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NVLAP
Bulk Asbestos Analysis

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Bulk Asbestos Analysis

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NVLAP AND THE NVLAP LOGO

Abstract

NIST Handbook 150-3 presents the technical requirements and guidance for the accreditation of laboratories under the National Voluntary Laboratory Accreditation Program (NVLAP) Bulk Asbestos Fiber Analysis program. It is intended for information and use by accredited laboratories, laboratories seeking accreditation, laboratory accreditation systems, users of laboratory services, and others needing information on the requirements for accreditation under this program. The 2025 edition of NIST Handbook 150-3 aligns with ISO/IEC 17025:2017. The requirements of NIST Handbook 150 and the specific requirements and interpretations in the NIST Handbook 150-3 must be combined to produce the criteria for accreditation in the NVLAP Bulk Asbestos Fiber Analysis program. For more information visit the NVLAP website.

Keywords

accreditation; conformity assessment; ISO/IEC 17025; laboratory; management system; NVLAP; standards; testing; asbestos; PLM.

Contents

Foreword

The NIST Handbook 150 publication series sets forth the procedures, requirements, and guidance for the accreditation of testing and calibration laboratories by the National Voluntary Laboratory Accreditation Program (NVLAP). The series is comprised of the following publications:

- NIST Handbook 150, *NVLAP Procedures and General Requirements*, which contains the general procedures and requirements under which NVLAP operates as an unbiased third-party accreditation body; and

- NIST Handbook 150-xx program-specific handbooks, which supplement NIST Handbook 150 by providing additional requirements, guidance, and interpretive information applicable to specific NVLAP laboratory accreditation programs (LAPs).

The program-specific handbooks are not stand-alone documents, but rather are companion documents to NIST Handbook 150. They tailor the general criteria found in NIST Handbook 150 to the specific tests, calibrations, or types of tests or calibrations covered by a LAP.

NIST Handbook 150-3, *NVLAP Bulk Asbestos Analysis*, presents the technical requirements and guidance for the accreditation of laboratories under the NVLAP Bulk Asbestos Analysis LAP. The 2021 edition of NIST Handbook 150-3 supersedes and replaces the 2006 edition.

The following main changes have been made to this handbook with respect to the previous edition:

- the numbering has been updated to reflect that used by ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*; (hereafter referred to as ISO/IEC 17025);

- all references to applicable international guides and standards have been updated; and

- Laboratory Bulletins previously issued for clarification, have been incorporated into this edition of the handbook.

This handbook is also available on the NVLAP website.

Questions or comments concerning this handbook should be submitted to NVLAP, National Institute of Standards and Technology, 100 Bureau Drive, Stop 2140, Gaithersburg, MD, 20899-2140; phone: 301-975-4016; e-mail: nvlap@nist.gov.

Introduction

The Asbestos Hazard Emergency Response Act (AHERA) was enacted in October 1986. AHERA requires laboratories that analyze asbestos bulk insulation samples taken from public, or private, elementary or secondary schools, to be accredited by the National Institute of Standards and Technology (formerly the National Bureau of Standards) National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP accredits laboratories for the 1982 procedure, *Interim Method for the Determination of Asbestos in Bulk Insulation Samples*, found in 40 CFR Part 763, Appendix E to Subpart E (formerly Appendix A to Subpart F). AHERA requires that two types of asbestos analysis laboratories be accredited by NVLAP: those performing analysis using polarized light microscopy (PLM) and those performing analysis using transmission electron microscopy (TEM).

In 1993, the EPA developed an improved method entitled Method for the Determination of Asbestos in Bulk Building Materials, EPA/600/R-93/116. The test method provides clarifications and improvements to the original 1982 method. Use of the improved method can provide more precise analytical results at low asbestos concentrations, enhanced analysis of non-friable materials such as floor tiles, roofing materials and others with masking organic or other problematic binders, and other analytical techniques (such as analytical electron microscopy) that may contain asbestos fibers that are below the limits of resolution of the PLM, and clearer instruction on the analysis of bulk materials, particularly where multiple layers are present. It also provides instructions for developing in-house reference materials for use by laboratory analysts.

While the improved method was recommended by the EPA to be used in place of the original 1982 procedure, and serve as the preferred substitute method, it was never formally designated as the interim method for AHERA and by regulatory reference, asbestos NESHAP compliance. NVLAP laboratories that use the procedures found within EPA/600/R-93/116 method must be accredited for use of the method and indicate it on their test reports.

