(a) The verification sample location or time has been randomly selected by the STD and is only given to the contractor immediately prior to sampling.

(b) The contractor's personnel are used only to provide labor to assist in physically obtaining the verification sample of the material.

(c) The STD is present to witness the taking of the verification sample.

(d) Both the STD witness and contractor labor are qualified sampling personnel.

(e) The STD witness controls the sampling process by choosing the location or timing and directing the taking of the verification sample.

(f) The STD witness immediately takes possession of the verification sample.

(2) STD verification sample independence and the intent of 23 CFR 637B are maintained when the above requirements are met. However, these situations should be the exception and not the rule. The verification sampling is expected to be performed entirely by STD personnel or their representative in the majority of situations.

b. Verification testing is required to be performed by the STD or its designated agent, excluding the contractor or vendor; therefore, verification testing cannot be based on contractor performed testing witnessed by the STD.

10. **What are the validation procedures performed on independent samples?** When comparing two data sets, such as department and contractor test results, it is important to compare both the variances and the means. The tests most often used are the *F*-test (comparison of variances) and the *t*-test (comparison of means), which are used together. A procedure that compares a single department test with 4 to 10 contractor tests is sometimes used but not recommended.

a. The *F*-test and *t*-test are the recommended methods because they have more power to detect actual differences than the method that relies on a single department test for the comparison. If either the *F*-test or the *t*-test show a significant difference ($F \geq F_{crit}$ or $t \geq t_{crit}$), it is questionable whether the data does truly come from the same population.

(1) The computational method used for the *t*-test differs depending on if the variances are found to be either equal or not equal. There is a *t*-test that corresponds with finding a difference in variances, $F \geq F_{crit}$ (see paragraph 7e). This has led to instances of incorrectly validating test results by finding no differences in the means ($t < t_{crit}$) after finding differences in the variances ($F \geq F_{crit}$). When a

difference in the variances is identified then the test results have not been validated, even if no difference in the means has been identified.

(2) The source of the difference should be identified if it is determined that a significant difference is likely between either the variances or the means. The identification of a difference between either variances or means is simply a notice that a difference exists. Therefore, the source of the difference must still be determined.

b. The method of comparing a single department test to a number of contractor tests should not be used. Although simple, it suffers from the fact that only a single department test is used when making the comparison. Any comparison method that is based on a single test result is not effective in detecting differences between data sets. This is due to the high variability that is associated with individual values, as compared with mean values.

11. **What are the test method comparison procedures performed on split samples?**

a. The comparison of a single split sample by using the D2S limits is simple and can be done for each split sample that is obtained. However, since it is based on comparing only single data values, it is not very powerful for identifying differences when they exist. Thus, it cannot detect real differences unless the results are far apart. The appeal of the D2S method lies in its simplicity rather than its power.

b. Due to D2S method limitations, it is recommended that the paired *t*-test (see paragraph 7d) be used on the total accumulated split sample results to allow for a comparison with more discerning power. If either of these comparisons indicates a difference, then an investigation to identify the cause of the difference should be initiated.

12. **When should split samples be used?** The split sampling, testing, and comparison procedures (see paragraph 11) are primarily used as a function of an Independent Assurance (IA) program as outlined in 23 CFR 637B. The use of split samples in the IA program provides a check on testing equipment and procedures. The evaluation of split samples helps to identify where the cause of any differences may occur by isolating the testing components. This complements the QA program and ensures credibility of the testing program.

13. **Can contractor split sample test results be used in the acceptance decision?**

a. In order for contractor split sample test results to be used in the acceptance decision, the contractor's test results used in the acceptance decision must be independently validated by the STD. The validation is not required if the STD

conducts all of the verification sampling and testing and does not wish to use the contractor's test results in the acceptance decision.

b. The contractor performs QC testing using independently obtained samples. The STD can perform verification testing using its half of the split samples when sampled as required in paragraph 9. The validation is accomplished by comparing the STD verification tests with the contractor's independently sampled QC tests (see Figure 1). The contractor's splits of the verification samples cannot be used for validation purposes because they are not independent of the STD samples. If both sets of split samples are used the only component of variability that can be compared is the testing variability. The split sample components of variability associated with materials, process, and sampling are the same, having come from the same location and sampler.

c. The contractor may or may not test their portion of the split sample. The validation procedure is the same in either case because the contractor's split samples cannot be used for validation (see Figure 1).

d. When the STD uses contractor personnel as labor to take verification samples as required in paragraph 9 and the STD then performs verification testing on these samples, the verification test results may be considered independent of the contractors test results. They may be considered independent because they have been sampled with control by the STD, independently tested, and independently compared to the contractor's independent QC test results (test results that do not include the contractor's set of split samples). Again, in order to be considered independent the two sets of samples must each contain the variability associated with the material, process, sampling, and testing.

e. If the contractor's independently sampled QC test results are validated by the STD verification test results, then the material can be accepted based on either:

(1) The total test results provided by the contractor that combine their independent QC test results and their split of the verification sample test results (see 2.1 in Figure 2),

(2) A combination of independent contractor QC test results excluding their split sample test results and the STD verification split test results (see 2.2 in Figure 2), or

(3) Only the contractor independent QC test results, excluding all split sample test results (see 2.3 in Figure 2).

f. The STD test results from their split portion of the verification samples and the contractor test results from their split portion of the of the verification samples

cannot be combined for the acceptance decision (see 2.4 in Figure 2). If the two sets of split test results are combined, they are no longer independent and the population of the contractor's independent test results will be biased and result in an invalid comparison. In essence, a double counting of test results would occur if the two sets of split test results were combined. This is true even though the two sets of test results may have different values.

g. A scenario may exist where all samples are taken by the STD and split between the STD and contractor. In this scenario the STD only performs verification tests on a specified percentage of all the split samples they have in their possession. It is important to note, the validation must still be performed on independent sample data. Again, this is accomplished by comparing the STD verification test results with the contractor's independent test results. The contractor's independent test results cannot include the split tests that match with the STD verification tests.

(1) For example, if 11 samples were split, the contractor tests all 11 samples and the STD tests only 3 samples, the 3 STD test results would be compared against the contractor's remaining 8 test results. Independence of the two sets of data is maintained by excluding the contractor's three test results that match the STD test results.

(2) In essence, the validation shown in Figure 1 has occurred when the STD does not test all of the split samples that are in its possession. By taking possession of all the split samples, the STD does have additional material for an investigation if the contractor's results do not validate or for use in a dispute resolution system.

h. Although split samples have physically been taken, it is the method which the data from these samples is analyzed that allows independent validation and their use in the acceptance decision. The independent validation is accomplished by validation procedures performed on independent samples (see paragraph 10), not by test method comparison procedures performed on split samples (see paragraph 11).

14. **What are the recommended quality measures?** The percent within limits (PWL) or percent defective (PD) are the recommended quality measures to be used. It is necessary to measure both the center and spread when characterizing a lot of material. These quality measures use the mean and standard deviation to measure center and spread and then estimate the percentage of the lot that is within, PWL, or outside of, PD, the specification limits. Since PD and PWL can easily be converted to one another simply by subtracting from 100, they are equivalent quality measures. The preference on which of the two quality measures to use, PWL or PD, is typically based on the department's preference to highlight how much of the material meets the requirements as described with PWL, rather than how much is defective as described with PD.

15. **What quality measures are not recommended?**

a. The average deviation from the target value should not be used as the quality measure for QA acceptance plans. This approach often encourages the contractor to manipulate its process during the production of a lot. In effect, the contractor increases process variability by making frequent adjustments to the process in order to get the average of the test results to be at or near the target value.

b. The average absolute deviation (AAD) from the target value should not be used as the quality measure for QA acceptance plans. To avoid the problem of over-adjusting the process in response to early test results, the average absolute deviation from the target has been used instead of the average deviation. By taking the absolute value of the deviation from the target, the contractor cannot benefit by any strategy other than aiming for the target value. However, the variability of the material may not be adequately measured. Very different sets of test results can give identical AAD values. Not only must it be questioned if equal pay is appropriate for these widely different conditions, the use of AAD fails to document these differences that should be used for future modifications of the specification. Specifically, the means and populations may vary considerably for different sets of test results that can give identical AAD values. These mean and variability differences are disregarded with acceptance based on AAD.

c. The conformal index (CI) should not be used as the quality measure for QA acceptance plans. The CI is very similar in practice to the AAD and has the same disadvantages of not being appropriate for a one-sided specification and potentially having the same CI value for very different test results.

d. The moving average should not be used as the quality measure for QA acceptance plans. The moving average was developed as a QC measure and not developed for use as an acceptance approach. The use of the moving average is not consistent with the use of lot-by-lot acceptance. When acceptance is based on a lot, it is assumed that the various lots are independent of one another. Since each individual test result appears in several moving average calculations, the moving averages are correlated and the results of one average are not independent of the next; therefore, it is difficult to determine when or where a lot begins or ends. In addition, it is not easy to determine pay factors on a lot-by-lot basis since the successive moving averages are correlated and individual lots are not well defined. As a result, acceptance procedures based on moving averages often result in production shut downs and plant adjustments rather than determining appropriate pay factors for specific production lots.

16. **What are contractor and department risks?**

a. The two types of risks discussed in this section are the seller's (contractor) risk (α) and the buyer's (department) risk (β). The acceptable level of α and β risks is a subjective decision that can vary from department to department. A properly developed QA acceptance plan takes these risks into consideration in a manner that is fair to both the department and contractor. Too large a risk for either party undermines credibility.

(1) Table 1 of the AASHTO Material's Specification R 9-97(2000), "Acceptance Sampling Plans for Highway Construction" (see paragraph 18d), has suggestions for risk levels for both the seller and buyer that range from 0.001 (0.1 percent) to 0.200 (20 percent). It should be noted that large sample quantities, on the order of 10 to 20 or more, are needed to achieve some of the risk levels provided in this table. Larger sample quantities will provide this lower level of risk to both the department and contractor. The selection of the number of samples required by a department may need to be modified based on an analysis of risks.

(2) The sample size is the number of test results used to judge the quality of a lot, and therefore it is directly related to the lot size. One reason to use larger lot sizes is the potential resultant increase in sample size. This tends to provide a much lower level of risk to both the contractor and department. However, an assumption that all of the material and construction processes remain consistent throughout the lot is required. Small lot sizes may not be compatible with large sample sizes due to a large amount of required testing. Larger sample sizes can be used with large lot sizes to decrease risks of making incorrect acceptance decisions. However, the possibility of combining materials from different populations must be taken into consideration. The final decision regarding sample size per lot cannot be made until an evaluation of risks has been completed. An attempt should be made to balance the risk between the contractor and department while holding the risk to a reasonable level. This means that a large number of samples may be required. If the risks cannot be held to a reasonable level for both, the department may have to accept a disproportionate level of risk.

b. The α and β risks are very narrowly defined to occur at only two specific quality levels. The α risk is the probability of rejecting material that is exactly at the acceptable quality level (AQL), while β is the probability of accepting material that is exactly at the rejectable quality level (RQL). Therefore, they do not provide a very good indication of the risks over a wide range of possible quality levels that a contractor may operate. It is necessary to construct an OC curve that illustrates the probability of acceptance for any quality level for the acceptance plan under consideration (see Figure 3) to evaluate how the acceptance plan will actually perform in practice. Another step that is necessary

to fully evaluate the risks for a pay adjustment acceptance plan is to plot OC curves associated with receiving various pay factors (see Figure 4).

c. The concept of α and β risks derives from statistical hypothesis testing where there is either a right or wrong decision. When α and β risks are applied to materials or construction, they are only truly appropriate for the case of a pass/fail or accept/reject decision. This may lead to considerable confusion if an attempt is made to apply them to the pay adjustment case.

(1) The evaluation of risks becomes more complicated when the acceptance system includes pay adjustment provisions. The α and β risks discussed do not fully incorporate the concept of pay adjustments. By itself, the α risk, defined as the probability that an acceptance plan will incorrectly reject acceptable quality material or construction, cannot reflect the fact that the material or construction may be accepted at any of the possible pay adjustments (full pay, increased or decreased pay). When working with a pay adjustment system, the contractor's risk may also be interpreted as the probability of acceptable material or construction being accepted at less than 100 percent pay. In order to avoid confusion in the terms when the contractor's risk is used in this manner, the risk is here called α_{100}. However, it is computed in the same manner as α at the AQL. In addition, the β risk, defined as the probability that the owner incorrectly accepts rejectable quality material or construction, cannot reflect the impact of pay adjustments on determining the department's risk. When working with a pay adjustment plan, the department's risk may also be interpreted as the probability of accepting rejectable quality material or construction at 100 percent pay or greater. In order to avoid confusion in the terms when the department's risk is used in this manner, it is here called β_{100}. There are α and β type risks (α_{PF} and β_{PF}) associated with any given level of pay adjustment or pay factor (PF) from zero through the bonus chosen by the STD. For example, at a pay factor of 0.90 (90 percent payment) the alpha and beta risks can be represented by α_{90} and β_{90}. Likewise, at a pay factor of 1.05 (bonus of 5 percent) alpha and beta can be represented by α_{105} and β_{105}.

(2) The use of α and β risks alone to evaluate pay adjustment acceptance plans is simply not sufficient. When developing a pay adjustment system the contractor's risk α_{PF} and the department's risk β_{PF} must also be considered for the entire range of risks associated with the system. If only one level of risk is evaluated alone, for example at 100 percent pay, some other risks associated with the system may be too high. Making any change to the system will change all risks involved.

d. An additional method to properly evaluate the risks when pay adjustments are added to the acceptance decision is the expected pay (EP) curve (see Figure 5).

The EP curve has the advantage of combining all of the possible levels into a single expected or long-term average pay for each given level of quality.

e. The EP curve can also be used to ensure that a department's acceptance plan will pay 100 percent for material that is accepted at the AQL. It is generally agreed that the average pay for AQL material should be 100 percent. An average pay of 100 percent cannot be achieved unless a bonus is allowed. If the department's pay equations or tables are not properly developed, the average pay factor may be above or below 100 percent at the AQL. This would result in the contractor either being underpaid or overpaid on average. If this is the case, the department should determine if an expected pay other than 100 percent is acceptable for AQL material.

f. While the average expected pay shown with an EP curve should be used in addition to considering α and β type risks, the use of EP curves alone is also not sufficient to fully evaluate an acceptance plan. The EP alone is not a complete measure of the likelihood that any individual lot will receive a correct pay factor. The variability of the individual pay factors about the EP curve must also be considered.

g. When a price adjustment acceptance plan is used, it is essential that the department develop an EP curve and multiple OC curves for the probability of receiving various pay factors over the total range of quality levels in addition to considering all levels of α and β type risks. Both OC and EP curves must be developed and analyzed to show how an acceptance plan was designed to function. In all cases, when pay adjustments are used in the acceptance decision, the OC curves should be constructed to confirm that the acceptance procedure is working as desired and, in particular, that the average pay factor at the AQL is 100 percent. The department may also want to look at computer simulation histograms of individual pay factors to obtain a picture of how much variability is associated with the pay factor determination.

h. It is important to note that for PWL or PD acceptance plans, computer simulation is almost always used to develop α and β risks, OC and EP curves. The OCPLOT computer program that was developed as a part of FHWA Demonstration Project No. 89 (see paragraph 18j) is able to develop OC and EP curves, run simulations on the effect of the variability of the individual lot pay factors on the final pay factor determination, and create histograms. This program can be found on the Federal Highway Administration Office of Pavement Technology website at https://www.fhwa.dot.gov/pavement/qasoft.htm.

17. **Are there any conflicts between American Association of State Highway and Transportation Officials (AASHTO) quality assurance publications and FHWA regulations?**

a. The companion reports "AASHTO Implementation Manual for Quality Assurance" (see paragraph 18h) and "AASHTO Quality Assurance Guide Specification"(see paragraph 18i) were published in February 1996 as reports of the AASHTO Highway Subcommittee on Construction. The Guide Specification is not an official AASHTO Specification and the Implementation Manual is not an official guide or voluntary standard because they have not been balloted and approved by the AASHTO Standing Committee on Highways and the AASHTO Board of Directors.

b. These reports provide uniform guidance to develop and implement quality assurance standard specifications. While these reports substantially follow 23 CFR 637B, some differences exist.

(1) One significant difference is that the reports provide for the use of either paired split (see paragraph 11) or independent (see paragraph 10) sample data comparisons for validation of contractor test results, while 23 CFR 637B allows only independent sample data for validation (see paragraph 8). The use of a paired split sample data comparison only verifies the test procedures and equipment, not the quality of the material (see paragraph 12). The use of independently obtained and tested samples assesses material, process, sampling and testing variability. Therefore, an acceptance program that uses paired split sample comparisons or witnessed tests for validation does not ensure the material quality and does not meet the requirements or intent of 23 CFR 637B.

(2) On the other hand, the use of split samples in the IA program provides a check on testing equipment and procedures. This complements the QA program and ensures the credibility of the testing program. The Implementation Manual offers the option of using either split or independent samples for IA. This does not agree with the regulation that IA testing may only be performed on split samples or proficiency samples. There is value to both split and independent samples; however, they do not provide interchangeable information.

18. **Are there any reference materials on quality assurance, risks, and statistics?** Yes. The following references apply to quality assurance, risks, and statistics.

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King W. Gee
Associate Administrator for Infrastructure

