Designation: D 3666 – 03

Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials[1]

This standard is issued under the fixed designation D 3666; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers the minimum requirements for field and laboratory personnel, for establishing and maintaining a quality system, and establishes minimum qualifications for agencies engaged in the testing and inspection of road and paving materials.

1.2 Criteria are provided for evaluating the capability of an agency to properly perform designated tests on road and paving materials, and for establishing guidelines pertaining to an agency's organization, personnel, facilities, and quality system. This specification may be supplemented by more specific criteria, such as that in Specification E 329, and requirements for particular projects.

1.3 This specification can be used as a basis to evaluate testing or inspection agencies, or both, and is intended for use for the qualifying or accrediting, or both, of testing or inspection agencies, public or private, engaged in the testing and inspection of road and paving materials.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 The following referenced documents are those that are specifically mentioned in Specification D 3666. These referenced documents are not meant to be all inclusive, as Specification D 3666 applies, as appropriate, to all test methods under the jurisdiction of Committee D04.

2.2 *ASTM Standards:*

C 128 Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate[2]

D 5 Test Method for Penetration of Bituminous Materials[3]

D 36 Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)[4]

D 70 Test Method for Specific Gravity and Density of Semi-Solid Bituminous Materials (Pycnometer Method)[3]

D 92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester[5]

D 113 Test Method for Ductility of Bituminous Materials[3]

D 139 Test Method for Float Test for Bituminous Materials[3]

D 244 Test Methods for Emulsified Asphalts[3]

D 290 Practice for Bituminous Mixing Plant Inspection[6]

D 1074 Test Method for Compressive Strength of Bituminous Mixtures[3]

D 1075 Test Method for Effect of Water on Compressive Strength of Compacted Bituminous Mixtures[3]

D 1559 Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus[7]

D 1560 Test Methods for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus[3]

D 1561 Practice for Preparation of Bituminous Mixture Test Specimens by Means of California Kneading Compactor[3]

D 1754 Test Method for Effects of Heat and Air on Asphaltic Materials (Thin-Film Oven Test)[3]

D 1856 Test Method for Recovery of Asphalt from Solution by Abson Method[3]

D 2041 Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures[3]

D 2170 Test Method for Kinematic Viscosity of Asphalts (Bitumens)[3]

D 2171 Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer[3]

D 2872 Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)[3]

D 3142 Test Method for Density of Liquid Asphalts (Hydrometer Method)[3]

D 3143 Test Method for Flash Point of Cutback Asphalt with Tag Open-Cup Apparatus[3]

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[1] This specification is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.95 on Quality Control, Inspection, and Testing Agencies.

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[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] *Annual Book of ASTM Standards*, Vol 04.03.

[4] *Annual Book of ASTM Standards*, Vol 04.04.

[5] *Annual Book of ASTM Standards*, Vol 05.01.

[6] Discontinued; see 2000 *Annual Book of ASTM Standards*, Vol 04.03.

[7] Discontinued; see 1998 *Annual Book of ASTM Standards*, Vol 04.03.

D 4402 Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer [4]
D 5506 Practice for Organizations Engaged in the Certification of Personnel Testing and Inspecting Bituminous Paving Materials[3]
D 6307 Test Method for Asphalt Content of Hot-Mix Asphalt by Ignition Method [3]
D 6521 Practice for Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV) [3]
D 6648 Test Method for Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR) [3]
E 329 Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction[8]

3. Terminology

3.1 *Definitions*—The approved standard definitions are listed below. In addition, for information purposes only, Appendix X1 includes definitions for the terms *verification*, *calibration*, *traceability*, and *uncertainty*.

3.1.1 *quality system*—the organizational structure, responsibilities, procedures, activities, capabilities and resources that together aim to ensure that laboratory services satisfy data requirements.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *agency*—the organization engaged to test or inspect road and paving materials as required by a specification or contract.

3.2.2 *quality system manual (QSM)*—a set of documents describing an agency's quality system.

3.2.3 *user*—the person or organization engaging the agency to provide inspections or tests; or using this specification to evaluate or accredit the agency.