Acknowledgments

Many of the basic requirements in this and earlier versions of the handbook were established by Mr. Eric Steel and Ms. Jennifer Verkouteren whose contributions are fundamental to the handbook series. The handbook was revised with the participation of technical experts in the field of bulk asbestos analysis and was approved by NVLAP. The extensive review and suggestions of Dr. Bo Li are particularly appreciated.

Special thanks are extended to the NIST Editorial Review Board readers, past and present, for their thorough, thoughtful content reviews and valuable comments. It is the authors' opinion that these inputs have improved the overall quality and usefulness of the publication.

1 General Information

1.1 Scope

1.1.1 NIST Handbook 150-3 specifies technical requirements and provides guidance for the accreditation of laboratories that provide analyses under the NVLAP Bulk Asbestos Analysis LAP. This handbook supplements and complements the NVLAP procedures and general requirements found in NIST Handbook 150, *NVLAP Procedures and General Requirements* and ISO/IEC 17025.

1.1.2 NIST Handbook 150-3, NIST Handbook 150, ISO/IEC 17025, NVLAP General Criteria Checklist and NIST Handbook 150-3 Checklist constitute the collective body of requirements that must be met by a laboratory seeking NVLAP accreditation in the Bulk Asbestos Analysis LAP.

1.1.3 This handbook is intended for information and use by laboratories accredited in the Bulk Asbestos Analysis LAP, assessors conducting onsite assessments, laboratories seeking accreditation, other laboratory accreditation systems, users of laboratory services, and others needing information on the requirements for accreditation in the Bulk Asbestos Analysis LAP.

1.1.4 Any laboratory (including commercial, manufacturer, university, or federal, state, or local government laboratory) that performs the AHERA test method may apply for NVLAP accreditation.

1.1.5 The NVLAP Bulk Asbestos Analysis program provides policies, requirements and competence criteria to ensure that the testing laboratories are competent to identify and determine the optical properties and the concentration of asbestos in a sample using polarized light microscopy.

1.2 Organization of handbook

The numbering and titles of clauses 4 through 8 of this handbook align with those of ISO/IEC 17025. The primary subclauses in clauses 4 through 8 (e.g., 4.1, 4.2, etc.) are also numbered and titled to correspond with ISO/IEC 17025, even when there are no additional requirements.

1.3 Program description

The PLM Program accredits testing laboratories to ensure that they are competent to analyze bulk asbestos samples using PLM. Public Law 99-519, *Asbestos Hazard Emergency Response Act of 1986*, referred to as AHERA, required the National Institute of Standards and Technology (formerly the National Bureau of Standards) to develop an accreditation program for laboratories conducting analyses of bulk samples of asbestos-containing materials.

1.4 References

The following documents are referenced in this handbook. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) shall apply within one year of publication or within another time limit specified by regulations or other requirements documents.

[1] NIST Handbook 150, *NVLAP Procedures and General Requirements*

[2] ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

[3] U.S. Environmental Protection Agency *Interim Method for the Determination of Asbestos in Bulk Insulation Samples* as found in 40 CFR, Part 763, Subpart E, Appendix E (formerly Subpart F, Appendix A), or the current U.S. Environmental Protection Agency method for the analysis of asbestos in building material

[4] U.S. Environmental Protection Agency *Method for the Determination of Asbestos in Bulk Building Materials* (EPA/600/R-93/116), 1993, R. L. Perkins and B. W. Harvey

[5] NISTIR 5951, *Guide for the Quality Control on the Qualitative and Quantitative Analysis of Bulk Asbestos Samples: Version 1*, Jennifer R. Verkouteren and David L. Duewer

[6] *Guide to Statistical Analysis of Bulk Asbestos Quality Control Data*, Steve Lerman (available from NVLAP upon request)

[7] NIST Technical Note 1297, 1994 Edition, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, Barry N. Taylor and Christ E. Kuyatt (available from NVLAP)

[8] reference text(s) on optical mineralogy and crystallography

[9] general references text(s) on statistics and quality assurance

1.5 Terms and definitions

For the purposes of this handbook, the terms and definitions given in NIST Handbook 150, as well as the following, apply:

1.5.1
asbestos

a commercial term applied to the asbestiform varieties of six different minerals. The asbestos types are chrysotile (asbestiform serpentine), amosite (asbestiform grunerite), crocidolite (asbestiform riebeckite), asbestiform anthophyllite, asbestiform tremolite, and asbestiform actinolite. The properties of asbestos that caused it to be widely used commercially are: 1) its ability to be separated into long, thin, flexible fibers; 2) high tensile strength; 3) low thermal and electrical conductivity; 4) high mechanical and chemical durability; and 5) high heat resistance.

1.5.2
Becke line
a band of light seen at the periphery of a specimen when the refractive indices of the specimen and the mounting medium are different; it is used to determine refractive index.