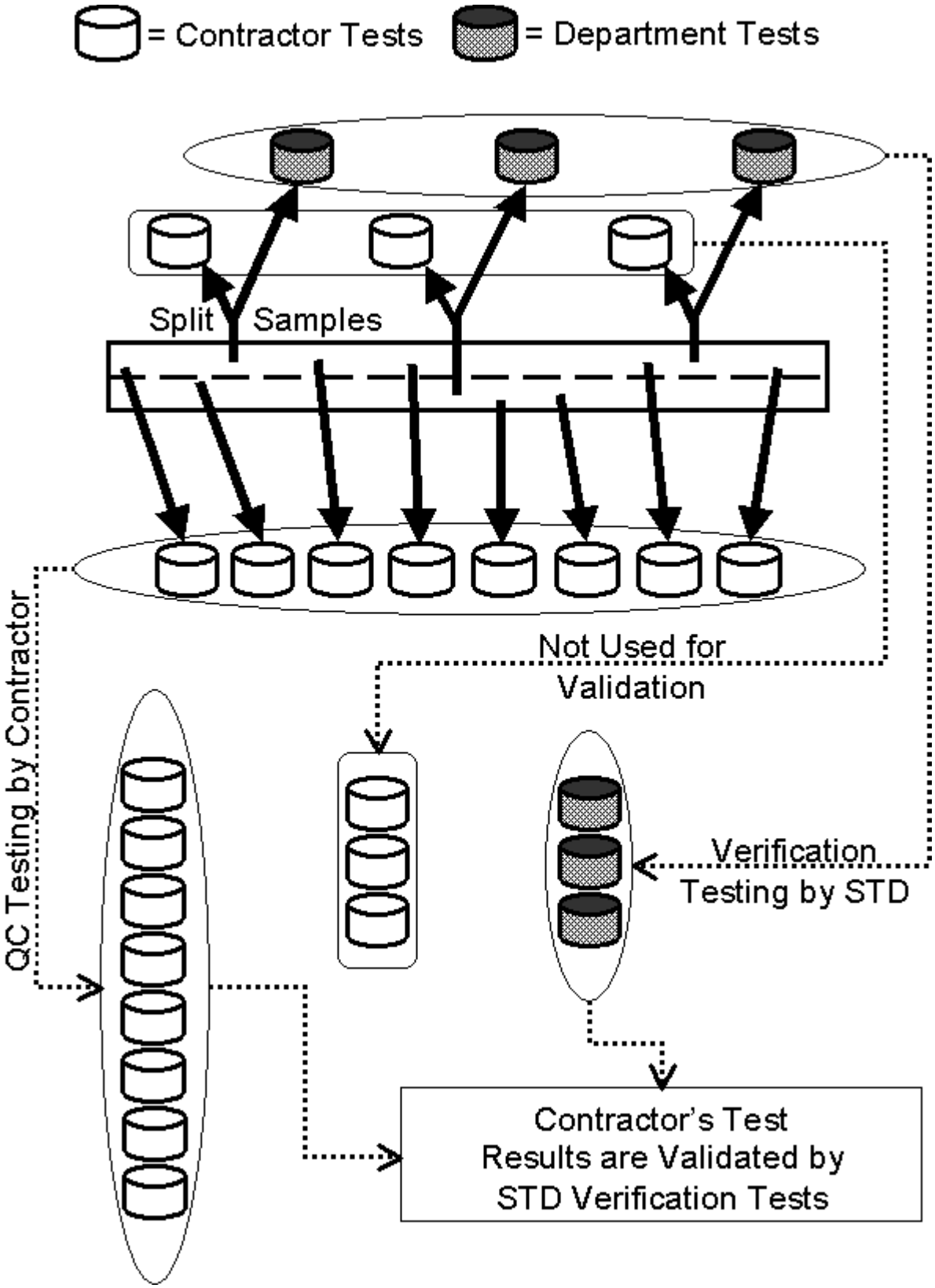

Figure 1 - Validation of Contractor's Tests

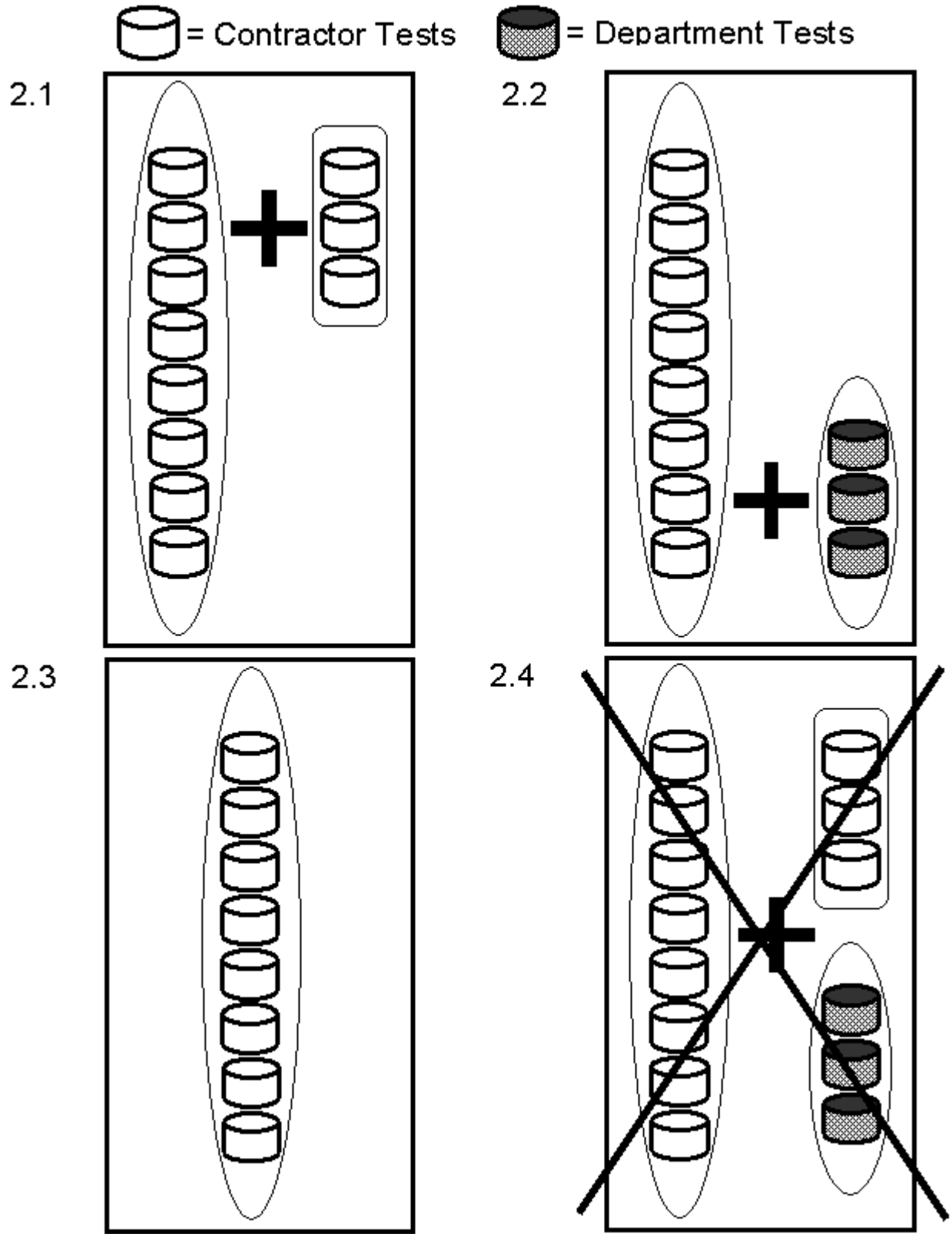

Figure 2 - Acceptance Based on Combined Test Results
(Using Sampling Plan in Figure 1)

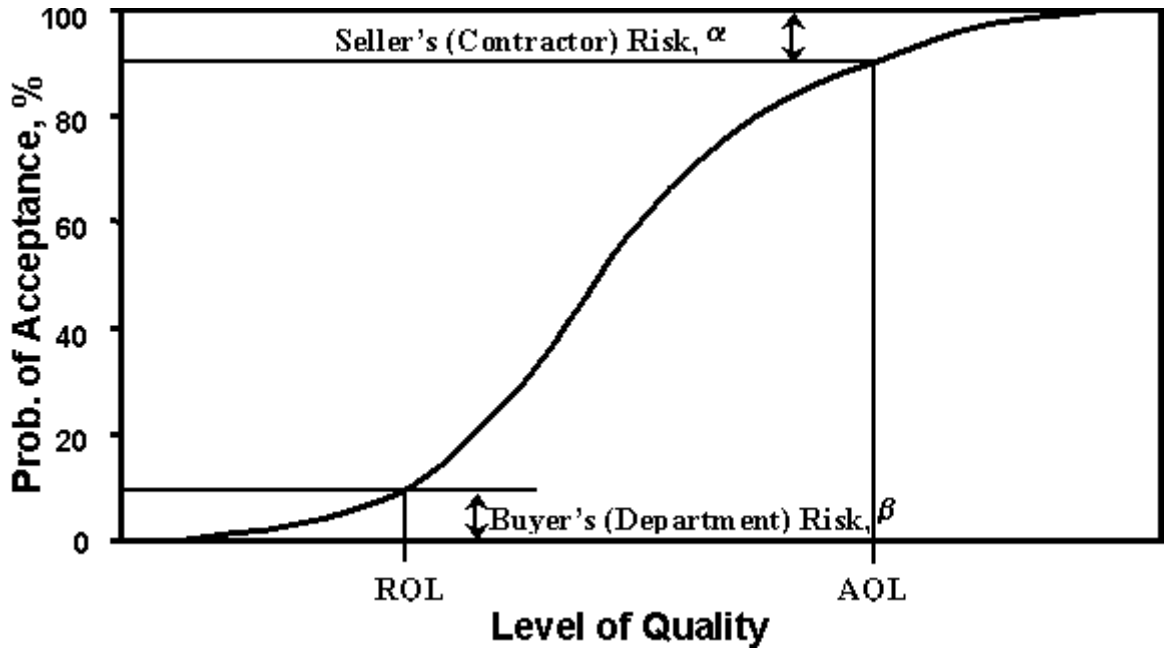

Figure 3 - Typical Operating Characteristic (OC) Curve for an Accept/Reject Acceptance

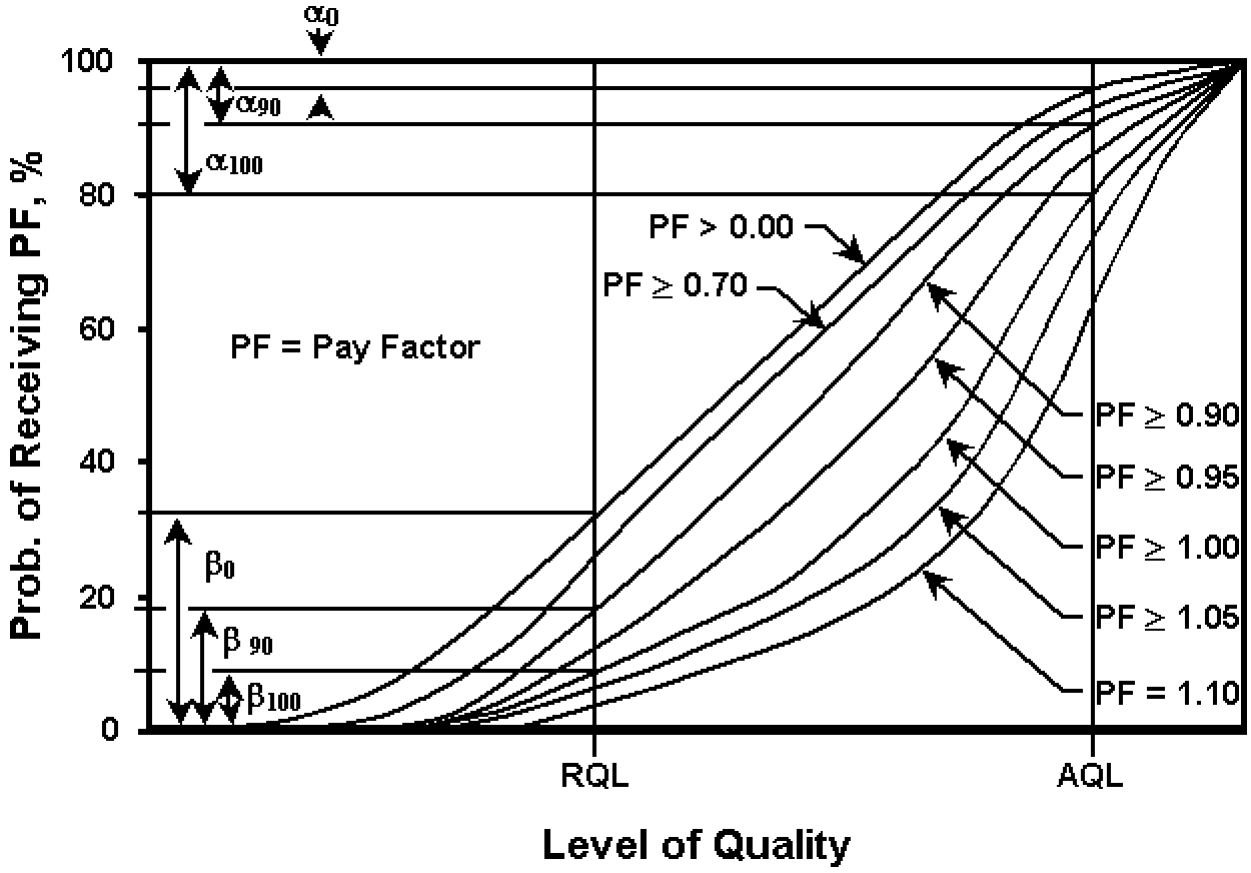

Figure 4 - Typical Operating Characteristic (OC) Curves for an Acceptance Plan with Pay Adjustments

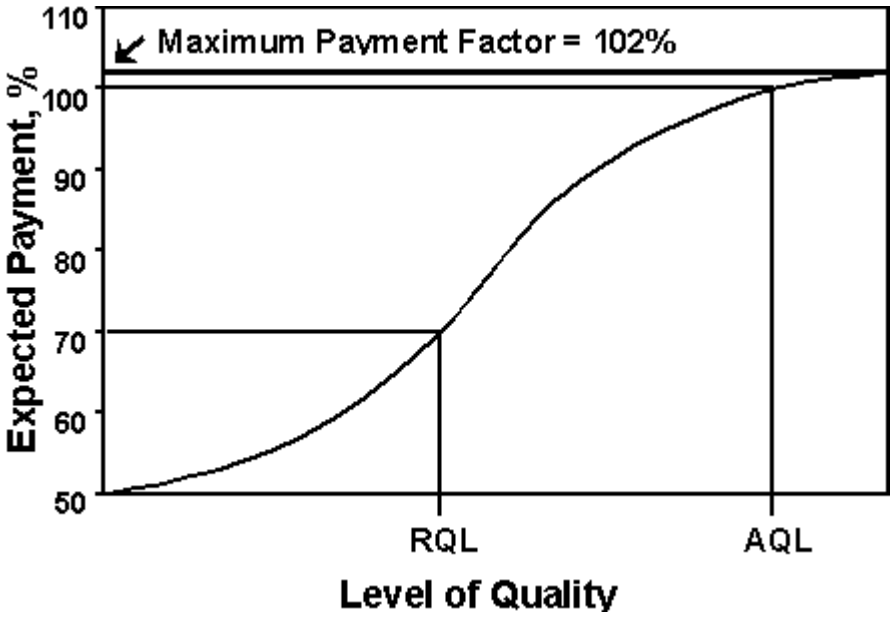

Figure 5 - Typical Expected Pay Curve

Construction Quality Assurance for Design-Build Highway Projects

FHWA Contact: Michael Rafalowski, HIPT-10, (202) 366-1571, michael.rafalowski@dot.gov

INTRODUCTION

A majority of State transportation agencies use the design-build (DB) contracting method to deliver some transportation projects. Documented benefits of DB include faster project delivery, improved constructability, less cost growth, early cost certainty, and fewer claims.

One area of DB contracting that requires closer examination is construction quality assurance (QA). DB is believed to provide a level of project quality equal to design-bid-build (DBB), as outlined in the Federal Highway Administration's (FHWA) *Design-Build Effectiveness Study.*[1] However, a recent examination of State agency DB procurement packages showed that roles and responsibilities for construction quality are not clearly defined in many instances. The paper "Does Design-Build Project Delivery Affect the Future of the Public Engineer?" examined 60 DB requests for proposals (RFPs) and found 23 cases in which assignment of responsibilities for verification and acceptance could not be determined.[2] National Cooperative Highway Research Program (NCHRP) Synthesis 376, *Quality Assurance in Design-Build Projects*, states "With the changing quality roles found in the DB delivery method, it is imperative that quality responsibilities and the responsible parties are clearly stated in the contract documents."[3] However, on DB projects, there is no change in the core QA functions of contractor quality control (QC) and agency acceptance. The design-builder still has a responsibility for QC, as does the contractor with DBB projects. The agency must retain its responsibility for the acceptance function, as required by Title 23, Code of Federal Regulations, Part 637 (23 CFR 637).[4]

One of the attributes of the DB delivery method is the single source of responsibility for design and construction issues. When preparing the RFP and contract documents, owners must clearly define the responsibilities of the design-builder and the contracting agency. The agency performs verification tests for compliance with RFP requirements and makes progress payments under the terms of the contract. However, by doing so, the agency does not assume responsibility for any design or construction issue. The design-builder remains fully responsible for the design and the construction of the final product.

PURPOSE

The purpose of this TechBrief is to help clarify the roles, responsibilities, and activities related to construction QA on DB projects. The specific topics discussed include QA, QC, and acceptance. Related topics such as independent assurance (IA), dispute resolution, personnel qualification, laboratory qualification, and warranties are also discussed. Some RFP and contract documents for DB projects have incorrectly assigned responsibility for acceptance to the design-builder, which is not in accordance with 23 CFR 637. Additionally, because the DB

project delivery method is often used on large, complex, fast-paced projects, it presents some unique challenges that merit discussion.

QUALITY ASSURANCE

The American Association of State Highway and Transportation Officials (AASHTO) defines *QA* as "(1) All those planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service; or (2) making sure the quality of a product is what it should be."(p. 14) [5]

Historically, agencies used the term QC/QA with QC referring to the contractor's role and QA to the agency's role. This term implied that QC and QA are separate functions; in fact, QA refers to the overall system for assuring project quality, with QC being one element of a comprehensive QA program. Therefore, the transportation industry has moved away from the term QC/QA and now uses QA.

Construction QA Programs

A construction QA program consists of the following core elements:

- Contractor QC.
- Agency acceptance.
- IA.
- Dispute resolution.
- Personnel qualification.
- Laboratory accreditation/qualification.

These core elements of QA apply regardless of the project delivery method. The agency's responsibility for acceptance cannot be assigned to the design-builder (or to a consultant under contract to the design-builder) but, rather, remains with the agency. Each of the six core elements of a construction QA program for DB is discussed below.

QUALITY CONTROL

FHWA's *Transportation Construction Quality Assurance Reference Manual* defines *QC* as "The system used by a contractor party to monitor, assess, and adjust their production or placement processes to ensure that the final product will meet the specified level of quality."(Section 2.3, p. 2–6) [6]

Use of QC Test Data in Acceptance Determination

While the primary purpose of QC sampling and testing is to provide timely information for the design-builder to monitor and guide each production or placement process, QC data for critical quality characteristics may also be used in the final acceptance determination. If QC test data are to be included in the agency acceptance decision, the QC data must be validated by agency verification test results. Lot and sublot sizes, sampling and testing methods, and sampling locations should be specified for each critical quality characteristic that will be verified by the agency. This information can be included directly in the DB contract documents, or reference can be made to the agency's standard specifications or guide schedule of sampling/testing frequencies. Not all characteristics that are monitored by QC are required to be verified by the agency. Design-builders will often perform more than the minimum level of QC, including testing of material properties beyond those critical quality characteristics that will be used in the agency acceptance decision.

QC Organization

There are different approaches to QC organizational structure on DB projects. Some agencies specify that the design-builder must demonstrate, through lines of authority in the organizational chart, that QC personnel are allowed to operate independently of DB construction forces to ensure that decisions made as part of the QC process are not influenced by schedule or budget. Another approach used by some agencies (especially on large DB projects) requires the design-builder to employ an independent testing firm to conduct sampling and testing of those critical quality characteristics that will be verified by the agency as part of the acceptance decision while a separate QC team works in close coordination with the construction forces, performing sampling and testing to monitor and guide production and placement processes.

Regardless of the approach, it is important that the DB team member in charge of construction quality report to senior management of the design-builder. This will convey support for QC and minimize potential conflicts with the production staff. Senior management must realize that superior quality will not happen without the seamless interaction between the QC teams, production/placement teams, and administration. The DB contract should clearly identify requirements for the QC organization.

Use of Consultants to Perform QC

Consultant technicians and inspectors may be used to conduct QC inspection and testing on a DB project. However, responsibility for the acceptance function cannot be relinquished to the design-builder per the requirements of 23 CFR 637.207(b).[4] Use of a consultant firm hired by the design-builder for sampling, testing, and inspecting does not relieve the agency of its responsibility for verification testing.

QC Documentation and Records

The agency should specify the minimum level of QC documentation that must be provided by the design-builder as well as the timeframe and format for providing the information. This typically includes all QC test results intended for inclusion in the agency acceptance decision. QC test results that are used strictly for process control may not need to be submitted but should be available for review by the agency as part of monitoring the design-builder's QC system.

Design-Builder Quality Management Plans

It is good practice to require the design-builder to provide a comprehensive quality management plan (QMP) that outlines the overall quality system for both design and construction of the project. The construction QC section of the QMP should describe all of the QC activities that will be conducted to assure that the completed items of work will meet the specified level of quality. If a QMP is required, the DB contract should specify the format and minimum content requirements as well as the procedure for agency review and acceptance of the QMP, including any updates and changes submitted by the design-builder following initial plan acceptance. During construction, the agency and the design-builder should monitor adherence to and effectiveness of the QMP. Any weaknesses discovered in the QC system should be corrected, including revisions to the QMP. Some agencies specify that failure by the design-builder to follow the QMP will result in actions such as suspension of work or withholding of payment.

ACCEPTANCE

FHWA-NHI-08-067 defines *acceptance* as "All factors used by the Agency (i.e., sampling, testing, and inspection) to evaluate the degree of compliance with contract requirements and to determine the corresponding value for a given product."(Section 2.3, p. 2–9) [6]

Agency Responsibility for Acceptance

According to 23 CFR 637.207(b), the agency's responsibility for acceptance does not change when using the DB delivery method. [4] While the design-builder is fully responsible for design, construction, and material selection, the agency is responsible for verifying RFP compliance and making progress payments by the acceptance of the work. As stated in FHWA-NHI-08-067, "All acceptance activities must be carried out by the agency or their designated agent (i.e., consultant under direct contract with the agency), independent of the contractor."(Section 2.3, p. 2–9) [6] This does not preclude the inclusion of design-builder QC data in the acceptance decision, provided that the QC data are validated by the agency's independently obtained verification data. It is important that the agency acceptance responsibilities be clearly defined in the DB contract documents.