4. Significance and Use

4.1 This specification provides the basic minimum criteria for use in evaluating the qualifications of testing or inspection agencies, or both, for road and paving materials. The criteria may be supplemented by more specific criteria and requirements. An individual user can also use it to judge the qualification of an agency.

4.2 The intent of this specification is to provide a consensus basis for evaluating a testing or inspection agency, or both, with respect to that agency's capability to objectively and competently provide the specific services needed by the user.

4.3 This specification may be used as a basis for accreditation.

5. Responsibilities and Duties

5.1 The agency shall ensure that only inspections or tests for which it is adequately equipped and staffed are performed.

5.2 The agency shall ensure that personnel perform only inspections and tests for which they are adequately trained, qualified and certified in accordance with applicable specifications.

5.3 The agency shall ensure that all equipment is properly maintained in good operating condition and is calibrated as applicable.

5.4 The agency shall perform all testing and inspection in accordance with appropriate standards and quality control criteria. Documents unique to the user shall be furnished to the agency.

6. General Capabilities

6.1 *Laboratory Testing*—The laboratory testing services of a road and paving materials testing agency shall include some or all of the following capabilities:

6.1.1 Testing of road and paving materials and mixtures in the laboratory,

6.1.2 Testing of aggregate for compliance with specification requirements,

6.1.3 Preparation and evaluation of mix design in accordance with the proper method common to the geographical area in which it offers services or in accordance with the appropriate ASTM or AASHTO standard procedure,

6.1.4 Determination of percent binder and gradation of plant aggregates in plant mix, and

6.1.5 Determination and verification of mix properties for comparison with the mix design.

6.2 *Field Testing and Inspection*—The field services of a road and paving materials testing and inspection agency shall include some or all of the following capabilities:

6.2.1 Investigation of aggregate at the source for compliance with specification requirements,

6.2.2 Inspection of proportioning and mixing at the plant or project site in accordance with Practice D 290 or user's requirements.

6.2.3 Inspection of handling, laying, and rolling operations of the mixture at the site,

6.2.4 Determination of thickness of compacted mixture, and

6.2.5 Determination of density and the percent compaction of a bituminous pavement after construction.

NOTE 1—Since the requirements for construction control can vary widely from project to project depending upon the nature of the mixture, location, and intended use of the bituminous mixture in the project, the capability of the agency for testing and inspection should be that necessary to accomplish construction control of the user's specific project or special requirements.

7. Personnel Qualifications

7.1 *Management and Supervision*—The testing and inspection services of the agency shall be under the direction of a person charged with scientific or engineering managerial responsibility. This person should be a registered engineer and a full-time employee of the agency and shall have a minimum of 5 years experience in inspecting and testing of road and paving materials and construction; however, in place of being a registered engineer, a person with equivalent science-oriented education and experience in having satisfactorily directed testing or inspection services, or both, of road and paving materials is acceptable. This person shall possess all applicable professional licenses or certificates required by public law or requirements of the authority in one or more fields which the

[8] *Annual Book of ASTM Standards*, Vol 04.02.

person directs. A NICET Level IV Certification in "Construction Materials Testing—Subfield Asphalt" would be considered an example of an acceptable certification of the experience of this individual.

NOTE 2—The National Institute for Certification in Engineering Technologies (NICET) is a nationally recognized certification organization.[9]

7.2 *Supervising Field or Laboratory Technician or Inspection*:

7.2.1 This person shall have a minimum of 5 years of relevant and progressively more responsible experience in testing and/or inspection of road and paving materials and hot mix asphalt construction as appropriate to their job classification.

7.2.2 This person shall have applicable technician level or inspector level, or higher, certifications/qualifications (see Note 3) through a program approved by a State DoT, or have a NICET Level III certification in Construction Materials Testing—Asphalt, or Transportation Technologist—Highway Materials.

7.3 *Field/Plant Inspector or Testing Technician*:

7.3.1 This person shall have applicable technician level or inspector level certifications/qualifications (see Note 3) through a program approved by a State DoT, or, have a NICET Level II certification in Construction Materials Testing—Asphalt, or Transportation Technologist - Highway Materials.