1.5.3
bias
a systematic error characterized by a consistent (non-random) measurement error.

1.5.4
binder
with reference to a bulk sample, a component added for cohesiveness (e.g., plaster, cement, glue, etc.).

1.5.5
birefringence
the numerical difference between the maximum and minimum refractive indices of an anisotropic substance. Birefringence may be estimated using a Michel-Levy chart from the interference colors observed under crossed polars. Interference colors are also dependent on the orientation and thickness of the grain, and therefore are used qualitatively to determine placement in one of the four categories listed below.

Qualitative	*Quantitative (N-n)*
none	0.00 or isotropic
low	≤ 0.010
moderate	0.011-0.050
high	> 0.050

1.5.6
bulk sample
a sample of building material obtained for the identification and quantification of asbestos. Bulk building materials may include a wide variety of friable and non-friable materials.

1.5.7
color
the color of a particle or fiber when observed under low-power magnification using top-lighting.

1.5.8
compensator
a device with known, fixed or variable retardation and vibration direction used for determining the degree of retardation (hence the thickness or value of birefringence) in an anisotropic specimen. It is also used to determine the sign of elongation of elongated materials. The most common compensator is the first-order red plate (530 nm to 550 nm retardation).

1.5.9
control chart
a graphical plot of test results with respect to time or sequence of measurement, together with limits within which they are expected to lie when the system is in a state of statistical control.

1.5.10
detection limit
the smallest concentration/amount of some component of interest that can be measured by a single measurement with a stated level of confidence.

1.5.11
dispersion staining (focal masking)
an optical means of imparting apparent or virtual color to transparent substances by use of an opaque screen (stop) in the objective back focal plane; it is used to determine refractive indices.

1.5.12
extinction
the condition in which an anisotropic substance appears dark when observed between crossed polars. This occurs when the vibration directions in the specimen are parallel to the vibration directions in the polarizer and analyzer. Extinction may be complete or incomplete; common types include parallel, oblique (inclined), symmetrical and undulose.

1.5.13
extinction angle
for fibers, the angle between the extinction position and the position at which the fiber is parallel to the polarizer or analyzer privileged directions.

1.5.14
fiber
with reference to asbestiform morphology: a structure consisting of one or more fibrils.

1.5.15
friable
refers to the cohesiveness of a bulk material, indicating that it may be crumbled or disaggregated by hand pressure.

1.5.16
gravimetry
any technique in which the concentration of a component is determined by weighing. As used in this document, it refers to the measurement of asbestos-containing residues after sample treatment by ashing, dissolution, etc.

1.5.17
homogeneous
uniform in composition and distribution of all components of a material, such that multiple subsamples taken for analysis will contain the same components in approximately the same relative concentrations.

1.5.18
matrix
non-asbestos, nonbinder components of a bulk material; for example, such components as cellulose, fiberglass, mineral wool, mica, etc.

1.5.19
Michel-Levy scale of retardation colors
a chart plotting the relationship between birefringence, retardation and thickness of anisotropic substances. Any one of the three variables can be determined if the other two are known.

1.5.20
morphology
the structure and shape of a particle. Characterization may be descriptive (platy, rod-like, acicular, etc.) or in terms of dimensions such as length and diameter (see asbestiform).

1.5.21
oblique illumination
illumination by light that is at an oblique angle to the optical axis.

1.5.22
pleochroism
the change in color or hue of a colored anisotropic substance when rotated relative to the vibration direction of plane polarized light.

1.5.23
point counting
a technique used to determine the relative projected areas occupied by separate components in a microscope slide preparation of a sample. For asbestos analysis, this technique is used to determine the relative concentrations of asbestos minerals to non-asbestos sample components.

1.5.24
refractive index (index of refraction)
the ratio of the velocity of light in a vacuum relative to the velocity of light in a medium. It is expressed as *n* and varies with wavelength and temperature.

1.5.25
sign of elongation
referring to the location of the high and low refractive indices in an elongated anisotropic substance, a specimen is described as positive when the higher refractive index is lengthwise (length slow), and as negative when the lower refractive index is lengthwise (length fast).

1.5.26
trace
the quantity of asbestos that is above the laboratory's detection limit and below its limit of quantification.

1.5.27
visual estimation
an estimation of the concentration of asbestos in a sample as compared to other sample components.

1.6 Program documentation

1.6.1 Assessors use NVLAP checklists to ensure that each laboratory receives an assessment comparable to that received by others and to ensure completeness, uniformity, and objectivity. Checklists assist assessors in documenting the assessment to the NVLAP requirements. Checklists contain definitive statements or questions about all aspects of the NVLAP requirements for accreditation and form part of the on-site assessment report (see NIST Handbook 150). The current version of each checklist is available from NVLAP.