Verification Sampling and Testing

23 CFR 637 defines *verification sampling and testing* as "Sampling and testing performed to validate the quality of the product." [4]

The highway agency (or its designated agent) is responsible for conducting verification sampling and testing to provide an assessment of product quality that is completely independent of the design-builder's QC process. As required in 23 CFR 637, "The verification testing shall be performed on samples that are taken independently of the quality control samples." [4] Splits of design-builder QC samples cannot be used for verification.

Verification sampling and testing may be performed at a lower frequency than the design-builder's QC testing, particularly on DB projects where QC data are included in the acceptance determination. On some large DB projects, agencies have used frequencies of 1 verification test for every 10 or more QC tests. In order for mathematical validation procedures to be reliable, it is suggested that a minimum of 7–10 agency verification results be obtained and used to validate the design-builder's QC data.

It may be necessary to adjust the frequency of verification testing to reflect the estimated number of QC tests for each item of work. Rates of verification testing may also differ based on the risks involved. For example, verification testing may be more frequent for structural concrete than for embankment materials.

On some DB projects, it may be challenging to conduct verification testing at the specified rate due to the quantities of material being placed and the fast-paced nature of the work. In addition, because DB projects are typically bid as a single lump sum amount or using a small number of lump sum pay items, agency tracking of material quantities can be more difficult than on DBB projects that use standard unit price items. This can make it more difficult to schedule verification activities and determine random sample locations. Agencies should take this into consideration when determining staffing levels for DB projects so as to provide sufficient verification testing. The agency and design-builder must work cooperatively to find solutions to these issues because quality cannot be sacrificed due to large material quantities or fast-paced work.

Validation of QC Data

Agencies that have not included QC data in the acceptance decision on DBB projects may choose to do so on DB projects. As previously stated, if the design-builder's random QC test data are to be included in the acceptance decision, the QC data must be mathematically "validated" against the agency verification test results for each lot of material. By including validated QC data in the acceptance decision, the frequency of verification testing by the agency (or its designated agent) can be reduced.

The DB contract documents should clearly outline the decision making process that will be used for validation of the QC data. It is important to specify the validation method (such as *F*- and *t*-tests), as well as actions that will be taken in the event that the design-builder QC test results are not validated by the agency verification results. There should be a well-defined process in place to resolve such an issue, including an investigation into the cause of the non-validation and increasing the rate of verification testing for the item. It is important to recognize that in some cases, even though the QC test data are not statistically validated, the material may be completely acceptable. In these cases, further investigation to determine the underlying cause of the non-validation is warranted. Also, it is necessary to specify the quality characteristics to which tests will be applied. Performing *F*- and *t*-tests on numerous quality characteristics for a particular material could make the analysis needlessly cumbersome. It is important that the agency identify the critical quality characteristics subject to the validation analysis for each material or work item.

Some materials, due to the small quantity being used, may not have a sufficient number of QC and verification tests to perform a statistical comparison. In these instances, use of an alternate method of acceptance may be necessary. To accept items requiring very few tests, it may be advisable to use only the agency's verification testing.

Quality Measures for Acceptance

Statistical quality measures used for acceptance, such as percent-within-limits (PWL), are well suited to DB projects, especially projects with work items having large quantities of materials. Agencies currently using PWL for work items on their DBB projects can easily incorporate it as the quality measure for the same items on DB projects. For agencies that do not use PWL, it may not be appropriate to utilize it on DB projects without first developing statistical specification limits that will provide a fair measure of quality. Statistical specification limits are typically developed by means of pilot projects completed over several years. Employing specification limits or procedures developed by another agency without proper evaluation could lead to unnecessary disputes.

The acceptable quality level (AQL) applied to each work item should be specified in the DB contract documents along with requirements for appropriate corrective action (rework or replacement) when the quality level is not met. The AQL can be set at different levels for different work items based on the risk associated with lower-quality material. Since most DB projects do not utilize unit price pay items, pay adjustments for material quality are often not applied. However, some agencies do apply pay adjustments either by including a typical unit price in the DB contract for the work item being evaluated or by requiring in the RFP that proposers submit a breakdown of work items with a unit price for each item subject to pay adjustment. When pay adjustment for quality is included in the DB contract, it is important that the agency monitor and measure material quantities. For work items not suited for PWL as the quality measure, such as items with small quantities, the agency's verification test results should be evaluated against engineering limits to determine acceptance.

Inspection

Just as on DBB projects, visual inspection is a key part of agency acceptance on DB projects. Acceptance inspection must be performed by the agency or its designated agent, not the design-builder. "The State's acceptance program should provide a reasonable level of inspection to adequately assess the specific attributes which reflect the quality of the finished product. Acceptance inspection should include inspection of the component materials at the time of placement or installation, as well as the workmanship and quality of the finished product." (7)

INDEPENDENT ASSURANCE

23 CFR 637 defines *IA* as "Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program." (4)

The purpose of the IA system is to assure the reliability of all data used by the agency in the acceptance determination. This includes the agency's verification data and the design-builder's QC data when validated QC data are to be included in the final acceptance determination. IA is intended to confirm that the sampling and testing activities performed by the agency and the design-builder are conducted by qualified personnel using proper procedures and properly calibrated and functioning equipment. The results of IA testing should never be used to evaluate material quality.

The responsibility for IA lies with the agency. IA sampling and testing is performed by agency personnel (or by personnel of a designated agent directly contracted by the agency) that are independent of the project. IA personnel, whether employed by the agency or a designated agent, cannot perform both IA and acceptance activities. For agencies that do not routinely include QC test results in the acceptance determination, using this approach on DB projects may create new challenges for the IA system. The design-builder may not be familiar with IA requirements. The need for the design-builder QC staff to cooperate with IA personnel should be clearly stated in the DB contract. Scheduling IA activities to obtain the required level of IA evaluations is often a challenge, and keeping track of ongoing QC and verification activities and personnel on large DB projects can magnify this problem. Using the system approach to IA is an effective strategy for DB projects, since IA frequency is based on covering all active testers and equipment over a period of time, independent of the number of QC and verification tests completed on a project.

It is important that all parties involved be aware of the role that IA plays in the overall QA program and work cooperatively to assure that IA staff is kept informed of project testing schedules and personnel. Some agencies include language in the DB contract requiring the design-builder to provide the agency's project staff with updated schedules and lists of QC personnel for upcoming QC sampling and testing so that IA activities can be scheduled.

DISPUTE RESOLUTION

If QC testing data will be included in the acceptance determination, agencies are required under 23 CFR 637 to have a dispute resolution system in place to resolve possible discrepancies between the design-builder's QC data and the agency's acceptance data. [4] While not required on projects where agency verification results will be used exclusively to determine acceptance, a dispute resolution system is highly recommended.

The dispute resolution process should be unbiased and timely. To address testing-related disputes, use of retained splits of samples used in the acceptance decision, alternate or third party laboratories, and a well-defined decision process to determine the outcome of the dispute are advisable. When retained splits are used, it is important that the dispute resolution split samples are properly labeled and that either the agency takes immediate possession of the dispute resolution split or proper sample security techniques, such as tamper-proof containers or security seals, are used.

PERSONNEL QUALIFICATION

All personnel performing sampling and testing for QC used in the acceptance decision, verification, or IA are required to be qualified, per 23 CFR 637.209. [4] Agencies participate in State, regional, or national technician qualification or certification programs to ensure that technicians and inspectors are properly qualified. The DB contract documents should specify the minimum qualifications for DB personnel performing QC sampling, testing, and inspection. Minimum qualifications for the design-builder's quality management personnel should also be clearly stated to ensure they have a thorough understanding of QA principles and experience working under QA specifications.

LABORATORY QUALIFICATION

Any laboratory used by the agency (or its designated agent) to perform verification testing and all design-builder laboratories that perform QC testing included in the acceptance decision must be qualified, as outlined in 23 CFR 637.209.[4] Laboratories that conduct QC testing only for process control are not covered by the regulation, but some agencies require these laboratories to meet a minimum standard such as approval by the agency or a certification organization. Laboratories operated by a designated agent of the agency that are used for IA or dispute resolution must be accredited by AASHTO, through a comparable program approved by FHWA, or by an accreditation body approved by the National Cooperation for Laboratory Accreditation.[8]

NON-CONFORMING MATERIALS AND WORKMANSHIP

The DB contract should describe the process for documentation and disposition of non-conforming work. Whether discovered by the design-builder or the agency, materials or

workmanship that do not meet the specified level of quality should be properly documented, including the nature of the non-conformance, location, extent, and disposition (e.g., removed and replaced, reworked, accepted based on engineering judgment, etc.). The authority to approve the final disposition of non-conforming materials or workmanship cannot be assigned to the design-builder. The agency's role in approving the disposition of non-conforming work should be clearly identified in the contract.

WARRANTIES

Some DB contracts include warranty provisions for some items of work. Contract language should specify the warranty period and the enforcement process, including a detailed description of the measures that will be used to determine warranty compliance. These measures are typically maximum levels of various distress types that, when exceeded during the warranty period, require correction by the design-builder. Some warranty provisions also include specific corrective action for each distress type. The inspection procedure for determining warranty compliance should be clearly outlined and include provisions for notification so that a design-builder representative can observe the warranty inspections. A process for dispute of warranty inspection findings should also be included. Use of warranty provisions does not remove the need for an effective design-builder QC system; on projects where the warranty does not provide coverage for the anticipated life of the warranted product, some level of agency acceptance is still required. The requirements for warranties on DB projects are covered under 23 CFR 635.413.[9]

SUMMARY

The DB project delivery system offers several documented benefits over the traditional DBB method on certain projects. While DB offers the design-builder more control over design, materials, and construction methods than DBB, the agency still has an important role in assuring quality. As agencies develop DB procurement documents, it is important that roles and responsibilities for design-builder QC and agency acceptance be clearly defined. The responsibility for acceptance by the agency (or their designated agent) is applicable regardless of the project delivery method used.

DB is often used on large, fast-paced projects, which can create challenges for conducting QA activities. Coordination and communication between the design-builder and the agency is essential for effective quality management. By working together within a well-defined QA program, the agency and design-builder can meet the goal of delivering a high quality project to the travelling public.

FURTHER INFORMATION

The following resources provide further information on this topic:

- National Highway Institute Course 134064, "Transportation Construction Quality Assurance".

- Office of Pavement Technology. (2012). *Independent Assurance Programs*, TechBrief, Publication No. FHWA-HIF-12-001, Federal Highway Administration, Washington, DC.

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9. *Construction and Maintenance*, Code of Federal Regulations, Title 23, Part 635, U.S. Government Printing Office, Washington, DC.

Researchers—For information related to Design-Build project delivery, contact Gerald Yakowenko (contract administration team leader) at gerald.yakowenko@dot.gov. Additional information related to the Materials Quality Assurance Program can be gained by contacting

the FHWA Quality Assurance Team: Michael Rafalowski (Office of Pavement Technology) at michael.rafalowski@dot.gov and Dennis Dvorak (Pavement and Materials Technical Service Team) at dennis.dvorak@dot.gov.

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Appendix B

Abbreviations and Definitions

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADOT	Arizona Department of Transportation
ASTM	American Society for Testing and Materials
ATTI	Arizona Technical Testing Institute
CCRL	Cement and Concrete Reference Laboratory
CFR	Code of Federal Regulations
CIQM	Construction Independent Quality Manager
CQMP	Construction Quality Management Plan
FHWA	Federal Highway Administration
FMS	Freeway Management System
IA	Independent Assurance
IMSA	International Municipal Signal Association
IQF	Independent Quality Firm
NCR	Nonconformance Report
NIST	National Institute of Standards and Technology
OV	Owner Verification
OVTIP	Owner Verification Testing and Inspection Plan
PCI	Precast Concrete Institute
PPD	Practice and Procedure Directive
QA	Quality Acceptance
QAP	Quality Assurance Program
QC	Quality Control

Acceptance Program means all factors that comprise ADOT's determination of the quality of the Work as specified in the Contract Documents. These factors include QA and OV sampling, testing, and inspection.

ADOT means the Arizona Department of Transportation, a public agency as constituted under the laws of the State of Arizona.

ADOT Standard Specifications means the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction, adopted by the Arizona State Transportation Board, including all revisions thereto applicable on the setting date.

Contract Documents means contract between ADOT and Contractor, including all exhibits attached hereto, as such contract or any such exhibits may be amended, supplemented, restated or otherwise modified, from time to time, and the executed originals of exhibits that are contracts.

Contractor means the individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, contracting with ADOT for performance of the Work.

Construction Independent Quality Manager means the individual appointed by the IQF who is responsible for management of construction Quality Acceptance functions, as more particularly described the Program and the Contract Documents.

Construction Quality Management Plan means the plan that establishes QC and QA procedures for the Work as more particularly described in the Contract Documents.

Element means (a) a discrete portion of the Project (e.g., a sign) or (b) a discrete condition to be inspected and measured as set forth in the Contract Documents.

Engineering Judgment means accepting any testing result or Work that does not adhere to the Contract Documents.

Guide Schedule means the Project specific sampling and testing guide schedule from the CQMP. This Project specific guide schedule is the required acceptance sampling and testing parameters as defined in this Program and the Contract Documents. The minimum sampling guide schedule is defined in Appendix D of this Program.

Independent Assurance means activities that are an unbiased and independent evaluation of all the sampling and testing (or inspection) procedures used in the Acceptance Program. The results of IA testing or inspection are not to be used as a basis of acceptance.

Independent Quality Firm means the independent firm identified in the Proposal (or such other firm approved by ADOT in ADOT's sole discretion) responsible for performing independent quality assurance material testing, inspection, and audits of the Construction Work and the Construction Quality Management Plan.

Material Code means each combination of material code and type code listed in Appendix E

Nonconformance Report is a defined resolution process for addressing any and all Nonconforming Work, as well as any meaning set forth in the Contract Documents.

Nonconforming Work means Work that does not conform to the requirements of the Contract Documents, any governmental approvals, any applicable law, or the released-for-construction drawings.

Owner Verification means inspection, sampling and testing performed by ADOT or ADOT's representatives to verify that the Project is constructed and accepted in compliance with the Contract Documents.

Owner Verification Firm means the firm hired by ADOT to perform OV.

Owner Verification Testing and Inspection Plan means project specific planned processes for performing OV per this Program and the Contract Documents.

Professional Engineer means a person who has been granted registration in one or more branches of engineering by the Arizona State Board of Technical Registration, and is authorized to practice professionally in the State of Arizona. If a branch of engineering is included in the title, such as Professional Civil Engineer, registration in that branch shall be required.

Project means facilities and all related structures, improvements and system to be developed, design, constructed, operated and maintained, or any of the foregoing, pursuant to the terms of the Contract Documents.

Program means the ADOT Quality Assurance Program - Projects Utilizing Contractor Performed Acceptance.

Quality Acceptance means all planned and systematic processes and actions performed by the IQF, as defined in the Contract Documents, for their portion of the Acceptance Program.

Quality Assurance Program means the FHWA required quality assurance program.

Quality Control means processes undertaken by the Contractor to produce Work compliant with the Contract Documents. Quality Control efforts are not part of the Acceptance Program.

Sole Discretion has the same meaning as set forth in the Contract Documents. If there is not a definition listed elsewhere in the Contract Documents, Sole Discretion means the right and power to decide a matter, which right may be exercised arbitrarily at any time and from time to time.

Work means all of the work required under the Contract Documents, including all administrative, design, engineering, right of way acquisition, support services, utility adjustment Work to be furnished or provided by the Contractor, procurement, professional, manufacturing, supply, installation, construction, supervision, management, testing, verification, labor, materials, equipment, maintenance, documentation, and other duties and services to be furnished and provided by the Contractor as required by the Contract Documents, including all efforts necessary or appropriate to achieve final acceptance, except for those efforts that the Contract Documents expressly specify will be performed by persons other than the Contractor.

Appendix C

Split Sample Tolerances

INDEPENDENT ASSURANCE AND CORRELATION TESTING ALLOWABLE VARIATIONS (±)
(See Notes 1 and 2 below.)

PORTLAND CEMENT CONCRETE	
TEST	SAMPLE RESULT vs. SPLIT RESULT (See Note 3 below.)
Coarse Aggregate Gradation:	
+1"	4
1"	4
3/4"	4
1/2"	4
3/8"	4
1/4"	4
No. 4	4
No. 8	4
Fine Aggregate Gradation:	
No. 4	4
No. 16	3
No. 50	3
No. 100	3
No. 200	1.5
28-Day Compressive Strength: (Class P, S, and B) (See Note 4 below.)	15% of the mix design strength

BITUMINOUS MIXTURES	
TEST	SAMPLE RESULT vs. SPLIT RESULT (See Note 3 below.)
Mineral Aggregate Gradation:	
+3/4"	4
3/4"	4
1/2"	4
3/8"	4
No. 4	4
No. 8	4
No. 30	2
No. 40	2
No. 200	1.0
Percent Asphalt	0.4
Bulk Density, pounds/cu. ft.	2.0
Rice Density, pounds/cu. ft.	2.0
Voids, percent	1.5
Marshall Stability, pounds	1200

SOILS AND AGGREGATES	
TEST	SAMPLE RESULT vs. SPLIT RESULT (See Note 3 below.)
Gradation, except for Portland Cement Concrete and Bituminous Mixtures:	
+1"	4
1"	4
3/4"	4
1/2"	4
3/8"	4
1/4"	4
No. 4	4
No. 8	4
No. 16	4
No. 40	3
No. 200	1.5
Sand Equivalent	6
Flakiness Index	3
Uncompacted Void Content	1.0
pH	0.4
Optimum Moisture, percent	2.0
Proctor Density, pounds/cu. ft.	4.0
Fractured Coarse Aggregate Particles (See Note 5 below.)	15% of the mean of the results
Plasticity Index: (See Note 5 below.)	
Liquid Limit (LL)	13% of the mean of the results
Plastic Limit (PL)	18% of the mean of the results

Note 1: Use applicable test characteristics specified for material being tested.
Note 2: Regional Materials Engineer to determine allowable variations for test characteristics not shown.
Note 3: Allowable variations apply for both independent assurance testing and correlation testing comparisons.
Note 4: Allowable variations based on a percentage of the mix design strength shall be rounded if necessary to the nearest whole number.
Note 5: Allowable variations based on a percentage of the mean of the results shall be rounded if necessary to the nearest whole number.

Appendix D

Independent Quality Firm Minimum Sampling Guide Schedule

The minimum acceptance sampling and testing requirements are listed in the tables contained in this appendix.

Index of Materials Listed in Tables 1 through 8

Some tables are larger than a single page.

Within these tables, some rows and / or columns extend onto the following page. If an individual row or column is blank, see the corresponding row or column directly above, on the previous page.