7.3.2 Trainees working toward certification can be used to perform the inspection or test, or both, if they work under the supervision of a certified/qualified individual as described in Sections 7.2.2 or 7.3.1, at the same facility, project or plant. The trainee cannot evaluate the test or inspection results or sign acceptance reports.

7.4 It is satisfactory for a person to fill one or more of the levels of management, supervision, inspector or technician positions in accordance with 7.1, 7.2 and 7.3 provided that person qualifies for the highest level. It is also recognized that frequently a few laboratory control tests are conducted at small field or peripheral locations; it is not the intent of this practice that the supervisory personnel be directly present at such locations at all times.

NOTE 3—The organization certifying should meet the requirements of Practice D 5506.

8. Quality System Criteria

8.1 The agency shall establish and implement a quality system which meets the following criteria:

8.1.1 *Quality System Manual (QSM)*—The agency shall establish and maintain a QSM that conforms to the requirements in Section 9. Each document in the QSM shall indicate its preparation date. If a document is revised, the date of revision shall be indicated on the document. The QSM shall be available for use by laboratory staff.

8.1.2 *Quality System Management*—The agency shall designate a person(s) having responsibility for determining if quality system implementation activities are being conducted by agency staff in the manner specified in the agency's quality system manual. This individual(s) shall have direct access to top management (see Note 4).

NOTE 4—This individual(s) may have other responsibilities (for example, laboratory manager).

NOTE 5—Inspection and testing procedures may reference published standards.

8.1.3 *Equipment Calibration and Verification*—The agency shall calibrate or verify all significant testing equipment associated with tests covered by the scope of this standard which the agency performs. As a minimum, the equipment listed in Table 1 shall be included if it is associated with tests performed by the agency. Applicable equipment shall be calibrated or verified at the intervals specified in the agency's QSM. The intervals specified in the QSM shall be no greater than those indicated in Table 1 (Note 6). Newly acquired equipment without manufacturers certification and equipment that has not been calibrated or verified because it has been removed from service shall be calibrated or verified before being placed in service. The agency shall have detailed written procedures for all in-house calibration and verification activities not addressed in standards. These procedures shall indicate the equipment required to perform the calibration or verification.

TABLE 1 Bituminous Materials Test Equipment

Equipment—Test Method	Requirement	Interval (Month)
Saybolt Viscometers—D 244	Calibrate	36
Mechanical Shakers	Verify sieving thoroughness	12
General Purpose Balances, Scales and Weights	Calibrate	12
Temperature Measuring Devices—D 5, D 70, D 113, D 2041, D 2170, D 2171, D 3142, D 4402, D 6648, D 2872, D 6521	Calibrate	6
Analytical Balances and Weights	Calibrate	24
Compression Testing Machine—D 1074, D 1075, D 1559, D 1560	Calibrate	12
CA Kneading Compactor—D 1561	Calibrate	24
Timers—D 2170, D 2171	Calibrate	6
Ovens	Verify temperature settings	4
Penetrometer and Accessories—D 5	Calibrate dial and timer accuracy and verify needle condition	6
Ductility Machine—D 113	Verify molds and speed of travel	12
TFO and RTFO Oven—D 1754, D 2872	Verify shelf/carriage rotation speed	12
Sieves	Verify physical condition	6
Molds, Followers, Calibration Cylinders—D 1560, D 1561	Verify critical dimensions	12
Molds, Manual Compaction Hammers, Breaking Heads—D 1559	Verify critical dimensions and mass of hammer	12
Molds and Plungers—D 1074	Verify critical dimensions	12
Brass Rings and Assembly—D 36	Verify critical dimensions	12
Pycnometers—D 70	Calibrate	12
Collars and Floats—D 139	Verify critical dimensions	12
Flowmeters—D 1856, D 2872	Calibrate	12
Molds and Tampers—C 128	Verify critical dimensions	24
Flash Cups—D 92, D 3143	Verify critical dimensions	12
Rotary transducers—D 4402	Verify with a reference fluid	6
Pressure Gages—D 6521	calibrate	6
Stainless steel beams—D 6648	Verify dimensions	12
Standard masses—D 6648	Verify masses	12
Internal balances—D 6307	Calibrate	12

[9] National Institute for Certification in Engineering Technologies, 1420 King Street, Alexandria, VA 22314-2715.