1.6.2 The NIST Handbook 150-3 Checklist (also referred to as the Bulk Asbestos Program-Specific Checklist) addresses the requirements specific to bulk asbestos analysis testing given in NIST Handbook 150-3 (this handbook), a reflection on observing test performance, testing accuracy and uncertainty, traceability and associated calibration uncertainty of standard reference materials, instrumentation, calibration, personnel competency, and test reporting.

1.6.3 All NVLAP programs use the NVLAP General Criteria Checklist, which contains the requirements published in NIST Handbook 150 and ISO/IEC 17025. The checklist items are numbered to correspond to clauses 4 through 8 of ISO/IEC 17025 and annexes A, B, and E of NIST Handbook 150.

1.6.4 NVLAP Lab Bulletins are issued to laboratories and assessors, when needed, to clarify program-specific requirements and to provide information about program additions and changes.

2 LAP establishment, development, and implementation

There are no requirements additional to those set forth in NIST Handbook 150, clause 2.

3 Accreditation process

3.1 General

An overview of the laboratory accreditation process is provided in NIST Handbook 150, clause 3, and includes information pertaining to application for accreditation; onsite assessment; proficiency testing; accreditation decision; granting accreditation; renewal of accreditation; changes to scope of accreditation; monitoring visits; and suspension, denial, revocation, and voluntary termination of accreditation.

3.2 Management system review

3.2.1 Prior to applying to NVLAP for initial or renewal of accreditation, a laboratory shall have a fully implemented management system.

3.2.2 The NVLAP assigned assessor reviews all relevant management system documentation for conformity with NVLAP requirements, including the requirements of this handbook, NIST Handbook 150, and ISO/IEC 17025. During this review, the assessor may request additional management system and/or technical documents and/or records, which will be returned upon request.

3.3 On-site assessment

3.3.1 The purpose of the onsite assessment is to determine the laboratory's compliance with ISO/IEC 17025, NIST Handbook 150, this handbook and its own management system and to assess the capability and competence of the testing activities for which accreditation is being requested.

3.3.2 The assessor will contact the laboratory to schedule a mutually acceptable date for the onsite assessment. An assessment normally takes up to two days depending on the scope of accreditation. Every effort is made to conduct an assessment with as little disruption as possible to the normal operations of the laboratory. If a laboratory requires that its established assessment date be changed, it must contact the assessor and NVLAP. The laboratory is responsible for any costs associated with the date change.

3.3.3 The onsite assessment will take place at the laboratory site. Prior to the visit, the NVLAP assessor provides a preliminary agenda, which may change based on observations during the onsite assessment. The assessor will need time and workspace to complete assessment documentation during his/her time at the laboratory site.

3.3.4 The assessor may request that all analysts who have been authorized to work on client samples participate in sample analysis and facilitate the assessor's requests as the situation permits. The samples may be selected randomly from the laboratory's sample log system, including the previous proficiency test samples. The test items should be analyzed as though

they are proficiency test samples.

3.3.5 The laboratory's facilities and equipment shall be available and in working order and be ready for examination according to the requirements identified in this handbook, ISO/IEC 17025, NIST Handbook 150, and the laboratory's management system documentation.

3.3.6 At the beginning of the onsite assessment, the laboratory shall make available all supporting technical information in a format that is conducive to a detailed review.

3.3.7 The NVLAP assessor will use the NVLAP General Criteria Checklist (ISO/IEC 17025) and the NIST Handbook 150-3 Checklist to record the results of the assessment. The checklists and the technical specifics contained in this handbook ensure that the assessment is complete and that all assessors cover the same items at each laboratory.

3.3.8 The activities covered during a typical on-site assessment are described below:

a) *Opening meeting:* The assessor will meet with laboratory management, supervisory personnel, and other personnel at the discretion of the laboratory's management to explain the purpose of the onsite assessment and to discuss the schedule for the assessment activities. Information provided by the laboratory on its application form may be discussed during this meeting.

b) *Staff interviews:* The assessor will ask the laboratory manager to assist in arranging times for individual interviews with laboratory staff members. The assessor will interview staff members filling key positions (e.g., Laboratory Manager, Technical Director, Quality Manager, Authorized Representative) and staff members who affect the outcome of the testing. The assessor may not need to talk to all staff members; however, the assessor will select staff members representing all aspects of the laboratory. These interviews are conducted to determine whether the staff members are properly trained, assigned, and supervised; are technically competent for the tasks assigned to them; and are implementing their assigned aspects of the management system in compliance with it.

c) *Records review:* The assessor will review laboratory documentation, including the management system, quality policies and procedures, equipment and maintenance records, record-keeping procedures, testing procedures, laboratory test records and reports, personnel competency records, personnel training plans and records, and safeguards for the protection of sensitive and proprietary information. The assessor may request additional information to clarify issues regarding nonconformities or to delve more deeply into technical issues.