INDEX OF MATERIALS LISTED IN TABLES 1 THROUGH 8
Admixtures for Portland Cement Concrete
Aggregate for Arrestor Bed
Aggregate for Cement Stabilized Alluvium
Aggregate for Cement Treated Base
Aggregate for Lean Concrete Base
Aggregate for Soil-Cement Bank Protection
Aggregate Base
Aggregate Subbase
Asphalt Cement (PG XX-XX)
Asphalt Cement (PG XX-XX) for Asphalt-Rubber
Asphaltic Concrete (Asphalt-Rubber) [AR-AC]
Asphaltic Concrete (Asphalt-Rubber) - End Product [AR-AC]
Asphaltic Concrete - End Product
Asphaltic Concrete (End Product) SHRP Volumetric Mix
Asphaltic Concrete Friction Course (ACFC)
Asphaltic Concrete Friction Course (Asphalt-Rubber) [AR-ACFC]
Asphaltic Concrete Friction Course (ACFC) - Miscellaneous
Asphaltic Concrete - Miscellaneous Paving
Asphaltic Concrete (Miscellaneous Structural)
Asphaltic Concrete (Miscellaneous Structural - Special Mix)
Asphalt-Rubber (CRA)
Bank Protection Fabric
Barbed Wire
Barbless Wire
Bearing Pads
Bedding Material for Pipe
Bedding Material for Polyvinyl Chloride (PVC) Irrigation Pipe
Bituminous Treated Base
Blotter Material
Borrow
Brick for Manholes
Cement Stabilized Alluvium
Cement Treated Base
Cement Treated Subgrade
Chain Link Fabric
Cinder Block
Coarse Aggregate for Portland Cement Concrete (PCC)
Cover Material
Crash Barrel Sand
Crumb Rubber for Asphalt-Rubber
Curing Compound
Decomposed Granite
Dual Component Pavement Markings
Embankment

INDEX OF MATERIALS LISTED IN TABLES 1 THROUGH 8
Emulsified Asphalt
Emulsified Asphalt Special Type
Emulsified Asphalt for Cold Recycled Asphaltic Concrete
Emulsified Recycling Agent (ERA)
Fence Hardware, Miscellaneous
Fence Post and Rails
Fence Stays
Filter Material for Perforated Pipe
Fine Aggregate for Portland Cement Concrete (PCC)
Fly Ash and Natural Pozzolan
Geocomposite Edge Drain System
Geocomposite Wall Drain System
Geogrid
Geomembrane
Geosynthetics
Glass Beads
Granite Mulch
Guardrail Elements
Guardrail Fasteners
Guardrail Posts and Blocks
High Strength Bolts, Nuts, Washers, or Anchor Bolts
Hydrated Lime (for use as mineral admixture in asphaltic concrete mixes)
Hydraulic Cement
Hydraulic Cement (for use in soil stabilization, mortar, and grout)
Joint Materials
Lean Concrete Base
Lime (for use in soil stabilization, mortar, and grout)
Lime Treated Subgrade
Liquid Asphalt [Cutback Asphalt - (Medium Curing Type)]
Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) [AR-AC]
Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) – End Product [AR-AC]
Mineral Aggregate for Asphaltic Concrete - End Product [without reclaimed asphaltic pavement (RAP)]
Mineral Aggregate for Asphaltic Concrete – End Product [with reclaimed asphaltic pavement (RAP)]
Mineral Aggregate for Asphaltic Concrete (End Product) SHRP Volumetric Mix [without reclaimed asphalt pavement (RAP)]
Mineral Aggregate for Asphaltic Concrete (End Product) SHRP Volumetric Mix [without reclaimed asphalt pavement (RAP)]
Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC)
Mineral Aggregate for Asphaltic Concrete Friction Course (Asphalt-Rubber) [AR-ACFC]
Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC) - Miscellaneous
Mineral Aggregate for Asphaltic Concrete - Miscellaneous Paving
Mineral Aggregate for Asphaltic Concrete (Miscellaneous Structural)
Mineral Aggregate for Asphaltic Concrete (Miscellaneous Structural – Special Mix)
Mineral Aggregate for Micro-Surfacing

INDEX OF MATERIALS LISTED IN TABLES 1 THROUGH 8
Natural Ground
Paint
Pavement Fabric
Paving Brick
Permanent Pavement Markings (Painted)
Pipe Backfill
Pipe, Corrugated Metal (CMP) [Coated or Non-coated]
Pipe, Non-Reinforced Cast-in-Place Concrete
Pipe, Polyvinyl Chloride (PVC) for Electrical Conduit
Pipe, Polyvinyl Chloride (PVC) for Water
Pipe, Precast Reinforced or Non-Reinforced Concrete
Pipe, Vitrified Clay
Plating Material for Pipe Ends
Portland Cement and Blended Hydraulic Cement (for use as mineral admixture in asphaltic concrete mixes)
Portland Cement Concrete (PCC) (Class P)
Portland Cement Concrete (PCC) (Class S) (with a compressive strength requirement less than 4,000 psi)
Portland Cement Concrete (PCC) (Class S) (with a compressive strength requirement equal to or greater than 4,000 psi)
Portland Cement Concrete (PCC) (Class B)
Portland Cement Structural Concrete for Minor Precast Structures
Post Clips and Hog Rings
Post-Tensioning Steel
Preformed Plastic Pavement Marking
Prestressed Concrete
Prestressing Steel
Raised Pavement Markers
Recycling Agent
Reinforcement Bars
Retroreflective Sheeting
Rock
Shotcrete
Sign Panel Silk-Screened Characters
Silica Fume
Slump Block
Soil for Shoulder Build-up
Soil-Cement Bank Protection
Separation Geotextile Fabric
Structure Backfill
Subgrade
T-Post
Thermoplastic Pavement Markings
Tie Wire and Tension Wire
Top Soil
Trench Backfill

INDEX OF MATERIALS LISTED IN TABLES 1 THROUGH 8
Utility Concrete
Water
Welded Wire Fabric (Smooth)
Welded Wire Fabric (Deformed)
Wire Rope
Woven Wire Fabric

TABLE 1 ACCEPTANCE SAMPLING GUIDE FOR SOILS				
SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
203	Borrow (within 3 ft. of finished subgrade elevation)	Gradation [1]	In-Place	One per 1500 ft.
		PI [1]		
203	Embankment	Proctor Density	In-Place	One per soil type, and as needed.
		Optimum Moisture		
		Compaction	In-Place	One per 1500 ft. per lift.
	Embankment for Metal Pile Location only	pH	In-Place or Source	One per source.
		Resistivity		
203	Natural Ground for Embankment 5 ft. or less in height	Proctor Density	In-Place	One per soil type, and as needed.
		Optimum Moisture		
		Compaction	In-Place	One per 1500 ft.
[1] Independent Assurance Sampling and Testing required.				

TABLE 1 (continued)
ACCEPTANCE SAMPLING GUIDE FOR SOILS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
203	Subgrade	Proctor Density	Roadway	One per soil type, and as needed.
		Optimum Moisture		
		Compaction	Roadway	One per 1500 ft.
		Gradation [1]	Roadway	One per 1500 ft. or change in material.
		PI [1]		
203	Soil for Shoulder Build-up	Gradation	In-Place or Source	One per soil type.
		PI		
		pH		
		Soluble Salts		
		Compaction	In-Place	One per 1500 ft. or as directed by the Engineer.
501	Trench Backfill	Proctor Density	In-Place	One per soil type, and as needed.
		Optimum Moisture		
		Compaction	In-Place	One per 100 CY.

[1] Independent Assurance Sampling and Testing required.

TABLE 1 (continued)
ACCEPTANCE SAMPLING GUIDE FOR SOILS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
803	Granite Mulch or Decomposed Granite	Gradation	In-Place or Source	One per 10,000 CY.
804	Top Soil	Gradation [(1)]	In-place	Written soil analysis per source and six samples per lot [a lot is considered approximately 20,000 CY per source].
		PI [(1)]		
		pH [(1)]		
		Soluble Salts		
		Calcium Carbonate		
		Exchange-able Sodium in percent and parts per million		

[(1)] Independent Assurance Sampling and Testing required.

TABLE 2 ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES				
SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
203 501 (When Contractor Quality Control **is not** a bid item.)	Structure Backfill or Pipe Backfill	Proctor Density Optimum Moisture	Stockpile	One per source, and as needed.
		Compaction	In-Place	One per 75 CY.
		Resistivity[1] pH[1]	Source or Stockpile	One per source.
		Gradation [1] PI [1]	On Job Site	One per 500 CY per source.
203 501 (When Contractor Quality Control **is** a bid item.)	Structure Backfill or Pipe Backfill	Proctor Density Optimum Moisture	Stockpile	One per source, and as needed.
		Compaction	In-Place	One per 100 CY.
		Resistivity[1] pH[1]	Source or Stockpile	One per source.
		Gradation [1] PI [1]	On Job Site	One per 1500 CY per source.
[1] Independent Assurance Sampling and Testing required.				

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
303 (When Contractor Quality Control **<u>is not</u>** a bid item.)	Aggregate Base Class 1, Class 2, and Class 3	Abrasion [2]	Source	One per source.
		Proctor Density	Crusher Belt or Stockpile	At start of production, then as material changes.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1000 ft.
		Fractured Coarse Aggregate Particles [1]	Stockpile	One per 10,000 tons.
		Gradation [1]	Windrow	One per 2000 tons, minimum one per shift.
		PI [1]		

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
303 (When Contractor Quality Control **is** a bid item.)	Aggregate Base Class 1, Class 2, and Class 3	Abrasion [2]	Source	One per source.
		Proctor Density	Crusher Belt or Stockpile	At start of production, then as material changes.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1500 ft.
		Fractured Coarse Aggregate Particles [1]	Stockpile	One per 10,000 tons.
		Gradation [1]	Windrow	One per 2000 tons, minimum one per shift.
		PI [1]		

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
303 (When Contractor Quality Control **is not** a bid item.)	Aggregate Subbase Class 4, Class 5, and Class 6	Proctor Density	Crusher Belt or Stockpile	At start of production, then as material changes.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1000 ft.
	Class 4	Fractured Coarse Aggregate Particles [1]	Stockpile	One per 10,000 tons.
		Gradation [1]	Windrow	One per 2000 tons, minimum one per shift.
		PI [1]		
		Abrasion [2]	Source	One per source.
	Class 5 and Class 6	Gradation [1]	Windrow	One per 2000 tons, minimum one per shift.
		PI [1]		

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
303 (When Contractor Quality Control **is** a bid item.)	Aggregate Subbase Class 4, Class 5, and Class 6	Proctor Density	Crusher Belt or Stockpile	At start of production, then as material changes.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1500 ft.
	Class 4	Fractured Coarse Aggregate Particles [1]	Stockpile	One per 10,000 tons.
		Gradation [1]	Windrow	One per 2000 tons, minimum one per shift.
		PI [1]		
		Abrasion [2]	Source	One per source.
	Class 5 and Class 6	Gradation [1]	Windrow	One per 2000 tons, minimum one per shift.
		PI [1]		

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
304 305	Aggregate for Cement Treated Base or Lean Concrete Base	Gradation [1]	Stockpile	One per 2000 tons, minimum one per shift.
		Fractured Coarse Aggregate Particles [1]	Stockpile	One per 10,000 tons.
		Abrasion [2]	Source	One per source.
	for Cement Treated Base	PI [1]	Stockpile	One per 2000 tons, minimum one per shift.
	for Lean Concrete Base	Sand Equivalent [1]	Stockpile	One every other day of Lean Concrete Base production.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
404	Cover Material	Abrasion [2]	Source or Stockpile	One per source.
		Bulk O.D. Specific Gravity	Stockpile	One per source.
		Percent Carbonates		
		Dry Unit Weight		
		Fractured Coarse Aggregate Particles	Stockpile	One per 600 tons.
		Flakiness Index		
		Gradation [1]	Final Stockpile	One per 300 tons.
		Moisture Content	Trucks at Scale	One per 300 tons.
404 412 413 415	Blotter Material	Gradation [1]	Final Stockpile	One per stockpile.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Mineral Aggregate for Micro-Surfacing	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates	Stockpile	One per source.
		Gradation [1]	Final Stockpile	One prior to start of Micro-Surfacing production, and one per 300 tons
		Sand Equivalent	Stockpile	One prior to start of Micro-Surfacing production, and one per 600 tons
		Fractured Coarse Aggregate Particles		
		Uncompacted Void Content		
		Moisture Content	Trucks at Scale	One per 300 tons.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
407	Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC)	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates		
		Specific Gravity		
		Gradation	Cold Feed	One prior to the start of ACFC production.
		Sand Equivalent [1]	Cold Feed or Stockpile	One prior to the start of ACFC production and one per each two days of ACFC production, minimum of two per project.
		Flakiness Index [1]		
		Fractured Coarse Aggregate Particles [1]		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation [1]	Cold Feed or Hot Bins	One per 500 tons of ACFC production, minimum of one per shift.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
409	Mineral Aggregate For Asphaltic Concrete (Miscellaneous Structural) [For Special Mix, see below.]	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Sand Equivalent	Stockpile	One per source.
		Fractured Coarse Aggregate Particles		
		Moisture Content	Prior to mixing with mineral admixture	One per each two days of asphaltic concrete production.
		Gradation	Cold Feed or Hot Bins	At discretion of the Engineer.
409	Mineral Aggregate for Asphaltic Concrete (Miscellaneous Structural – Special Mix)	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Sand Equivalent [1]	Stockpile	One per source.
		Uncompacted Void Content [1]	Stockpile	One prior to start of asphaltic concrete production.
		Fractured Coarse Aggregate Particles [1]	Cold Feed or Stockpile	One per each two days of asphaltic concrete production, minimum of two per project.
		Moisture Content	Prior to mixing with mineral admixture	One per each two days of asphaltic concrete production.
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete (Miscellaneous Structural - Special Mix) on Page 45.)	

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
411	Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC) - Miscellaneous	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates		
		Sand Equivalent	Stockpile	One per source.
		Flakiness Index		
		Fractured Coarse Aggregate Particles		
		Moisture Content	Prior to mixing with mineral admixture	One per each two days of ACFC production.
		Gradation	Cold Feed or Hot Bins	At the discretion of the Engineer.
413	Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) [AR-AC]	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Specific Gravity	Stockpile	One per source.
		Gradation	Cold Feed	One prior to the start of AR-AC production.
		Sand Equivalent [1]	Cold Feed or Stockpile	One prior to the start of AR-AC production and one per each two days of AR-AC production, minimum of two per project.
		Fractured Coarse Aggregate Particles [1]		
		Moisture Content	Prior to mixing with mineral admixture	One per each two days of AR-AC production.
		Gradation [1]	Cold Feed or Hot Bins	One per 500 tons of AR-AC production, minimum of one per shift.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
414	Mineral Aggregate for Asphaltic Concrete Friction Course (Asphalt-Rubber) [AR-ACFC]	Abrasion [2]	Source or Stockpile	One per source.
		Specific Gravity	Stockpile	One per source.
		Percent Carbonates		
		Gradation	Cold Feed	One prior to the start of AR-ACFC production.
		Sand Equivalent [1]	Cold Feed or Stockpile	One prior to the start of AR-ACFC production and one per each two days of AR-ACFC production, minimum of two per project.
		Fractured Coarse Aggregate Particles [1]		
		Flakiness Index [1]		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation [1]	Cold Feed or Hot Bins	One per 500 tons of AR-ACFC production, minimum of one per shift.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
415	Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) - End Product [AR-AC]	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Sand Equivalent	Stockpile	One at least five working days prior to start of AR-AC production.
		Fractured Coarse Aggregate Particles		
		Uncompacted Void Content		
		Ignition Furnace Calibration		
		Sand Equivalent [1]	Cold Feed or Stockpile	One per each two days of AR-AC production, minimum of two per project.
		Fractured Coarse Aggregate Particles [1]		
		Uncompacted Void Content [1]		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete (Asphalt-Rubber) - End Product on Page 46.)	

[1] Independent Assurance Sampling and Testing required.

[2] Historical abrasion values may be used provided testing was conducted within the past two years.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
416	Mineral Aggregate for Asphaltic Concrete - End Product **[without reclaimed asphalt pavement (RAP)]** (See Page 18 for mixes with RAP.)	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Sand Equivalent	Stockpile	One at least five days prior to start of asphaltic concrete production.
		Fractured Coarse Aggregate Particles		
		Uncompacted Void Content **(Special Mix only)**		
		Ignition Furnace Calibration		
		Sand Equivalent [1]	Cold Feed or Stockpile	One per each two days of asphaltic concrete production, minimum of two per project.
		Fractured Coarse Aggregate Particles [1]		
		Uncompacted Void Content [1] **(Special Mix only)**		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete - End Product on Page 47.)	

[1] Independent Assurance Sampling and Testing required.

[2] Historical abrasion values may be used provided testing was conducted within the past two years.

TABLE 2 (continued) ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES				
SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
416	Mineral Aggregate for Asphaltic Concrete - End Product **[with reclaimed asphalt pavement (RAP)]** See PPD [3]. (See Page 17 for mixes without RAP.)	Abrasion [2] (Virgin Agg. and RAP Agg. separately)	Source or Stockpile	One per source.
		Percent Carbonates (if required) (Composite of Virgin Agg. and RAP Agg.)		
		Sand Equivalent (Virgin Agg. only)	Stockpile	One at least five days prior to start of asphaltic concrete production.
		Fractured Coarse Aggregate Particles (Composite of Virgin Agg. and RAP Agg.)		
		Uncompacted Void Content **(Special Mix only)** (Virgin Agg. only)		
		Ignition Furnace Calibration (Virgin Agg., RAP Agg., and RAP material)		
		Gradation, Binder Content [1], and Moisture Content of RAP material	Individual stockpiles (belt cut may be used for single stockpile)	One per each lot of asphaltic concrete production.
		Sand Equivalent [1] (Virgin Agg. only)	Cold Feed or Stockpile	One per each two days of asphaltic concrete production, minimum of two per project.

		Fractured Coarse Aggregate Particles [1] (Composite of Virgin Agg. and RAP Agg. obtained from Arizona Test Method 428)		
		Uncompacted Void Content [1] **(Special Mix only)** (Virgin Agg. only)		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete - End Product on Page 47.)	

[1] Independent Assurance Sampling and Testing required.

[2] Historical abrasion values may be used provided testing was conducted within the past two years.

[3] ADOT Materials Practice and Procedure Directive.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
417	Mineral Aggregate for Asphaltic Concrete (End Product) SHRP Volumetric Mix **[without reclaimed asphalt pavement (RAP)]** (See Page 20 for mixes with RAP.)	Abrasion [2]	Source or Stockpile	One per source.
		Percent Carbonates (if required)		
		Sand Equivalent	Stockpile	One at least five days prior to start of asphaltic concrete production.
		Fractured Coarse Aggregate Particles		
		Uncompacted Void Content		
		Ignition Furnace Calibration		
		Sand Equivalent [1]	Cold Feed or Stockpile	One per each two days of asphaltic concrete production, minimum of two per project.
		Fractured Coarse Aggregate Particles [1]		
		Uncompacted Void Content [1]		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete (End Product) SHRP Volumetric Mix on Page 48.)	

[1] Independent Assurance Sampling and Testing required.

[2] Historical abrasion values may be used provided testing was conducted within the past two years.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
417	Mineral Aggregate for Asphaltic Concrete (End Product) SHRP Volumetric Mix **[with reclaimed asphalt pavement (RAP)]** See PPD [3]. (See Page 19 for mixes without RAP.)	Abrasion [2] (Virgin Agg. and RAP Agg. separately)	Source or Stockpile	One per source.
		Percent Carbonates (if required) (Composite of Virgin Agg. and RAP Agg.)		
		Sand Equivalent (Virgin Agg. only)	Stockpile	One at least five days prior to start of asphaltic concrete production.
		Fractured Coarse Aggregate Particles (Composite of Virgin Agg. and RAP Agg.)		
		Uncompacted Void Content (Virgin Agg. only)		
		Ignition Furnace Calibration (Virgin Agg., RAP Agg., and RAP material)		
		Gradation, Binder Content [1], and Moisture Content of RAP material	Individual stockpiles (belt cut may be used for single stockpile)	One per each lot of asphaltic concrete production.
		Sand Equivalent [1] (Virgin Agg. only)	Cold Feed or Stockpile	One per each two days of asphaltic concrete production, minimum of two per project.

		Fractured Coarse Aggregate Particles [1] (Composite of Virgin Agg. and RAP Agg. obtained from Arizona Test Method 428)		
		Uncompacted Void Content [1] (Virgin Agg. only)		
		Moisture Content	Prior to mixing with mineral admixture	
		Gradation	(See Bituminous Mixture requirements for Asphaltic Concrete (End Product) SHRP Volumetric Mix on Page 48.)	

[1] Independent Assurance Sampling and Testing required.

[2] Historical abrasion values may be used provided testing was conducted within the past two years.

[3] ADOT Materials Practice and Procedure Directive.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Mineral Aggregate for Asphaltic Concrete - Miscellaneous Paving	Abrasion [2]	Source or Stockpile	One per source.
		Sand Equivalent	Stockpile	One per source.
		Gradation	Cold Feed or Hot Bins	At discretion of the Engineer.
501	Bedding Material for Pipe	Gradation [1]	Source or Stockpile	One per 300 CY per source.
		PI [1]		
		pH [1]		One per source.
		Resistivity [1]		
		Proctor Density	Source or Stockpile	One per source, and as needed.
		Optimum Moisture		
		Compaction	In-Place	One every 50 CY.
501	Filter Material for Perforated Pipe	Gradation [1]	Source or Stockpile	One per 300 CY per source.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
501	Plating Material for Pipe Ends	Gradation	Source or Stockpile	One per source, and as needed.
		PI		
		Proctor Density		
		Optimum Moisture		
		Compaction	In-Place	One every 50 CY.
702	Crash Barrel Sand	Gradation	Plant or Site	One per each attenuator system location.
		Dry Unit Weight per cubic foot		
		Moisture Content		
	Sand and Rock Salt Mixture (when Sand Barrel Crash Cushions are installed at elevations above 3,000 feet)	Percent Rock Salt		
808	Bedding Material for Polyvinyl Chloride (PVC) Irrigation Pipe	Gradation	Source or Stockpile	One per source.