NOTE 6—When a maximum calibration or verification interval for a specific piece of test equipment is specified in a standard, the maximum interval specified by this document is intended to be the same as the maximum interval specified by the standard.

8.1.4 *Inspection of Facilities*—The agency shall have its laboratory procedures and equipment inspected at intervals of approximately 2 years by an evaluation authority as evidence of its competence to perform required tests. The agency shall within 30 days of the receipt of the evaluation authority written report document on how the deficiencies were corrected.

NOTE 7—The AASHTO Materials Reference Laboratory (AMRL) of the National Institute of Standards and Technology is a qualified national authority.

8.1.5 *Agency Accreditation*—The agency shall possess a certificate of accreditation listing D 3666 from a national authority as evidence that it meets the requirements of this standard.

NOTE 8—Accreditation programs offered by AASHTO (AASHTO Accreditation Program—AAP), the American Association for Laboratory Accreditation (A2LA) and the National Voluntary Laboratory Accreditation Program (NVLAP) are examples of programs offered by national authorities.

8.1.6 *Proficiency Sample Testing*—The agency shall participate in applicable AMRL proficiency sample programs.

NOTE 9—The AASHTO Materials Reference Laboratory (AMRL) located at the National Institute of Standards and Technology in Gaithersburg, Maryland, distributes proficiency samples for bituminous materials testing.

8.1.7 *Test Records*— The agency shall maintain test records which contain sufficient information to permit verification of any test reports. Records pertaining to testing shall include original observations, calculations, derived data and an identification of personnel involved in sampling and testing. The agency shall prepare test reports which clearly, accurately and unambiguously present the information specified in Table 2. The procedure for amending reports shall require that the previously existing report be clearly referenced when an amendment is made. The references shall establish a clear audit trail from the latest issuance or deletion to the original report and its supporting data.

NOTE 10—The requirements in Table 2 apply to the record that is used to present the laboratory's test results in their final form. In some cases, a test report or test data sheet is the final form of the data.

8.1.8 *Records Retention*—Records pertaining to testing, equipment calibration and verification, test reports, internal quality system reviews, proficiency sample testing, test technician training and evaluation, and personnel shall be retained by the laboratory in a secure location for a minimum of one year.

TABLE 2 Test Report Requirements (see Note 10)

(*1*) Name and address of the testing laboratory
(*2*) Identification of the report and the date issued
(*3*) Name and address of the client or identification of the project
(*4*) Description and identification of the test sample
(*5*) Date of receipt of the test sample
(*6*) Date(s) of test performance
(*7*) Identification of the standard test method used and a notation of any known deviations from the test method
(*8*) Test results and other pertinent data required by the standard test method
(*9*) A name of the person(s) accepting technical responsibility for the test report

NOTE 11—Although a 1 year retention schedule is adequate in some instances, there are many circumstances when a longer retention may be advantageous to the agency. Records concerning the calibration and verification of equipment are an example. Retention schedules of this type usually require such records to be held throughout the useful life of the equipment.

8.1.9 *Equipment Calibration and Verification Records*—The agency shall maintain calibration and verification records for all equipment specified in the QSM. Such records shall include:

8.1.9.1 Detailed results of the calibration and verification work performed (dimensions, mass, force, frequency, temperature, time, etc.),

8.1.9.2 Description of the equipment calibrated or verified including model and serial number or other acceptable identification (see 9.1.3.1),

8.1.9.3 Date the work was done,

8.1.9.4 Identification of the individual performing the work,

8.1.9.5 Identification of the calibration or verification procedure used,

8.1.9.6 The previous calibration or verification date and the next due date, and

8.1.9.7 Identification of any in-house calibration or verification device used.

8.1.10 *External Audit Records*—The agency shall maintain records of any external audits and documentation describing how the deficiencies were corrected.