TABLE 2 (continued) ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES				
SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
913	Rock for Wire Tied Riprap, Gabions, Riprap (Slope Mattress), and Rail Bank Protection	Specific Gravity	Source	One per source.
		Gradation (visual)	Project	One per 1/2 shift.
	Rock for Grouted Riprap and Dumped Riprap	Specific Gravity	Source	One per source.
		Gradation	Project	One per 1/2 shift.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Fine Aggregate for Portland Cement Concrete (PCC) Classes P, S, and B	Gradation [1]	Batch Plant Conveyer Belt or Stockpile	Once per week of production.
		Sand Equivalent [1]		
		Soundness [when used in concrete over 4500 ft. elevation]	Stockpile	One per source. For evaluation of concrete aggregate sources, see PPD [3].
		Organic Impurities		
		Mortar Strength		
		Deleterious Substances [Clay Lumps and Friable Particles; Lightweight Particles]	Stockpile	At the discretion of Materials Group. For evaluation of concrete aggregate sources, see PPD [3].

[1] Independent Assurance Sampling and Testing required.

[3] ADOT Materials Practice and Procedure Directive.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Coarse Aggregate for Portland Cement Concrete (PCC) Classes P, S, and B	Gradation [1]	Batch Plant Conveyer Belt or Stockpile	Once per week of production.
		Soundness [when used in concrete over 4500 ft. elevation]	Stockpile	One per source. For evaluation of concrete aggregate sources, see PPD [3].
		Abrasion [2]		
		Deleterious Substances [Clay Lumps and Friable Particles; Lightweight Particles; Material Passing No. 200 Sieve]	Stockpile	With the exception of "Material Passing No. 200 Sieve", at the discretion of Materials Group. For evaluation of concrete aggregate sources, see PPD [3].
		Fractured Coarse Aggregate Particles	Stockpile	One per source.

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

[3] ADOT Materials Practice and Procedure Directive.

TABLE 2 (continued)
ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Aggregate for Arrestor Bed	Abrasion [2]	Screen Belt or Stockpile	One per source.
		Specific Gravity		
		Gradation [1]	Screen Belt or Stockpile	One per shift.
		Fractured Coarse Aggregate Particles [1]		
		Flakiness Index [1]		
Refer to Special Provisions	Aggregate for Soil-Cement Bank Protection or Cement Stabilized Alluvium	Gradation [1]	Source or Stockpile	One per 2000 tons, minimum of one per day.
		PI [1]		

[1] Independent Assurance Sampling and Testing required.

[2] Provided Construction & Materials Group concurs, historical abrasion values may be used.

TABLE 3
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005	Recycling Agent RA-1 RA-5 RA-25 RA-75	Per Specifications	Circulation Line Recom-mended [4]	Certificate of Compliance required and duplicate samples (each one gallon in a metal can) per 1/2 shift.
1005 404	Liquid Asphalt [Cutback Asphalt - (Medium Curing Type)] MC-70 MC-250 MC-800 MC-3000 for Prime Coat	Per Specifications	Distributor Recom-mended [4]	Certificate of Compliance required and duplicate samples (each one gallon in a metal can) per delivery unit.

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005	Emulsified Asphalt RS-1 CRS-1 RS-2 CRS-2 SS-1 CSS-1 CRS-2P	Per Specifications	Supplier (For pre-approval of material.)	See PPD [3].
		Residue	Distibutor Recom-mended [4]	See PPD [3].
				For preapproved emulsions, Certificate of Compliance required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.
404	for Chip Seal Coat, Tack Coat, and Fog Coat			For emulsions not preapproved, Certificate of Analysis required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.

[3] ADOT Materials Practice and Procedure Directive.

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005 404	Emulsified Asphalt Special Type (Diluted SS-1 or CSS-1) for Tack Coat and Fog Coat	Residue	Distributor Recom-mended [4]	See PPD [3]. For preapproved undiluted emulsions, Certificate of Compliance required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit. For undiluted emulsions not preapproved, Certificate of Analysis required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.

[3] ADOT Materials Practice and Procedure Directive.

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005	Asphalt Cement (PG XX-XX)	Per Specifications		
404	for Tack Coat			Certificate of Compliance required.
416 417	for Asphaltic Concrete		Supplier or Project	A two gallon sample (two full one-gallon metal cans) at least five days prior to start of asphaltic concrete production (for calibration of ignition furnace).
			Circulation Line Recom-mended [4]	
404	for Chip Seal Binder Coat		Distributor Recom-mended[4]	Certificate of Compliance required and duplicate samples (each one gallon in a metal can) per 1/2 shift.
407 409 411 416 417	for Asphaltic Concrete, or ACFC		Circulation Line Recom-mended [4]	

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005		Per Specifications	Supplier (For pre-approval of material)	See PPD [3].
	Emulsified Recycling Agent (ERA) ERA-1 ERA-5 ERA-25 ERA-75	Residue	Distributor Recom-mended [4]	See PPD [3].
				For preapproved ERA, Certificate of Compliance required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.
				For ERA not preapproved, Certificate of Analysis required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.
404	ERA (Diluted) for Fog Coat	Residue	Distributor Recom-mended [4]	See PPD [3].
				For preapproved undiluted ERA, Certificate of Compliance required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.
				For undiluted ERA not preapproved, Certificate of Analysis required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.

[3] ADOT Materials Practice and Procedure Directive.

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005 1009 410	Asphalt Cement (PG XX-XX) for Asphalt - Rubber (Sprayed Applications)	Per Specifications	Delivery Unit or Terminal (if blended at terminal)	Certificate of Compliance required and duplicate samples (each one gallon in a metal can) for each shipment - not less than one set of duplicate samples for each 40 tons.
1005 1009 413 414 415	Asphalt Cement (PG XX-XX) for Asphalt - Rubber for AR-AC or AR-ACFC	Per Specifications	Delivery Unit or Terminal (if blended at terminal) [(4)]	Certificate of Compliance required and duplicate samples (each one gallon in a metal can) per 1/2 shift.
1009	Crumb Rubber for Asphalt - Rubber Type A or Type B	Gradation	Project (or Terminal (if blended at terminal)	Certificate of Compliance required and one sample [approximately 1500 grams (one gallon) per Arizona Test Method 714] per lot per type.
1009 410	Asphalt - Rubber [CRA [(5)]] Type 1, Type 2, or Type 3 (Sprayed Applications)	Per Special Provisions.	Distributor Recom-mended [(4)]	Certificate of Compliance required and a one gallon sample in a metal can per delivery unit.

[(4)] Point of sampling specified by Engineer.

[(5)] CRA = Crumb Rubber Asphalt

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1009 413 414 415	Asphalt - Rubber [CRA [5]] Type 1, Type 2, or Type 3 For AR-AC or AR-ACFC			Certificate of Compliance required.
		Penetration	Circulation Line Recom-mended [4]	Duplicate samples (each one gallon in a metal can) per 1/2 shift.
		Softening Point		
		Resilience		
		Rotational Viscosity		
		Rotational Viscosity (at plant)		One sample (one gallon in a metal can) per batch.
415	for AR-AC		Supplier or Project	A two gallon sample (two full one-gallon metal cans) at least five days prior to start of asphaltic concrete production (for calibration of ignition furnace).
			Circulation Line Recom-mended [4]	

[4] Point of sampling specified by Engineer.

[5] CRA = Crumb Rubber Asphalt

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

TABLE 3 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Emulsified Asphalt for Cold Recycled Asphaltic Concrete HFE-150P HFE-300P	Per Special Provisions.	Supplier (for pre-approval of material.)	See PPD [3].
		Residue	Distibutor Recom-mended [4]	See PPD [3].
				For preapproved emulsions, Certificate of Compliance required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.
				For emulsions not preapproved, Certificate of Analysis required and duplicate samples (each 1/2 gallon in a plastic container) per delivery unit.

[3] ADOT Materials Practice and Procedure Directive.

[4] Point of sampling specified by Engineer.

Note: During production, samples of bituminous material shall be taken by the contractor and witnessed by the Engineer.

TABLE 4 ACCEPTANCE SAMPLING GUIDE FOR PORTLAND CEMENT CONCRETE				
SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
402	Dowel Bar	Epoxy Coating		Certificate of Compliace required for each shipment from the coating manufacturer. Certificate of Anaysis required for each shipment from the coating applicator.
401 1006	Portland Cement Concrete (PCC) Class P	Compressive Strength [1]	Immediately before going into paver or forms, or as otherwise directed by the Engineer.	Five samples per lot.
		Slump		(For compressive strength, one set of three cylinders per sample.)
		Air Content (when Required)		
		Temperature		
		Thickness	Roadway	10 cores per lot.
1006	Portland Cement Concrete (PCC) Class S **(with a compressive strength requirement less than 4,000 psi)**	Compressive Strength [1]	At Discharge [6]	One sample for each 100 CY, or fraction thereof, of continuously placed concrete per day from each batch plant. For daily placements of 10 CY or less, at the discretion of the Engineer.
		Slump		
		Temperature		(For compressive strength, one set of two cylinders per sample.)
		Air Content (when Required)	At Discharge [6]	Sample for air content every 50 CY when elevation is above 3000 ft. For daily placements of 10 CY or less, at the discretion of the Engineer.

[1] Independent Assurance Sampling and Testing required.

[6] Concrete pumped to facilitate placement will be sampled for acceptance at the final point of placement. Samples will be taken during continuous discharge of concrete that has been pumped beyond the pump hopper without interruption at the normal production rate. Where freeze-thaw durability is of concern (such as in bridge decks, overlays, approach slabs, and barrier walls), the concrete shall also be sampled at the truck to determine air loss through the pump. In accordance with Subsection 601-3.03(C), if the loss of air as measured between the supply truck and the point of placement exceeds two percent, the contractor shall employ measures acceptable to the Engineer to reduce the loss of air to less than two percent. If sampling at the point of placement is not practical, as determined by the Engineer, or creates a safety concern, the concrete shall be sampled for acceptance at the truck. When acceptance sampling can only be performed at the truck, the acceptable range of air content of the supplied mix will be adjusted to not less than five percent nor more than eight percent in accordance with Subsection 1006-3.01.

TABLE 4 (continued)
ACCEPTANCE SAMPLING GUIDE FOR PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Portland Cement Concrete (PCC) Class S **(with a compressive strength requirement equal to or greater than 4,000 psi)**	Compressive Strength [1]	At Discharge [6]	One sample for each 50 CY, or fraction thereof, of continuously placed concrete per day from each batch plant. For daily placements of 10 CY or less, at the discretion of the Engineer.
		Slump		
		Temperature		(For compressive strength, one set of three cylinders per sample.)
		Air Content (when Required)	At Discharge [6]	Sample for air content every 50 CY when elevation is above 3000 ft. For daily placements of 10 CY or less, at the discretion of the Engineer.

[1] Independent Assurance Sampling and Testing required.

[6] Concrete pumped to facilitate placement will be sampled for acceptance at the final point of placement. Samples will be taken during continuous discharge of concrete that has been pumped beyond the pump hopper without interruption at the normal production rate. Where freeze-thaw durability is of concern (such as in bridge decks, overlays, approach slabs, and barrier walls), the concrete shall also be sampled at the truck to determine air loss through the pump. In accordance with Subsection 601-3.03(C), if the loss of air as measured between the supply truck and the point of placement exceeds two percent, the contractor shall employ measures acceptable to the Engineer to reduce the loss of air to less than two percent. If sampling at the point of placement is not practical, as determined by the Engineer, or creates a safety concern, the concrete shall be sampled for acceptance at the truck. When acceptance sampling can only be performed at the truck, the acceptable range of air content of the supplied mix will be adjusted to not less than five percent nor more than eight percent in accordance with Subsection 1006-3.01.

TABLE 4 (continued)
ACCEPTANCE SAMPLING GUIDE FOR PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Portland Cement Concrete (PCC) Class B	Compressive Strength [1]	At Discharge [6]	One sample for each 100 CY of concrete placed from each batch plant For daily placements of 10 CY or less, at the discretion of the Engineer.
		Slump		
		Temperature		(For compressive strength, one set of two cylinders per sample.)
		Air Content (when Required)	At Discharge [6]	Sample for air content every 50 CY when elevation is above 3000 ft. For daily placements of 10 CY or less, at the discretion of the Engineer.

[1] Independent Assurance Sampling and Testing required.

[6] Concrete pumped to facilitate placement will be sampled for acceptance at the final point of placement. Samples will be taken during continuous discharge of concrete that has been pumped beyond the pump hopper without interruption at the normal production rate. Where freeze-thaw durability is of concern (such as in bridge decks, overlays, approach slabs, and barrier walls), the concrete shall also be sampled at the truck to determine air loss through the pump. In accordance with Subsection 601-3.03(C), if the loss of air as measured between the supply truck and the point of placement exceeds two percent, the contractor shall employ measures acceptable to the Engineer to reduce the loss of air to less than two percent. If sampling at the point of placement is not practical, as determined by the Engineer, or creates a safety concern, the concrete shall be sampled for acceptance at the truck. When acceptance sampling can only be performed at the truck, the acceptable range of air content of the supplied mix will be adjusted to not less than five percent nor more than eight percent in accordance with Subsection 1006-3.01.

TABLE 4 (continued)
ACCEPTANCE SAMPLING GUIDE FOR PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
601 1006	Portland Cement Structural Concrete for Minor Precast Structures (Manholes, Cattle Guards, Utility Vaults, Catch Basins, Flared Ends, etc.)	Rebound Hammer	At Fabrication Yard	One set of readings per precast unit.
601 1006	Prestressed Concrete	Compressive Strength	At Discharge (6)	One sample per member or for each day's production. (For compressive strength, a minimum of two sets of 3 cylinders for detensioning, and one set of 3 cylinders for 28-day breaks.)
		Slump		
		Temperature		
912	Shotcrete	Compressive Strength	Test Panels	Three cores from a test panel every 100 CY or fraction thereof, per day.
		Slump	At Mixer Discharge	One per 50 CY or fraction thereof, per day.
		Air Content (For Shotcrete placed at an elevation of 3,000 feet or above)	For wet-mix process, just prior to pumping	
			For dry-mix process, from in-place material	
922 1006	Utility Concrete	None		

[6] Concrete pumped to facilitate placement will be sampled for acceptance at the final point of placement. Samples will be taken during continuous discharge of concrete that has been pumped beyond the pump hopper without interruption at the normal production rate. Where freeze-thaw durability is of concern (such as in bridge decks, overlays, approach slabs, and barrier walls), the concrete shall also be sampled at the truck to determine air loss through the pump. In accordance with Subsection 601-3.03(C), if the loss of air as measured between the supply truck and the point of placement exceeds two percent, the contractor shall employ measures acceptable to the Engineer to reduce the loss of air to less than two percent. If sampling at the point of placement is not practical, as determined by the Engineer, or creates a safety concern, the concrete shall be sampled for acceptance at the truck. When acceptance sampling can only be performed at the truck, the acceptable range of air content of the supplied mix will be adjusted to not less than five percent nor more than eight percent in accordance with Subsection 1006-3.01.

TABLE 5
ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH
PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
402	Dowel Bar	Epoxy Coating		Certificate of Compliace required for each shipment from the coating manufacturer. Certificate of Anaysis required for each shipment from the coating applicator.
602 1003	Prestressing Steel (Spiral, Bars, Strand Wire, or Wire)	Tensile Strength	Project or Fabrication Plant	Certificate of Compliance required and one 6 ft. piece from each bar size, heat, reel, or coil.
602 1003	Post-Tensioning Steel	Tensile Strength	Project	Certificate of Compliance required and one 6 ft. piece from each bar size, heat, reel, or coil.
605 1003	Reinforcement Bars (Epoxy Coated or Uncoated)	Yield Strength, Tensile Strength, Bend Test, Elongation, Weight/Foot, and Coating Thickness (if applicable)		
	Phoenix and Tucson Sources		Fabrication Plant or Supplier's Yard	Certificate of Compliance required and samples as per PPD [(3)].
			Project	Certificate of Compliance required and one 7 ft. bar per shipment. See PPD [(3)].
	Other sources		Project	Certificate of Compliance required and samples as per PPD [(3)].
1003	Welded Wire Fabric (Smooth)	Tensile Strength, Diameter, Spelter, Weld Shear, Reduction in Area	Supplier's Yard or Project	Certificate of Compliance required and one 2 ft. x 2 ft. sample per 25 rolls.

[(3)] ADOT Materials Practice and Procedure Directive.

TABLE 5 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH
PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1003	Welded Wire Fabric (Deformed)	Tensile Strength, Weld Shear, Weight/Foot	Supplier's Yard or Project	Certificate of Compliance required and one 4 ft. x 4 ft. sample per 25 sheets.
1006	Admixtures			Certificate of Compliance required and must be on the Department's Approved Products List. See Subsection 1006-2.04.
1006	Curing Compound		Project	For material previously approved,Certificate of Analysis only. See Subsection 1006-6.01.
				For material not previously approved, Certificate of Compliance and a 1/2 gallon sample per lot. See Subsection 1006-6.01.
1006	Fly Ash and Natural Pozzolan			Material supplied from an Approved Material Source. See Subsection 1006-2.01.
1006	Silica Fume			Certificate of Compliance required with each lot. See See Subsection 1006-2.01.

TABLE 5 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Water	Soluble Salts pH	Source	One sample (1 pint in glass container) per source [7].
1006	Hydraulic Cement (All Types)			Material supplied from an Approved Material Source. See Subsection 1006-2.01.
1011	Joint Materials	Per Specifications		Silicone joint sealant must be on the Department's Approved Product List. In addition, a Certificate of Analysis shall accompany each lot or batch of sealant.
				For joint materials other than silicone joint sealant, only a Certificate of Compliance is required.

[7] No sample is necessary if water is potable and comes from a proven source.

TABLE 5 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH
PORTLAND CEMENT CONCRETE

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1013 604	Bearing Pads (Preformed Fabric)	Thickness Compression Load	Project/ Contractor's Yard	Certificate of Analysis required and two sample pads from every 100, or fraction thereof, with a minimum of one sample pad from each lot for each type of pad. (Tested by ADOT.)
1013 604	Bearing Pads (Plain and Fabric Reinforced Elastomeric)	Per Specification Subsection 1013-2	Project/ Contractor's Yard	Certificate of Analysis required and two sample pads from every 100, or fraction thereof, with a minimum of one sample pad from each lot for each type of pad. (Not tested by ADOT) [Tested by Engineer approved testing laboratory. See Subsection 1013-3.01.]
1013 604	Bearing Pads (Steel Reinforced Elastomeric)	Per Specification Subsection 1013-2	Project/ Contractor's Yard	Certificate of Analysis required and two sample pads from every 100, or fraction thereof, with a minimum of one sample pad from each lot for each type of pad.(Not tested by ADOT) [Tested by Engineer approved testing laboratory. See Subsection 1013-3.01.]

TABLE 6 ACCEPTANCE SAMPLING GUIDE FOR STABILIZED SOILS AND BASES				
SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
301	Lime Treated Subgrade	Proctor Density	Roadway	One per soil type, and as needed.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1000 ft.
302	Cement Treated Subgrade	Proctor Density	Roadway	One per soil type, and as needed.
		Optimum Moisture		
		Compaction	Roadway	One per lift per 1000 ft.
304	Cement Treated Base	Proctor Density	Roadway	At start of production then one per week, and as needed.
		Optimum Moisture		
		Compaction	Roadway or Point of Placement	One per lift per 1000 ft.
		Compressive Strength [(1)]		Three random samples per shift. (Three specimens from each sample.)
[(1)] Independent Assurance Sampling and Testing required.				

TABLE 6 (continued)
ACCEPTANCE SAMPLING GUIDE FOR STABILIZED SOILS AND BASES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
305	Lean Concrete Base	Compressive Strength [1]	At Discharge	Four random samples per 4000 SY, minimum four samples per shift.
		Slump		
		Air Content (when required)		
		Thickness	Roadway	Per Specifications.
Refer to Special Provisions	Bituminous Treated Base	See Special Provisions	Roadway	At the discretion of the Engineer.
Refer to Special Provisions	Cement Stabilized Alluvium	Compressive Strength [1]	Roadway or Point of Placement	One set of three per 1500 CY, minimum one set of three per 1/2 shift.
Refer to Special Provisions	Soil-Cement Bank Protection	Compressive Strength [1]	Roadway or Point of Placement	One set of three per 1500 CY, minimum one set of three per 1/2 shift.

[1] Independent Assurance Sampling and Testing required.

TABLE 7
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MIXTURES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
407	Asphaltic Concrete Friction Course (ACFC)	% Asphalt (1) Moisture Content (1)	Trucks at Mixing Plant	4 per shift.
409	Asphaltic Concrete (Miscellaneous Structural) [For Special Mix, see below]	% Asphalt Moisture Content Rice Marshall Density	Roadway	At the discretion of the Engineer.
409	Asphaltic Concrete (Miscellaneous Structural - Special Mix)	% Asphalt (1) Moisture Content (1) Rice (1) Marshall Density (1) Gradation (1)	Roadway	One sample per 500 tons.
411	Asphaltic Concrete Friction Course (ACFC) - Miscellaneous	% Asphalt Moisture Content	Trucks at Mixing Plant	At the discretion of the Engineer.
413	Asphaltic Concrete (Asphalt – Rubber) [AR-AC]	% Asphalt-Rubber (1) Moisture Content (1)	Roadway	4 per shift.

(1) Independent Assurance Sampling and Testing required.

TABLE 7 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MIXTURES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
414	Asphaltic Concrete Friction Course (Asphalt – Rubber) [AR-ACFC]	% Asphalt-Rubber (1)	Trucks at Mixing Plant	4 per shift.
		Moisture Content (1)		
415	Asphaltic Concrete (Asphalt-Rubber) - End Product [AR-AC]	% Asphalt-Rubber (1)	Roadway	4 per lot.
		Moisture Content (1)		
		Gradation (1)		
		Marshall Density (1)		
		Rice (1)		
		Compaction	Roadway	20 cores per lot (10 locations/2 cores per location).

(1) Independent Assurance Sampling and Testing required.

TABLE 7 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MIXTURES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
416	Asphaltic Concrete - End Product [For mixes containing reclaimed asphalt pavement (RAP), see PPD [3].]	% Asphalt [1]	Roadway	4 per lot.
		Moisture Content [1]		
		Gradation [1]		
		Marshall [1] [Density, Stability, and Flow]		
		Rice [1]		
		Compaction, unless otherwise specified. (Courses > 1½ inch in nominal thickness)	Roadway	20 cores per lot (10 locations/2 cores per location).

[1] Independent Assurance Sampling and Testing required.

[3] ADOT Materials Practice and Procedure Directive.

TABLE 7 (continued)
ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MIXTURES

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
417	Asphaltic Concrete (End Product) SHRP Volumetric Mix [For mixes containing reclaimed asphalt pavement (RAP), see PPD [3].]	% Asphalt [1]	Roadway	4 per lot.
		Moisture Content [1]		
		Gradation [1]		
		Gyratory Density [1]		
		Rice [1]		
		Compaction (Courses > 1½ inch in nominal thickness)	Roadway	20 cores per lot (10 locations/2 cores per location).
Refer to Special Provisions	Asphaltic Concrete - Miscellaneous Paving			Tested at the discretion of the Engineer.

[1] Independent Assurance Sampling and Testing required.

[3] ADOT Materials Practice and Procedure Directive.

TABLE 8
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
301 503 913 1010	Lime (for use in soil stabilization, mortar, and grout)	Chemical and Physical		See PPD [3].
407 409 411 413 414 415 416 417	Hydrated Lime (for use as mineral admixture in asphaltic concrete mixes)			Material supplied from an Approved Material Source. See PPD [3].
302 304 501 503 505 601 602 912 913 1010	Hydraulic Cement (for use in soil stabilization, mortar, and grout)	Chemical and Physical		See PPD [3].
407 409 411 413 414 415 416 417	Portland Cement and Blended Hydraulic Cement (for use as mineral admixture in asphaltic concrete mixes)			Material supplied from an Approved Material Source. See PPD [3].

[3] ADOT Materials Practice and Procedure Directive.

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
501	Corrugated Metal Pipe (CMP) [Coated or Non-coated]			Certificate of Compliance required.
501 1006	Non-Reinforced, Cast-in-Place Concrete Pipe	Compressive Strength	At Discharge [6]	Per Specifications.
		Slump		
		Air Content (when required)		
		Temperature		
		Wall Thickness	Site	
501 1010	Precast Reinforced or Non-Reinforced Concrete Pipe	Compression (D-Load)	Supplier's Yard	Certificate of Compliance required and one sample for each 100 sections per size per type.
		Wall Thickness		
Refer to Special Provisions	Vitrified Clay Pipe	Compression	Project	One sample for each 100 sections per size per type.
505	Brick for Manholes	Compression	Project	One sample (6 bricks of like kind and size) per project.

[6] Concrete pumped to facilitate placement will be sampled for acceptance at the final point of placement. Samples will be taken during continuous discharge of concrete that has been pumped beyond the pump hopper without interruption at the normal production rate. Where freeze-thaw durability is of concern (such as in bridge decks, overlays, approach slabs, and barrier walls), the concrete shall also be sampled at the truck to determine air loss through the pump. In accordance with Subsection 601-3.03(C), if the loss of air as measured between the supply truck and the point of placement exceeds two percent, the contractor shall employ measures acceptable to the Engineer to reduce the loss of air to less than two percent. If sampling at the point of placement is not practical, as determined by the Engineer, or creates a safety concern, the concrete shall be sampled for acceptance at the truck. When acceptance sampling can only be performed at the truck, the acceptable range of air content of the supplied mix will be adjusted to not less than five percent nor more than eight percent in accordance with Subsection 1006-3.01.

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Paving Brick	Compression Absorption	Project	One sample (6 paving bricks of like kind and size) per project.
Refer to Special Provisions	Cinder Block	Compression Absorption	Project	One sample (6 cinder blocks of like kind and size) per project.
Refer to Special Provisions	Slump Block	Compression Absorption	Project	One sample (6 slump blocks of like kind and size) per project.
601	Vertical Restrainer	Tensile	Project	1 test loop/40 assembly per type 1 , and Certificate of Analysis required.
604 731 1004 1012	High Strength Bolts, Nuts, Washers, or Anchor Bolts	Rockwell Hardness Wedge Tensile Strength	Project	Certificate of Analysis required and three samples per lot, or 0.1% of lots in excess of 3000, for each bolt diameter, including nuts and washers.
608 1007	Retroreflective Sheeting	Per Specifications		Certificate of Compliance required and also must be on the Department's Approved Products List
608	Sign Panel Silk-Screened Characters			Certificate of Compliance required.

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
704 708 709	Glass Beads	Roundness Gradation Refractive Index Moisture Resistance Heavy Metal Concentration (if required)	Supplier's Yard (Recom-mended) or Project	See PPD [3]. = = = = = = = = = = = = = = = = = = For other than Dual Component Pavement Markings: - Certificate of Compliance required*, and if preapproved, a copy of the Central Lab test results. - If <u>not</u> preapproved by Central Lab, Certificate of Compliance required*, and a gallon sample when material is supplied in a "super sack." - *If required, a Certificate of Analysis must also be submitted (certifying that the Heavy Metal Concentration meets the specifications). = = = = = = = = = = = = = = = = = = For Dual Component Pavement Markings: - Certificate of Analysis required**, and if preapproved, a copy of the Central Lab test results. - If <u>not</u> preapproved by Central Lab, Certificate of Analysis required**, and a gallon sample when material is supplied in a "super sack. - **The Certificate of Analysis shall also include a Material Safety Data Sheet (MSDS).

[3] ADOT Materials Practice and Procedure Directive.

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
704	Thermoplastic Pavement Markings	Per Specifications	Manufac-turer	For precertification, the manufacturer shall prepare a metal can powder sample per specifications.
			Project	Certificate of Compliance and a copy of the Central Materials Chemistry Lab test results are required. Also must be on the Department's Approved Products List.
				In-place field verification checks for thickness or sampling for composite testing will be made at the discretion of the Engineer . Material shall be sampled utilizing a 4 inch x 12 inch galvanized sheet metal plate without additional application of glass beads.
705	Preformed Plastic Pavement Marking			Certificate of Compliance required*, and also must be on the Department's Approved Products List. *A Certificate of Analysis is also required (certifying that the Heavy Metal Concentration of the glass beads meets the specifications).

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
706	Raised Pavement Markers	Per Specifications	Project	Certificate of Compliance required for markers and adhesive.
				Adhesive must be on the Department's Approved Products List.
				For non-reflective pavement markers, one sample (one marker) per lot per type.
				For reflective pavement markers, one sample (three markers) per lot per type.
708	Permanent Pavement Markings (Painted)	Per Specifications	Supplier, Contractor, or Manufac-turer	For precertification: The Supplier, Contractor, or Manufacturer shall prepare a one-gallon powder sample per specifications.
			Project	Certificate of Compliance and a copy of the Central Materials Chemistry Lab test results are required.
				Check-samples of finished paint while being applied, at intervals determined by the Engineer.

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
709	Dual Component Pavement Markings	Per Specifications	Project	Certificate of Analysis required and must be on the Department's Approved Projects List. Random spot checks for thickness.
732	Polyvinyl Chloride (PVC) Pipe for Electrical Conduit	Resistance to Crushing	Project	One sample per 5000 ft.
808	Polyvinyl Chloride (PVC) Pipe for Water	Wall Thickness Burst Pressure Diameter	Project	One sample per 10,000 ft.
902	Chain Link Fabric			Certificate of Compliance required.
902	Fence Post and Rails			Certificate of Compliance required.
902 903	Miscellaneous Fence Hardware			Certificate of Compliance required.
902 903	Post Clips, Hog Rings, Tie Wire, or Tension Wire			Certificate of Compliance required.

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
903	Barbed Wire or Barbless Wire	Tensile Strength Spelter Diameter	Supplier's Yard or Project	Certificate of Compliance[8] required and one 4 ft. sample per 50 rolls.
903	Fence Stays			Certificate of Compliance required.
903	T-Post	Weight/Foot Length	Supplier's Yard or Project	Certificate of Compliance[8] required and one post per 500 posts, or fraction thereof, per lot.
903	Woven Wire Fabric	Spelter Diameter Tensile Strength	Supplier's Yard or Project	Certificate of Compliance[8] required and one sample [3 feet long, the full height (width) of the fabric] per 50 rolls.
904 913	Wire Rope			Certificate of Compliance required.

[8] Certifying that manufacturing processes and application of coating occurred in the United States. (This certification required for Federal-Aid projects only. See Special Provisions for exception based on quantity being used.)

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1002	Paint	Per Specifications	Project	Paint for use on structural steel and other metallic surfaces: - Certificate of Compliance is required and the system must be on the Department's Approved Products List. = = = = = = = = = = = = = = = = = =
			= = = = = = = =	Paint for use on concrete or masonry surfaces: -
			Supplier or Contractor	A sample (one quart in a metal can) of the material from each batch must be submitted to Central Lab for testing prior to use. -
			Project	Certificate of Compliance and a copy of the Central Materials Chemistry Lab test results are required. Also must be on the Department's Approved Products List. = = = = = = = = = = = = = = = = = =
			= = = = = = = =	Paint for use on other than structural steel and other metallic surfaces, concrete surfaces, or masonry surfaces: -
			Project	Certificate of Compliance is required and one sample (one quart in a metal can) per batch submitted to Central Lab for testing.

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1012	Guardrail Elements			Certificate of Compliance required.
1012	Guardrail Fasteners	Rockwell Hardness	Project	For other than High Strength Anchor Bolts, Certificate of Compliance required and three samples per lot, or 0.1% of lots in excess of 3000, for each bolt diameter, including nuts and washers.
		Tensile Strength		For High Strength Anchor Bolts, see Page 51.
1012	Guardrail Posts and Blocks	None		Certificate of Compliance required.
				For timber guardrail posts and blocks, see PPD [3].

[3] ADOT Materials Practice and Procedure Directive.

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1014	Geosynthetics		Supplier and Project	If material has been preapproved, Certificate of Compliance required and one sample for every 10 rolls per lot. (Minimum of one sample per lot.) Samples shall not be taken within 5 feet from either end of the roll, and shall be at least 6 feet long by the full width of the roll.
			Project	If material has not been preapproved, Certificate of Analysis required and one sample for every 10 rolls per lot. (Minimum of one sample per lot.) Samples shall not be taken within 5 feet from either end of the roll, and shall be at least 6 feet long by the full width of the roll.
NOTE: Information on Geosynthetics continued on next page.				

TABLE 8 (continued)
ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS MATERIALS

SPECIFI-CATION SECTION	MATERIAL	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
NOTE: Information on Geosynthetics continued from previous page.				
1014 412	Pavement Fabric	Per Specification Subsection 1014-2		
1014 306	Geogrid	Per Specification Subsection 1014-3		
1014 208	Separation Geotextile Fabric	Per Specification Subsection 1014-4		
1014 913	Bank Protection Fabric	Per Specification Subsection 1014-5		
1014 203	Geocomposite Wall Drain System	Per Specification Subsection 1014-6		
1014 307	Geocomposite Edge Drain System	Per Specification Subsection 1014-7		
208	Geomembrane	See Special Provisions.		

Appendix E

Example Material Identification Codes

Material codes and type codes are used to identify what a material is used for. Each code combination in each line below makes up an individual Material Code allowed to be used on the Project. For example, the Material Code for Aggregate Base Class 2 is: AB-2. The Material Code for Decomposed Granite is: DG.

Soils, Aggregates, Stabilized Soils and Bases

The source of the material (supplier or segment) should also be document.

Portland Cement Concrete

Portland cement concrete mixes should be identified by mix design and plant number.

Hot-Mix Asphalt Concrete

Hot-mix asphalt cement concrete mixes should be identified by mix design and plant number.

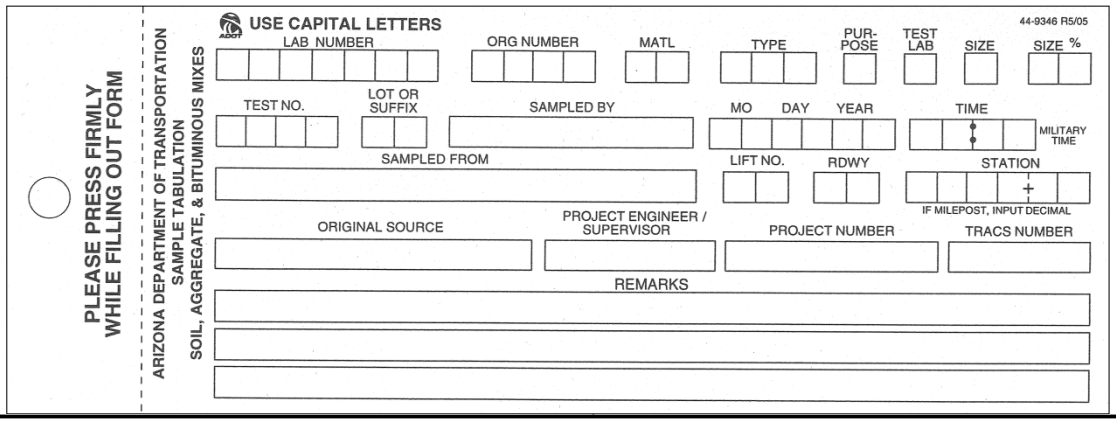
Material Code Combinations			
Material	Code	Type	Code
Admix	AD		
Aggregate	AG	Bituminous Treated Base	BB
Aggregate	AG	Cement Treated Base	CB
Aggregate	AG	Cement Treated Subgrade	CS
Aggregate	AG	Lean Concrete Base	LC
Aggregate	AG	Lime Treated Subgrade	LS
Aggregate	AG	Road Mix	RM
Aggregate	AG	Soil Cement	SC
Aggregate Base	AB	Class 1	1
Aggregate Base	AB	Class 2	2
Aggregate Base	AB	Class 3	3
Aggregate Subbase	AS	Class 4	4
Aggregate Subbase	AS	Class 5	5
Aggregate Subbase	AS	Class 6	6
Arrestor Bed Aggregate	AA		
Asphaltic Concrete	AC	1/2" Asphaltic Concrete	12
Asphaltic Concrete	AC	1/2" Fine Band 417 AC	12F
Asphaltic Concrete	AC	1/2" Coarse Band 417 AC	12K
Asphaltic Concrete	AC	3/4" Asphaltic Concrete	34

Material Code Combinations			
Material	Code	Type	Code
Asphaltic Concrete	AC	3/4" Fine Band 417 AC	34F
Asphaltic Concrete	AC	3/4" Coarse Band 417 AC	34K
Asphaltic Concrete	AC	Asphaltic Concrete Friction Course (ACFC)	FC
Asphaltic Concrete	AC	Asphalt-Rubber Asphaltic Concrete (AR-AC)	RD
Asphaltic Concrete	AC	Asphalt-Rubber Asphaltic Concrete Friction Course (AR-ACFC)	RF
Asphaltic Concrete	AC	Base Mix	BM
Asphaltic Concrete	AC	Bituminous Treated Base	BB
Asphaltic Concrete	AC	AZ409 Miscellaneous Structural	409MI
Asphaltic Concrete	AC	AZ409 Miscellaneous Structural (Special Mix)	409SP
Asphaltic Concrete	AC	Other	OT
Asphaltic Concrete	AC	Recycled Asphaltic Concrete	RC
Asphaltic Concrete	AC	Road Mix	RM
Asphaltic Concrete Friction Course (ACFC)	FC		
Asphalt-Rubber Asphaltic Concrete (AR-AC)	RD		
Asphalt-Rubber Asphaltic Concrete Friction Course (AR-ACFC)	RF		
Backfill	BF	Aluminum Pipe	AP
Backfill	BF	Concrete Pipe	CP
Backfill	BF	Metal Pipe	MP
Backfill	BF	Plastic Pipe	PP
Backfill	BF	Slurry	SL
Backfill	BF	Special	SP
Backfill	BF	Trench	TR
Bedding Material	BM	Concrete Pipe	CP
Bedding Material	BM	Corrugated Metal Pipe	MP
Bedding Material	BM	PVC Pipe	PV
Bedding Material	BM	Slurry	SL
Blotter Material	BL		
Borrow	BW		
Cement Stabilized Alluvium	CS		
Coarse Aggregate	CA	Size 1	1

Material Code Combinations			
Material	Code	Type	Code
Coarse Aggregate	CA	Size 2	2
Coarse Aggregate	CA	Size 3	3
Coarse Aggregate	CA	Size 4	4
Coarse Aggregate	CA	Size 5	5
Coarse Aggregate	CA	Size 6	6
Coarse Aggregate	CA	Size 7	7
Coarse Aggregate	CA	Size 8	8
Coarse Aggregate	CA	Size 9	9
Coarse Aggregate	CA	Size 10	10
Coarse Aggregate	CA	Size 24	24
Coarse Aggregate	CA	Size 56	56
Coarse Aggregate	CA	Size 57	57
Coarse Aggregate	CA	Size 67	67
Coarse Aggregate	CA	Size 68	68
Coarse Aggregate	CA	Size 78	78
Coarse Aggregate	CA	Size 89	89
Coarse Aggregate	CA	Size 357	357
Coarse Aggregate	CA	Size 467	467
Coarse Aggregate	CA	Composite Samples	NA
Cover Material	CM		
Crash Barrel Sand	CB		
Decomposed Granite	DG		
Embankment	EM		
Embankment	EM	Requiring 95% Compaction	95
Embankment	EM	Requiring 100% Compaction	100
Entrained Air (Air Content)	ET		
Filter Material	FM		
Fine Aggregate	FA		
Fly Ash	FF		
Granite Mulch	GM		
Granulated (Crumb) Rubber	GR		
Grout	GT		
Maintenance	MT		
Membrane Seal	MS		
Mineral Aggregate	MA		
Mineral Aggregate	MA	½” Asphaltic Concrete	12
Mineral Aggregate	MA	½” Fine Band 417 AC	12F
Mineral Aggregate	MA	½” Coarse Band 417 AC	12K
Mineral Aggregate	MA	¾” Asphaltic Concrete	34