8.1.11 *Proficiency Sample Records*—The agency shall retain results of participation in proficiency sample programs including data sheets, summary reports, and documentation describing steps taken to determine the cause of poor results and corrective actions taken.

8.1.12 *Test Methods and Procedures*—The agency shall maintain copies of standard and nonstandard procedures for testing performed which is covered by the scope of this standard and shall ensure that the procedures are the most current and are readily accessible to employees performing the work.

9. Quality System Manual (QSM) Requirements

9.1 The agency shall establish and maintain a QSM meeting the following requirements:

9.1.1 *Organization and Organizational Policies*:

9.1.1.1 The QSM shall contain the legal name and address of the agency—and that of the main office or company, if different—and any other information needed to identify the organization.

9.1.1.2 The QSM shall contain the ownership and management structure of the agency. Names, affiliations and positions of principal officers and directors shall be listed.

9.1.1.3 The QSM shall contain an organization chart showing relevant internal organizational components.

9.1.2 *Staff*:

9.1.2.1 The QSM shall contain an outline or chart showing operational personnel positions and their lines of authority and responsibility.

9.1.2.2 The QSM shall contain position descriptions for each technical operational position shown on the agency's organization chart in testing areas covered by the scope of this standard. These descriptions shall identify the position and include a description of the duties associated with the position, required skills, education and experience, and supervision exercised and received. A reference to where the required position descriptions may be found is acceptable if they are not included in the QSM.

9.1.2.3 The QSM shall contain a brief biographical sketch, noting the education, work experience, licensure, and certifications of technical staff involved in testing areas covered by the scope of this standard. Alternatively, the QSM may contain a reference to the location of the biographical sketches.

9.1.2.4 The QSM shall contain a document which describes the method(s) used to ensure that all agency technical staff are trained and qualified to perform tests covered by the scope of this standard. In addition to the description of training methods the document shall indicate what position(s) or employee(s) is responsible for the agency training program and maintenance of training records.

NOTE 12—There may be several different methods employed for differing conditions of staff experience and background including (*1*) on-the-job apprentice training (one on one) for new employees with little or no experience in laboratory or inspection work; (*2*) verification of competency by the agency for an individual with prior experience performing a specific test; (*3*) formal in-house training sessions for certification, rating, or competency evaluation; and (*4*) training by external organizations.

9.1.2.5 The QSM shall contain a document describing the method(s) used to evaluate staff competency to ensure that each test covered by the scope of this standard is performed in accordance with standard procedures. This description shall include the frequency of evaluations for each technician and indicate what position(s) or employee(s) is responsible for evaluating staff competency and maintaining records. These procedures shall ensure that each technician performing the test method is evaluated.

NOTE 13—Proficiency sample testing may be useful in evaluating staff competency, however, it should be used in conjunction with observation of actual testing performed.

9.1.2.6 The QSM shall contain a form(s) for recording training and competency evaluation activities summarized in 9.1.2.4 and 9.1.2.5 including the name of the trainee, name of the evaluator, test method evaluated, the dates and results.

9.1.3 *Facilities and Equipment*:

9.1.3.1 *Inventory*—The QSM shall contain an inventory of major sampling, testing, calibration and verification equipment associated with the test methods covered by the scope of this standard. A reference to where the inventory is located is acceptable if it is not included in the QSM. The inventory shall include, for each piece of major equipment, the name, manufacturer, model and serial number. An identification number assigned by the agency or other unique identifying information may be substituted for the model and serial number if this is the practice normally followed by the agency.

NOTE 14—Major equipment includes equipment such as shakers, physical or chemical testing machines, balances, baths, ovens, microscopes, and computing equipment dedicated to testing. Equipment such as chairs, desks and file cabinets may be excluded. Major equipment does not usually include expendable items such as miscellaneous glassware, sieves, molds and viscometers.

9.1.3.2 *Equipment Calibration and Verification*—The QSM shall contain a list(s) giving a general description of equipment for performing tests covered by the scope of this standard which require calibration or verification. For each item listed the list shall include the interval of calibration or verification, a reference to the calibration or verification procedure used (Note 15), and the location of calibration and verification records.