Material Code Combinations			
Material	Code	Type	Code
Mineral Aggregate	MA	¾" Fine Band 417 AC	34F
Mineral Aggregate	MA	¾" Coarse Band 417 AC	34K
Mineral Aggregate	MA	AZ409 Miscellaneous Structural	409MI
Mineral Aggregate	MA	AZ409 Misc. Structural Special Mix	409SP
Mineral Aggregate	MA	Asphaltic Concrete Friction	FC
		Course (ACFC)	
Mineral Aggregate	MA	Asphalt-Rubber Asphaltic	RD
		Concrete (AR-AC)	
Mineral Aggregate	MA	Asphalt-Rubber Asphaltic	RF
		Concrete Friction Course	
		(AR-ACFC)	
Mineral Aggregate	MA	Base Mix	BM
Mineral Aggregate	MA	Other	OT
Mineral Aggregate	MA	Recycled Asphaltic Concrete	RC
Mechanically Stabilized Earth	ME	Reinforced Zone Material	R1
Mechanically Stabilized Earth	ME	Retained Zone Material	R2
Natural Ground	NG		
Natural Ground	NG	Requiring 95% Compaction	95
Other	OT		
Pipe Plating	PM		
Pneumatically Placed Mortar	NM		
Reclaimed Asphalt Pavement	RP	Coarse	C
Reclaimed Asphalt Pavement	RP	Fine	F
Reclaimed Asphalt Pavement	RP	Other	O
Rip Rap	RR		
Rock Mulch	RM		
Slurry	SL	3/8" Aggregate	38
Slurry	SL	#4 Aggregate	4
Structure Backfill	SB		
Subgrade	SG		
Subgrade	SG	Requiring 95% Compaction	95
Subgrade	SG	Requiring 100% Compaction	100
Subgrade Seal	SS		
Top Soil	TS		
Water	HO		
Winter Cinders	WC		

Example Sample Ticket



Purpose Codes:

A	Acceptance
M	Miscellaneous
C	Control
P	Independent Assurance
I	Informational

Testing Lab Codes:

C	Central Lab
R	Regional Lab
P	Project Lab

Size Codes – Stockpiles:

B	Blend
F	Fine
I	Intermediate
C	Coarse
K	Coarsest

Roadway Codes:

NB	Northbound
SB	Southbound
EB	Eastbound
WB	Westbound
RA	Ramp A
RB	Ramp B, etc.
FR	Frontage Road
XR	Crossroad

Bins:

9	Composite of Bins
1	Bin #1
2	Bin #2, etc.

Appendix F

Owner Verification Levels of Testing Verification

Level 1 **Level 2** **Level 3**

Soils

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
SOILS (For this Material Category, the Level 1 Analysis uses α = 0.01)			
Embankment (any depth)	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
Embankment for Metal Pile	pH	ARIZ 236c	**3**
	Resistivity	ARIZ 236c	**3**
Natural Ground below Embankment	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
Subgrade	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
Subgrade top 3' Subgrade Acceptance Chart	Gradation (-#200 only)	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**
Soil for Shoulder Build-up	Gradation	ARIZ 201c	**3**
	PI	AASHTO T-89 & T-90	**3**
	pH	ARIZ 236c	**3**
	Soluble Salts	ARIZ 237b	**3**
	Compaction	ARIZ 230a or 235	**1**
Trench Backfill	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
Granite Mulch	Gradation	ARIZ 201c	**3**

Decomposed Granite	Gradation	ARIZ 201c	**3**
Top Soil	Gradation	ARIZ 201c	**3**
	PI	AASHTO T-89 & T-90	**3**
	pH	ARIZ 236c	**3**
	Soluble Salts	ARIZ 237b	**3**
	Calcium Carbonate	AASHTO T-217	**3**
	Exchangeable Sodium in % & ppm	ARIZ 729	**3**

Aggregates

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
AGGREGATES (For this Material Category, the Level 1 Analysis uses α = 0.01)			
Structure Backfill or Pipe Backfill	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
	Resistivity	ARIZ 236c	**3**
	pH	ARIZ 236c	**3**
	Gradation	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**
Aggregate Base Class 1, Class 2, and Class 3	Abrasion	AASHTO T-96	**3**
	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Gradation	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**
Aggregate Subbase Class 4, Class 5, and Class 6	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
Class 4	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Gradation	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**
	Abrasion	AASHTO T-96	**3**
Class 5 and Class 6	Gradation	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**

Aggregate for Cement Treated Base or Lean Concrete Base	Gradation	ARIZ 201c	**2**
	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Abrasion	AASHTO T-96	**3**
for Cement Treated Base	PI	AASHTO T-89 & T-90	**2**
for Lean Concrete Base	Sand Equivalent	ARIZ 242a	**3**
Cover Material	Abrasion	AASHTO T-96	**3**
	Bulk O.D. Specific Gravity	ARIZ 210	**3**
	Percent Carbonates	ARIZ 238	**3**
	Dry Unit Weight	AASHTO T-19	**3**
	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Flakiness Index	ARIZ 233	**3**
	Gradation	ARIZ 201c	**3**
	Moisture Content	AASHTO T-265	**3**
Blotter Material	Gradation	ARIZ 201c	**3**
Mineral Aggregate for Micro-Surfacing	Abrasion	AASHTO T-96	**3**
	Percent Carbonates	ARIZ 238a	**3**
	Gradation	ARIZ 201c	**3**
	Sand Equivalent	ARIZ 242a	**3**
	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Uncompacted Void Content	ARIZ 247	**3**
	Moisture Content	AASHTO T-265	**3**
Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC)	Abrasion	AASHTO T-96	**3**
	Percent Carbonates	ARIZ 238a	**3**
	Specific Gravity	ARIZ 210b	**3**
	Sand Equivalent	ARIZ 242a	**2**
	Flakiness Index	ARIZ 233	**3**
	Fractured Coarse Aggregate Particles	ARIZ 212	**3**
	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete Friction Course (Miscellaneous Structural)	Abrasion	AASHTO T-96	**3**
	Percent Carbonates (if required)	ARIZ 238a	**3**
	Sand Equivalent	ARIZ 242a	**3**

		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Gradation	ARIZ 201c	**3**
Mineral Aggregate for Asphaltic Concrete Friction Course (Miscellaneous Structural - Special Mix)		Abrasion	AASHTO T-96	**3**
		Percent Carbonates (if required)	ARIZ 238a	**3**
		Sand Equivalent	ARIZ 242a	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Gradation	ARIZ 201c	**3**
Mineral Aggregate for Asphaltic Concrete Friction Course (ACFC) - Miscellaneous		Abrasion	AASHTO T-96	**3**
		Sand Equivalent	ARIZ 242a	**3**
		Flakiness Index	ARIZ 233	**3**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Gradation	ARIZ 201c	**3**
Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) [AR-AC]		Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
		Specific Gravity	ARIZ 210b	**3**
		Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete Friction Course (Asphalt-Rubber)[AR-ACFC]		Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
		Specific Gravity	ARIZ 210b	**3**
		Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Flakiness Index	ARIZ 233	**3**
		Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete (Asphalt-Rubber) - End Product [AR-AC]	Source or Stockpile	Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
	Stockpile	Sand Equivalent	ARIZ 242a	**3**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Ignition Furnace Calibration	ARIZ 427	**3**

	Cold Feed or Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
	Mix	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete - End Product [without RAP]	Source or Stockpile	Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
	Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Ignition Furnace Calibration	ARIZ 427	**3**
	Cold Feed or Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
	Mix	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete - End Product [with RAP]	Source or Stockpile	Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
	Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Ignition Furnace Calibration	ARIZ 427	**3**
	Individual RAP Stockpiles	Gradation	ARIZ 201c	**2**
		Binder Content	ARIZ 427	**3**
		Moisture Content	ARIZ 427	**3**
	Cold Feed or Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
	Mix	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete- End Product (SHRP)[without RAP]	Sourceor Stockpile	Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
	Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Ignition Furnace Calibration	ARIZ 427	**3**

	Cold Feed or Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
	Mix	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete - End Product (SHRP) [with RAP]	Source or Stockpile	Abrasion	AASHTO T-96	**3**
		Percent Carbonates	ARIZ 238a	**3**
	Stockpile	Sand Equivalent	ARIZ 242a	**3**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
		Ignition Furnace Calibration	ARIZ 427	**3**
	Individual RAP Stockpiles	Gradation	ARIZ 201c	**2**
		Binder Content	ARIZ 427	**2**
		Moisture Content	ARIZ 427	**3**
	Cold Feed or Stockpile	Sand Equivalent	ARIZ 242a	**2**
		Fractured Coarse Aggregate Particles	ARIZ 212	**3**
		Uncompacted Void Content	ARIZ 247a	**3**
	Mix	Gradation	ARIZ 201c	**2**
Mineral Aggregate for Asphaltic Concrete - Miscellaneous Paving		Abrasion	AASHTO T-96	**3**
		Sand Equivalent	ARIZ 242a	**3**
		Gradation	ARIZ 201c	**3**
Bedding Material for Pipe		Gradation	ARIZ 201c	**2**
		PI	AASHTO T-89 & T-90	**2**
		pH	ARIZ 236c	**3**
		Resistivity	ARIZ 236c	**3**
		Proctor Density	ARIZ 225a or 245	**3**
		Optimum Moisture	ARIZ 225a or 245	**3**
		Compaction	ARIZ 230a or 235	**1**
Filter Material for Perforated Pipe		Gradation	ARIZ 201c	**2**
Plating Material for Pipe Ends		Gradation	ARIZ 201c	**3**
		PI	AASHTO T-89 & T-90	**3**
		Proctor Density	ARIZ 225a or 245	**3**

	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**3**
Crash Barrel Sand	Gradation	ARIZ 201c	**3**
	Dry Unit Weight	AASHTO T-19	**3**
	Moisture Content	AASHTo T-265	**3**
Bedding Material for PVC Irrigation Pipe	Gradation	ARIZ 201c	**3**
Rock for Wire Tied Riprap, Gabions, Slope Mattress, Rail Bank Protection	Specific Gravity	ARIZ 210b	**3**
	Gradation (Visual)	Visual	**3**
Rock for Grouted Riprap & Dumped Riprap	Specific Gravity	ARIZ 210b	**3**
	Gradation	ARIZ 201c	**3**
Fine Aggregate for Portland Cement Concrete (PCC) Classes P, S, & B	Gradation	ARIZ 201c	**2**
	Sand Equivalent	ARIZ 242a	**2**
	Organic Impurities	AASHTO T-21	**3**
	Mortor Strength	AASHTO T-176	**3**
	Deleterious Substances	AASHTO T-112 & T-113	**3**
Coarse Aggregate for Portland Cement Concrete (PCC) Classes P, S, & B	Gradation	ARIZ 201c	**2**
	Abrasion	AASHTO T-96	**3**
	Deleterious Substances	AASHTO T-112 & T-113	**3**
	Fractured Coarse Aggregate Particles		**3**
Aggregate for Arrestor Bed	Abrasion	AASHTO T-96	**3**
	Specific Gravity	ARIZ 210b	**3**
	Gradation	ARIZ201c	**2**
	Fractured Coarse Aggregate Particles	ARIZ 212	**2**
	Flakiness Index	ARIZ 233c	**3**
Aggregate for Soil-Cement or Cement Stabilized Alluvium	Gradation	ARIZ 201c	**2**
	PI	AASHTO T-89 & T-90	**2**

Bituminous

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
BITUMINOUS MATERIAL (NOT MIXES)			
Recycling Agent	Per Specifications	Certificate of Compliance	**3**
Liquid Asphalt (Cutback Asphalt -Medium Curing) for Prime Coat	Per Specifications	Certificate of Compliance	**3**
	Per Specifications	Certificate of Compliance	**3**
Emulsified Asphalt for Chip Seal	Per Specifications	Certificate of Compliance	**3**
	Residue	ARIZ 504	**3**
	Per Specifications	Certificate of Compliance	**3**
Emulsified Asphalt for Tack Coat and Fog Coat	Per Specifications	Certificate of Compliance	**3**
	Residue	ARIZ 504	**3**
	Per Specifications	Certificate of Compliance	**3**
Asphalt Cement PG XX-XX)	Per Specifications	Certificate of Compliance	**2**
for Tack Coat	Per Specifications	Certificate of Compliance	**3**
for Asphaltic Concrete	Per Specifications	Certificate of Compliance	**2**
for Asphaltic Concrete or ACFC	Per Specifications	Certificate of Compliance	**2**
Emulsified Recycling	Per Specifications	Certificate of Compliance	**3**
	Residue	ARIZ 504	**3**
ERA	Residue	ARIZ 504	**3**
for Fog Coat	Per Specifications	Certificate of Compliance	**3**
Asphalt Cement (PG XX-XX) for Asphalt -Rubber (Sprayed Applications)	Per Specifications	Certificate of Compliance	**2**
Asphalt Cement (PG XX-XX) for Asphalt - Rubber for AR-AC or AR-ACFC	Per Specifications	Certificate of Compliance	**2**

Crumb Rubber for Asphalt - Rubber Type A or Type B	Gradation	ARIZ 714	**3**
Asphalt - Rubber [CRA (5)] Type 1, Type 2, or Type 3 (Sprayed Applications)	Per Specifications	Certificate of Compliance	**3**
Asphalt - Rubber [CRA (5)] Type 1, Type 2, or Type 3 For AR-AC or AR-ACFC	Penetration	ASTM D5	**3**
	Softening Point	ASTM D36	**2**
	Resilience	ASTM D5329	**2**
	Rotational Viscosity	AASHTO T-316	**3**
	Rotational Viscosity (at plant)	AASHTO T-316	**3**

Portland Cement Concrete

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
PORTLAND CEMENT CONCRETE (For this Material Category, the Level 1 Analysis uses α = 0.025)			
Portland Cement Concrete Pavement (PCCP) Class P	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Temperature	ASTM C1064	**3**
	Air Content (when Required)	AASHTO T-152	**2**
	Thickness	AASHTO T-148 & ARIZ 317a	**1**
Portland Cement Structural Concrete Class S and B	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Temperature	ASTM C1064	**3**
	Air Content (when Required)	AASHTO T-152	**2**
Portland Cement Concrete (PCC) Class S (with a compressive strength req't equal to or greater than 4,000 psi)	Compressive Strength	ARIZ 314b	**1**
	Slump/Spread (for SCC)	AASHTO T-119	**2**
	Temperature	ASTM C1064	**3**
	Air Content (when Required)	AASHTO T-152	**2**
Portland Cement Concrete (PCC) Class B	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Temperature	ASTM C1064	**3**
	Air Content (when Required)	AASHTO T-152	**2**
Portland Cement Structural Concrete for Minor Precast Structures	Rebound Hammer	ASTM C805	**3**
Prestressed Concrete	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Temperature	ASTM C1064	**3**
Shotcrete	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Air Content	ASTM C1064	**3**

Materials Used With Portland Cement Concrete

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
MATERIALS USED WITH PORTLAND CEMENT CONCRETE			
Prestressing Steel (Spiral, Bars, Strand Wire, or Wire)	Tensile Strength	AASHTO M203 & M204	**3**
Post-Tensioning Steel	Tensile Strength	AASHTO M203 & M204	**3**
Reinforcement Bars	Tensile Strength	AASHTO M31	**3**
Welded Wire Fabric (Smooth)	Per Specifications	Certificate of Compliance	**Inspection**
Welded Wire Fabric (Deformed)	Per Specifications	Certificate of Compliance	**Inspection**
Admixtures	Per Specifications	Certificate of Compliance	**Inspection**
Curing Compound	Per Specifications	Certificate of Compliance	**Inspection**
Curing Compound	Water Loss		**Inspection**
	% Solids		**Inspection**
Fly Ash and Natural Pozzolan	Per Specifications	Certificate of Compliance	**Inspection**
Silica Fume	Per Specifications	Certificate of Compliance	**Inspection**
Water	Soluble Salts	AASHTO T-26	**Inspection**
	pH	AASHTO T-26	**Inspection**
Hydraulic Cement	Per Specifications	Certificate of Compliance	**Inspection**
Hydraulic Cement (All Type)	Chemical & Physical	ASTM C465 & ASTM C595	**Inspection**
Joint Materials	Per Specifications	Certificate of Compliance	**Inspection**
Bearing Pads (All Type)	Thickness	Measurement	**3**
	Compression Load	Certificate of Analysis	**3**

Stabilized Soils and Bases

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
STABILIZED SOILS & BASES (For this Material Category, the Level 1 Analysis uses α = 0.01)			
Lime Treated Subgrade	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
Cement Treated Subgrade	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
Cement Treated Base	Proctor Density	ARIZ 225a or 245	**3**
	Optimum Moisture	ARIZ 225a or 245	**3**
	Compaction	ARIZ 230a or 235	**1**
	Compressive Strength	ARIZ 241a	**1**
Lean Concrete Base	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Air Content (when required	AASHTO T-152	**2**
	Thickness	AASHTO T-148	**1**
Cement Stabilized Alluvium	Compressive Strength	ARIZ 314b	**1**
Soil-Cement Bank Protection	Compressive Strength	ARIZ 314b	**1**

Bituminous Mixtures

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
BITUMINOUS MIXTURES (For this Material Category, the Level 1 Analysis uses α = 0.025)			
Asphaltic Concrete Friction Course [ACFC] (407)	% Asphalt	ARIZ 421	**3**
	Moisture Content	ARIZ 406c	**3**
Asphaltic Concrete [AC] Marshall Mixes Misc. Structural (409 & 409 Special)	% Asphalt	ARIZ 427	**1**
	Moisture Content	ARIZ 406c	**3**
	Rice	ARIZ 417d	**2**
	Lab Density (Marshall), Stab, Flow	ARIZ 410e	**2**
	Gradation (only 409 Special)	ARIZ 427	**2**
Asphaltic Concrete Friction Course [ACFC] - Misc. (411)	% Asphalt	ARIZ 421	**3**
	Moisture Content	ARIZ 406c	**3**
Asphaltic Concrete (Asphalt-Rubber) [AR-AC] (413)	% Asphalt Rubber	ARIZ 421	**3**
	Moisture Content	ARIZ 406c	**3**
Asphaltic Concrete Friction Course (Asphalt – Rubber) [AR-ACFC] (414)	% Asphalt Rubber	ARIZ 421	**3**
	Moisture Content	ARIZ 406c	**3**
Asphaltic Concrete (Asphalt-Rubber) [AR-AC] End Product (415)	% Asphalt Rubber	ARIZ 427	**1**
	Moisture Content	ARIZ 406c	**3**
	Rice	ARIZ 417d	**2**
	Lab Density (Marshall), Stab, Flow	ARIZ 410e	**2**
	Calculated Lab Voids	ARIZ 424	**1**
	Gradation	ARIZ 427	**2**
	Compaction (in place field voids)	ARIZ 415c	**1**
Asphaltic Concrete [AC] Marshall Mixes End Product (416)	% Asphalt	ARIZ 427	**1**
	Moisture Content	ARIZ 406c	**3**
	Rice	ARIZ 417d	**2**
	Lab Density (Marshall), Stab, Flow	ARIZ 410e	**2**
	Calculated Lab Voids	ARIZ 424	**1**
	Gradation	ARIZ 427	**2**
	Compaction (in place field voids)	ARIZ 415c	**1**

Asphaltic Concrete SHRP Volumetric Mixes (417)	% Asphalt	ARIZ 427	**1**
	Moisture Content	ARIZ 406c	**3**
	Rice	ARIZ 417d	**2**
	Lab Density (Gyratory Compactor)	AASHTO 312	**2**
	Calculated Lab Voids	ARIZ 424	**1**
	Gradation	ARIZ 427	**2**
	Compaction (in place field voids)	ARIZ 415c	**1**

Miscellaneous

MATERIAL OR PRODUCT	TYPE OF TEST(S) REQUIRED	TEST METHOD	VERIFICATION LEVEL
MISCELLANEOUS MATERIALS (For this Material Category, the Level 1 Analysis uses α = 0.025)			
Lime	Per Specifications	Certificate of Compliance	**Inspection**
Hydrated Lime	Per Specifications	Certificate of Compliance	**Inspection**
Hydraulic Cement	Per Specifications	Certificate of Compliance	**Inspection**
Portland Cement and Blended Hydraulic Cement	Per Specifications	Certificate of Compliance	**Inspection**
Corrugated Metal Pipe (CMP)	Per Specifications	Certificate of Compliance	**Inspection**
Non-Reinforced, Cast-in-Place Concrete Pipe	Compressive Strength	ARIZ 314b	**1**
	Slump	AASHTO T-119	**2**
	Air Content (when required)	ASTM C1064	**2**
	Temperature	AASHTO T-152	**3**
	Wall Thickness		**2**
Precast Reinforced or Non-Reinforced Concrete Pipe	Compressive Strength	ARIZ 314b	**2**
	Thickness	Measurement	**2**
Vitrified Clay Pipe	Compression	ARIZ 314b	**3**
Brick for Manholes	Compression	ARIZ 314b	**3**
Paving Brick	Compression	ARIZ 314b	**3**
	Absorption	ARIZ 251	**3**
Cinder Block	Compression	ARIZ 314b	**3**
	Absorption	ARIZ 251	**3**
Slump Block	Compression	ARIZ 314b	**3**
	Absorption	ARIZ 251	**3**
High Strength Bolts, Nuts, Washers, or Anchor Bolts	Rockwell Hardness	ASTM E18	**3**
	Wedge Tensile Strength	ASTM F606	**3**
Retroreflective Sheeting	Per Specifications	Certificate of Compliance	**3**
Sign Panel Silk-Screened Characters	Per Specifications	Certificate of Compliance	**3**
Glass Beads	Roundness	ASTM D1155	**3**

	Gradation	ASTM D1214	**3**
	Refractive Index		**3**
	Moisture Resistance		**3**
	Heavy Metal Concentration (if required)		**3**
Preformed Plastic Pavement Marking	Per Specifications	Certificate of Compliance	**3**
Thermoplastic Pavement Markings	Per Specifications	Certificate of Compliance	**3**
Raised Pavement Markers	Per Specifications	Certificate of Compliance	**Inspection**
Permanent Pavement Markings (Painted)	Per Specifications	Certificate of Compliance	**3**
Dual Component Pavement Markings	Per Specifications	Certificate of Compliance	**3**
Polyvinyl Chloride (PVC) Pipe for Electrical Conduit	Per Specifications	Certificate of Compliance	**Inspection**
Polyvinyl Chloride (PVC) Pipe for Water	Per Specifications	Certificate of Compliance	**Inspection**
Chain Link Fabric	Per Specifications	Certificate of Compliance	**Inspection**
Fence Post and Rails	Per Specifications	Certificate of Compliance	**Inspection**
Miscellaneous Fence Hardware	Per Specifications	Certificate of Compliance	**Inspection**
Post Clips, Hog Rings, Tie Wire, or Tension Wire	Per Specifications	Certificate of Compliance	**Inspection**
Barbed Wire or Barbless Wire	Per Specifications	Certificate of Compliance	**Inspection**
Fence Stays	Per Specifications	Certificate of Compliance	**Inspection**
T-Post	Per Specifications	Certificate of Compliance	**Inspection**
Woven Wire Fabric	Per Specifications	Certificate of Compliance	**Inspection**
Wire Rope	Per Specifications	Certificate of Compliance	**Inspection**
Paint	Per Specifications	Certificate of Compliance	**Inspection**
Guardrail Elements	Per Specifications	Certificate of Compliance	**Inspection**
Guardrail Fasteners	Rockwell Hardness	ASTM E18	**3**
	Tensile Strength	ASTM F606	**3**

Guardrail Posts and Blocks	Per Specifications	Certificate of Compliance	**Inspection**
Geosynthetics	Per Specifications	Certificate of Compliance	**3**
Pavement Fabric	Per Specifications	Certificate of Compliance	**3**
Geogrid	Per Specifications	Certificate of Compliance	**3**
Separation Geotextile Fabric	Per Specifications	Certificate of Compliance	**3**
Bank Protection Fabric	Per Specifications	Certificate of Compliance	**3**
Geocomposite Wall Drain System	Per Specifications	Certificate of Compliance	**3**
Geocomposite Edge Drain System	Per Specifications	Certificate of Compliance	**3**
Geomembrane	Per Specifications	Certificate of Compliance	**3**
Grout	Compressive Strength	ARIZ 314b	**2**

Appendix G

Independent Assurance Test Methods

The following test methods will be evaluated annually as part of the independent assurance program.

Field Sampling and Testing

1. Density of Soils
    i. ARIZ 230 – Field Density (Sand Cone)
    ii. ARIZ 235 – Field Density (Nuclear)

2. Plastic Concrete
    i. ASTM C143 – Concrete Slump
    ii. ASTM C231 – Concrete Air Content
    iii. ASTM C31 – Concrete Cylinder Fabrication

Note: Field technicians will be evaluated annually based on observation.

Laboratory Testing

1. Soil and Aggregate
    i. ARIZ 201c – Sieve Analysis of Soils & Aggregates
    ii. AASHTO T176 – Sand Equivalent
    iii. AASHTO T90 – Plastic Limit & Plasticity Index

2. Hardened Concrete
    i. ARIZ 314b – Compressive Strength of Concrete

3. Bituminous Mixture Compaction
    i. ARIZ 410e – Compaction/Testing HMA by Marshall Method
    ii. AASHTO T312 – HMA Density by Gyratory Compactor

4. Bituminous Mixture Other
    i. ARIZ 415c – Bulk Specific Gravity of Compacted Bituminous Mixtures
    ii. ARIZ 417d – Maximum Theoretical Specific Gravity of HMA (Rice Test)
    iii. ARIZ 427 – Asphalt Binder Content (Ignition)

Note: Laboratory technicians will be evaluated annually based on either observation, an individual's IA split test results (small groups), or an individual's proficiency test result (large group). Technicians will be evaluated for the test method they will perform.

OV and IQ firms are required to request IA evaluations a minimum of two weeks in advance. ADOT will try to accommodate requests made with less than two weeks' notice.

Appendix H

Independent Quality Firm Data Transfer Requirements

The IQF transmits their test results to ADOT to allow ADOT to perform the required owner verification (including statistical analyses). This appendix provides direction on how to transmit this data to ADOT's Uncle Sam system.

Definitions

Third party: this is the client who will provide the deliverable described in this document.

ADOT analysis project: this refers to an instance of web application along with data import tasks configured to accept data from two parties: ADOT and the third party above. The main purpose of the project is to group and aggregate imported tests based on certain attributes of the tests, resulting in statistical analyses.

Data import / sync: this refers to the scheduled task configured to perform an ETL (extract, transform, load) on the source .bacpac tables into the target (master) database.

Master database: this is the database into which the ADOT data and third-party data will sync. The ADOT analysis project utilizes this database as its backend to perform analyses on the test data, among other things.

Purpose

The purpose of this document is to provide details on the deliverable database file which a third party will need to provide for import into an ADOT analysis project. Information included in this document is: the database schema and table definitions expected to be provided by the third party; additional notes on how tables should be populated; and the delivery method to which the third party should adhere.

This document references a sample deliverable .bacpac file and an analysis configuration view (see below for more information) that should be provided in conjunction.

Deliverable and Delivery Method

The expectation is that the third party will provide a database that matches the table schema described below and contained in the sample file. The database should be compatible with Microsoft SQL Server 2016 and exported in .bacpac format.

The third party will coordinate with the administrator of the ADOT analysis project to determine the expected schedule as well as export location. There is a scheduled task that can be deployed to grab the third party's .bacpac file via FTP or SFTP.

Tables Summary
The following is a summary of each schema in the expected deliverable. This is meant to aid the third party in understanding the purpose of the tables in addition to the table definitions provided afterward.

Configuration table (config.ConfigurationSettings):
This table is not used in the master database, it is purely for tracking purposes of the third party.

Reference data tables (schema of "ref")
These tables house reference data which the header and result tables have relations. These tables are also synced to the master database upon import.

Note that the records in these tables will need to be manually kept in sync with the records used in the same tables in ADOT's import (the records should mirror exactly the records in ADOT's import tables). The third party is not expected to add or remove any records from this table, but if absolutely necessary, the third party must coordinate with ADOT to ensure that records are properly added in both their and ADOT's imports. Properly adding a record in each database means the key value in the reference table matches as well as any other description data. If they do not match, there will almost surely be issues when the data is imported into the master database.

Sample reference data configuration from ADOT's last project import is available in the accompanying .bacpac file.

Header and result tables (schema of "test")
These tables house the test headers and accompanying results that the third party would like to import into the master database for analysis.

Versioning: Versioning is an important concept regarding these two tables. The data sync is wired to only perform inserts on new records regarding the third party's headers and results; update to existing records are not accepted. The reasoning behind this logic is that the third party must implement a new version of a header / result set to be recognized by the ADOT analysis project if an update needs to be made. Additionally, when performing analyses of the test data, only the "latest" version of the header / result sets will be evaluated.

To create the initial version of a header / result set, add a test.Header record with a new, unique Lab_Test_Nbr value; the Version value should be 1. Also, add the appropriate linked test.Result records as well.

To increment the version, add another test.Header record with the same Lab_Test_Nbr value. Increment the Version value by 1 from the previous version; you will need to add the test.Result records to be used with this latest version as well, in addition to any other data changes that may differentiate version 2 from version 1.

See sample .bacpac file for versioning examples.

Validation: It is additionally important to understand the concept of header / result validation as only valid third-party data is applicable for analysis in the master database. For clarity, we have broken this down into two different types of validation: root data validation and analysis configuration validation.

Root validation: Certain test header fields must be "whitelisted" in the master database in order to be recognized as valid. The third party will need to coordinate with the administrator of the ADOT analysis project regarding this. These fields are denoted with "Subject to root validation" in the table notes below.

Analysis configuration validation: Not all test headers and result sets are necessarily valid for analysis; the material code / material grade, test type, and test result specifier combination must be expected so that the ADOT analysis system knows which level of verification and analysis category into which it falls. (See accompanying spreadsheet that shows a view of how these fields are joined together, and see "Analysis Configuration View" below for additional information.) The affected fields are denoted with "Subject to analysis configuration validation" in the table notes below.

Name formatting: The two fields which include technician names (test.Header.SampledBy and test.Result.TestedBy) both require a delimiter between the first name and the last name so the names are parsed correctly by the data import. The delimiter is "###" – so an example of the expected name provided is "John###Smith" for technician with a first name of John, and a last name of Smith. Additionally, for test.Result.TestedBy, there may be multiple technicians provided in one record. The technicians are delimited by "^". An example of two technicians in this field is "John###Smith^Tom###Sawyer" which would denote that two technicians – one technician with a first name of John and a last name of Smith and another technician with a first name of Tom and a last name of Sawyer.

Trace log tables (schema of "dbo")
The trace log tables are not used directly in the application for the third-party submission, but are meant to be an audit of the changes to the header and result records throughout time.

For the most part, the fields in the audit table should mirror the fields for the main table (TraceLogHeader for test.Header and TraceLogResult for test.Result) at the time of the audit, with the addition of the two audit fields, TraceLogType and TraceLogDT.

Accompanying Data

1. Sample .bacpac

See .bacpac file (attached file to this appendix) for a mockup of the expected deliverable from the third party.

2. Analysis Configuration View

The accompanying spreadsheet provides a look at the view in the ADOT analysis project with which header and result sets must join to be considered for analysis. While we have provided additional fields that may or may not be useful in understanding the data, the columns in the view pertinent to the data import are the following: “Materials,” “TestTypeDescription,” and “TestResultSpecifiers.”

The third party should provide headers and result sets whose header materials and result test types and test result specifiers match this view, if they want the record to be used in analysis in the master database.

Table Definitions

Table: **config.ConfigurationSettings**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
ProjectNumber	char	8	False		Primary Key

Table: **ref.AnalysisType**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
AnalysisTypeID	int		False		Primary Key
AnalysisTypeDescription	varchar	255	True	Description of the different category (type) of test (concrete, soil, and aggregates)	

Table: **ref.Feature**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
FeatureID	int		False		Primary Key
FASTFeatureCode	char	20	False	FAST code for the roadway feature	
FASTFeatureDescription	char	100	False	Full English description of the feature	

Table: **ref.Purpose**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
PurposeID	int		False		Primary Key
FASTPurposeCode	char	1	False	Code for the purpose of the sample testing	
FASTPurposeDescription	char	25	False	Full English description of the purpose	

Table: **ref.SieveSize**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
SieveSizeSuffix	nvarchar	123	False		Primary Key
SieveSizeDescription	nvarchar	255	False		

Table: **ref.TestType**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
TestTypeID	int		False		Primary Key
TestTypeDescription	varchar	60	False	Full English description of the various types of concrete and soil and aggregate tests.	

Table: **ref.UnitOfMeasure**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
UnitOfMeasureID	int		False		Primary Key
UnitOfMeasureDescription	varchar	50	False	Description of the unit of measure.	

Table: **test.Header**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
ID	int		False		Primary Key
HeaderID	int		True		Unique key used to identify header in master database.
AnalysisTypeID	int		False		Foreign Key referencing ref.AnalysisType. AnalysisTypeID
CourseLift	char	6	True	Sample Lift Number.	
Direction	char	10	True	Travel direction.	
FeatureID	int		True		Foreign Key referencing ref.Feature.FeatureID

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
MaterialGrade	varchar	15	True	Material Grade - 2, 12A, 34B, etc. *Subject to root validation.* *Subject to analysis configuration validation.*	
MaterialCode	char	10	True	Material Code - AC, FA, BM, etc. *Subject to root validation.* *Subject to analysis configuration validation.*	
Misc	varchar	255	True	Sample Remarks	
Roadway	varchar	285	True	Project Location and/or Highway Termini Description	
SampleID	varchar	30	True	Surrogate Key / ID / Number to identify specific sample	
SampleLocation	varchar	60	True	Location where the sample is take from	
SampleTypeCode	varchar	4	True	Purpose of the sample (Acceptance, Correlation, etc.) See the [ref].[Purpose] table for the definition of the purpose code. *Subject to root validation.*	

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
SampledBy	varchar	50	True	The name of the person who took the sample. *Subject to name formatting.*	
SampledDate	date		True	The date on which the sample was taken.	
SectionID	int		True	The section ID where the sample is taken from. Corresponds to "Segment": enter 1 for "A"; 2 for "B"; 3 for "C"; 4 for "D"; 6 for "Offsite"	
SplitSampleID	varchar	30	True	Surrogate Key / ID / Number to identify the sample split from this sample.	
Station	varchar	21	True		
StructureNumber	varchar	50	True		
SupplierName	varchar	128	True	Full supplier name. *Subject to root validation.*	
PlantName	varchar	128	True		
ProductCode	varchar	50	True	*Subject to root validation.*	
Lab_Test_Nbr	varchar	20	True	*Used for versioning.*	
ProjectNumber	varchar	8	True		
SurrogateKey	int		False	Internal tracking field – not used for third party submissions.	
SurrKeySource	varchar	5	True	Internal tracking field – not used for third party submissions.	
Version	int		True	*Used for versioning.*	

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
OriginalSource	varchar	50	True	Internal tracking field – not used for third party submissions.	

Table: **test.Result**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
ResultID	int		False		Primary Key; key used to identify result in master database.
HeaderID	int		False		Foreign Key referencing test.Header.HeaderID.
TestTypeID	int		False	*Subject to analysis configuration validation.*	Foreign Key referencing ref.TestType.TestTypeID.
UnitOfMeasureID	int		True		Foreign Key referencing ref.UnitOfMeasure. UnitOfMeasureID
TestResultSpecifier	varchar	255	True	*Subject to analysis configuration validation.*	
TestResultSize	varchar	255	True	Valid values: 1", 1-1/2", 1/2", 1/4", 2", 2-1/2", 3", 3/4", 3/8", No. 10, No. 100, No. 16, No. 200, No. 30, No. 4, No. 40, No. 50, No. 8, Negative No. 4, Negative No. 200, Oversize 3, Oversize 6	
TestResultValueNumeric	float		True	When the result of the measurement is a number, this is the measurement value.	
TestResultValueString	varchar	255	True	When the result of the measurement is a string, this is the measurement result.	

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
SurrogateKey	int		True	Internal tracking field – not used for third party submissions.	
TestedBy	varchar	100	True	The name of the person(s) who performed the test. *Subject to name formatting.*	
SurrKeySource	varchar	4	True	Internal tracking field – not used for third party submissions.	
AuditKey	varchar	568	True	Internal tracking field – not used for third party submissions.	
StampCode	int		True	Enter: 1 for pass; 2 for engineer decision; 5 for fail; 9 for informational; 0 for not assigned.	

Table: **dbo.TraceLogHeader**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
TraceLogHeaderID	int		False		Primary Key
TraceLogType	char	1	False	Enter: "I" for insert; "U" for update; "D" for delete.	
TraceLogDT	smalldatetime		False	Date of audit log entry.	
HeaderID	int		True		
AnalysisTypeID	int		True		
CourseLift	char	6	True		
Direction	char	10	True		
FeatureID	int		True		
MaterialGrade	varchar	15	True		
MaterialCode	varchar	100	True		
Misc	varchar	255	True		
Roadway	varchar	285	True		

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
SampleID	varchar	30	True		
SampleLocation	varchar	250	True		
SampleTypeCode	varchar	4	True		
SampledBy	varchar	100	True		
SampledDate	date		True		
SectionID	int		True		
SplitSampleID	varchar	30	True		
Station	varchar	21	True		
StructureNumber	varchar	50	True		
SupplierName	varchar	128	True		
PlantName	varchar	128	True		
ProductCode	varchar	50	True		
Lab_Test_Nbr	varchar	20	True		
ProjectNumber	varchar	8	True		
SurrogateKey	int		True		
SurrKeySource	varchar	5	True		
Version	int		True		
OriginalSource	varchar	50	True		

Table: **dbo.TraceLogResult**

Field Name	Data Type	Length	Nullable	Notes	Key / Relational
TraceLogResultID	int		False		Primary Key
TraceLogType	char	1	False	Enter: "I" for insert; "U" for update; "D" for delete.	
TraceLogDT	smalldatetime		False	Date of audit log entry.	
ResultID	int		True		
HeaderID	int		True		
TestTypeID	int		True		
UnitOfMeasureID	int		True		
TestResultSpecifier	varchar	255	True		
TestResultSize	varchar	255	True		
TestResultValueNumeric	float		True		
TestResultValueString	varchar	255	True		
SurrogateKey	int		False		
TestedBy	varchar	100	True		
SurrKeySource	varchar	4	True		
AuditKey	varchar	568	True		
StampCode	int		True		

Certificate Of Completion

Envelope Id: C45ADE1E55714362BABC433DB5325734
Status: Completed
Subject: Please DocuSign: 20201124 ADOT QAP - Final - For Signature.pdf
Source Envelope:
Document Pages: 183
Signatures: 2
Certificate Pages: 5
Initials: 0
AutoNav: Enabled
EnvelopeId Stamping: Enabled
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Envelope Originator:
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Phoenix, AZ 85007
KDea@azdot.gov
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Jesus A Sandoval-Gil jsandoval-gil@azdot.gov State Materials Engineer ADOT Security Level: Email, Account Authentication (None)	DocuSigned by: Jesus A Sandoval-Gil F9A6FBCB94A6460... Signature Adoption: Pre-selected Style Using IP Address: 184.103.172.32	Sent: 11/24/2020 1:25:52 PM Viewed: 11/24/2020 1:38:06 PM Signed: 11/24/2020 1:39:45 PM

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Electronic Record and Signature Disclosure:
Accepted: 11/24/2020 1:53:00 PM
ID: 55c32fcf-9f27-4180-9826-cfc880668972

In Person Signer Events	Signature	Timestamp

Editor Delivery Events	Status	Timestamp

Agent Delivery Events	Status	Timestamp

Intermediary Delivery Events	Status	Timestamp

Certified Delivery Events	Status	Timestamp

Carbon Copy Events	Status	Timestamp

Witness Events	Signature	Timestamp

Notary Events	Signature	Timestamp

Envelope Summary Events	Status	Timestamps

Envelope Sent	Hashed/Encrypted	11/24/2020 1:25:52 PM
Certified Delivered	Security Checked	11/24/2020 1:53:00 PM

Envelope Summary Events	Status	Timestamps
Signing Complete	Security Checked	11/24/2020 1:53:23 PM
Completed	Security Checked	11/24/2020 1:53:23 PM

Payment Events	Status	Timestamps

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Browsers (for SENDERS):	Internet Explorer 6.0? or above
Browsers (for SIGNERS):	Internet Explorer 6.0?, Mozilla FireFox 1.0, NetScape 7.2 (or above)
Email:	Access to a valid email account
Screen Resolution:	800 x 600 minimum
Enabled Security Settings:	• Allow per session cookies • Users accessing the internet behind a Proxy Server must enable HTTP 1.1 settings via proxy connection

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