NOTE 15—The reference to the calibration or verification procedure used may indicate a standard calibration procedure, in-house calibration or verification procedure, or if the work is performed by an outside agency.

NOTE 16—In addition to being in the QSM this information may also be included in the calibration and verification records on each piece of equipment.

9.1.3.3 The QSM shall contain a document which describes the agency's method for ensuring that the calibration and verification procedures are performed for all required equipment at the specified intervals. This document shall include the position of the individual(s) responsible for ensuring that calibration and verification activities are carried out, and procedures for handling equipment which is new, removed from service, out of calibration or defective.

9.1.3.4 The QSM shall contain in-house equipment calibration and verification procedures, when they cannot be referenced in applicable standards, or have a reference to their location.

9.1.3.5 The QSM shall contain certificates or other documents that establish the traceability of in-house equipment or reference standards used for calibration and verification, or have a reference to their location in their agency.

9.1.4 *Test Records and Reports*:

9.1.4.1 The QSM shall contain a document which describes methods used by the agency to produce test results and to prepare, check and amend test reports.

9.1.4.2 The QSM shall contain typical test report forms which illustrate the manner in which tests results and supporting information (See 8.1.8) are documented.

NOTE 17—A printout showing a typical test record is acceptable if the laboratory uses electronic media for report storage.

9.1.5 *Sample Management*—The QSM shall contain a document describing procedure(s) for sample identification, storage, retention, and disposal of samples.

NOTE 18—In this context, the term "storage" refers to what is done before testing. The term "retention" refers to what is done after testing.

9.1.6 *Diagnostic and Corrective Action*:

9.1.6.1 The QSM shall contain a document(s) describing participation in proficiency sample and on-site inspection programs (Note 19), methods used to identify poor results and procedures followed when poor results or deficiencies occur.

NOTE 19—AMRL conducts on-site inspection and proficiency sample programs.

9.1.6.2 The QSM shall contain a document outlining the method(s) used in responding to external technical complaints.

9.1.7 *Internal Quality System Review*—The QSM shall contain a document describing the scope of internal quality system reviews, establishing the frequency of these reviews, identifying individuals responsible for the review, describing the distribution of reports to management and identifying the location of resulting records.

9.1.8 *Subcontracting*—The QSM shall contain a document describing the policies which the agency follows relative to subcontracting, if it engages in such activities. A reference to where the policies may be found is acceptable if they are not included in the QSM. These policies shall include procedures followed by the agency in selecting competent subcontractors who meet the requirements of this specification and reporting the results of testing performed by subcontractors. If the agency does not engage in such activities, the QSM shall contain a statement to that effect.

10. Keywords

10.1 construction materials testing; evaluation; human resources; minimum requirements; organization; physical resources; qualifications; quality control; quality system; quality system manual; records

APPENDIX

(Nonmandatory Information)

X1. XXXX

This appendix includes definitions for four terms relating to calibration. The statements and definitions included in this appendix are intended to promote an understanding of measurement traceability and explain how measurement traceability is established and maintained.

X1.1 Traceable Measurements

X1.1.1 Measurements, not the instrument, can be traceable.

X1.1.2 There is a need for traceable measurements if test results are to be accurate.

X1.1.3 Measurement traceability is established through calibration.

X1.1.4 The uncertainty estimates obtained during calibration are used to judge whether the instrument is suitable for its intended purpose.

X1.1.5 Measurement traceability is maintained through verification of calibration (a regular check of instrument output using a control standard).

X1.1.6 There is a need to re-establish traceability or recalibrate only when instrument measurements drift out of control (as determined through verification of calibration).

X1.2 Definitions

X1.2.1

verification, *n*—a check or test to ensure conformance to a standard.

calibration, *n*—a process that establishes the relationship between the results of a measurement instrument, measurement system, material measure, or reference values assigned to the corresponding values of a reference standard.

traceability, *n*—the property of a result of a measurement whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties.

uncertainty, *n*—a parameter associated with the result of a measurement that defines the range of the values that could be reasonably attributed to the measured quantity.