NOTE 1 Laboratory staff must be available to answer questions; however, the assessor may review the documents and records in private. The assessor usually does not ask to remove any laboratory documents or records from the laboratory premises.

NOTE 2 Assessors do not need access to employee information that may be considered sensitive or private such as salary, medical information, or performance reviews for work done outside the scope of the laboratory's accreditation. However, this information is often stored together with technical information that an assessor will need to review (e.g., job descriptions, résumés, and technical performance reviews). In these cases, an assessor will work with the laboratory to ensure the review is performed without violating individual privacy. At the discretion of the laboratory, a member of the human resources department may be present during the review of personnel information.

d) *Internal audit and management review:* The assessor will review and discuss with the laboratory staff the laboratory's internal audit and management review activities, which are separate and distinct activities. The discussion will include all aspects of those activities including the management system procedures, the audit findings, the results of the management review, and the actions taken to resolve those findings.

e) *Equipment and software:* The assessor will examine equipment and facilities and determine whether appropriate environmental conditions are maintained. The assessor will examine hardware and software for function and appropriateness, review software validation and verification procedures.

f) *Demonstrations:* The assessor will observe demonstrations of bulk asbestos sample preparation techniques and analysis and discuss them with the technical personnel to determine their understanding of the procedures.

g) *Proficiency testing:* The assessor will discuss all aspects of proficiency testing results with appropriate staff. Test methodology and records documenting the laboratory's execution of the testing will be reviewed and discussed. Unusual trends and outlying results will be discussed.

h) *Onsite assessment report:* An assessor will complete an onsite assessment report, which summarizes the findings and clearly lists nonconformities and comments (positive or negative). This report normally consists of the Narrative Summary, the NVLAP General Criteria Checklist, and the NIST Handbook 150-3 Checklist. The first page of the report will be signed by the NVLAP assessor and the NVLAP Authorized Representative to acknowledge the discussion, but this does not necessarily indicate agreement by the laboratory. A complete onsite assessment report will be provided to the laboratory through the NVLAP Interactive Web System (NIWS).

i) *Closing meeting:* The assessor will conduct a closing meeting with the laboratory management, supervisory personnel, the authorized representatives, and other staff members at the discretion of the laboratory's management to discuss findings. During the visit, the assessor will have categorized each identified finding as either a nonconformity or a comment. These will be discussed at the closing meeting. The assessor will specifically note items that have been corrected during the on-site assessment along with any requirements for additional action. Any disagreements between the laboratory and the assessor may be referred to NVLAP for resolution.

3.4 Proficiency testing

3.4.1 Proficiency testing is required for all bulk asbestos laboratories before initial accreditation can be granted and for maintaining accreditation in the program. The test will be conducted by a proficiency testing provider in accordance with 40 CFR, Part 763, Subpart E, Appendix E or the current U. S. Environmental Protection Agency method for the analysis of asbestos in building materials, using the laboratory's normal operating procedures.

3.4.2 The laboratory shall participate in mandatory bulk asbestos proficiency testing regularly scheduled, and satisfy the following requirements:

a) analysis shall not be contracted out to another laboratory;

NOTE A laboratory that subcontracts proficiency testing to another laboratory will be immediately suspended for not participating in the test round and risks revocation of its accreditation.

b) previous proficiency tests data and associated corrective action documents shall be available for review during assessment;

c) all analysts (full and part time) shall participate in all proficiency testing rounds;

d) plans shall be developed and implemented for resolving problems with analyses;

e) appropriate laboratory personnel must discuss with participating analysts any problems with the testing and document accordingly;

f) test results shall be used for intra- and inter-analyst comparisons;

g) test results, when applicable, shall be used in determining accuracy and precision for each analyst;

h) the laboratory shall keep and use proficiency testing materials as in-house instructional materials, unless otherwise directed; and

i) proficiency testing materials shall not be considered as NIST-traceable standards.

3.4.3 Proficiency testing may involve materials or artifacts that will be returned to the proficiency testing provider for use by other participants. These materials should be protected from damage both in the laboratory and during shipment back to the proficiency testing provider. Examples of such materials and artifacts are permanently mounted slides, photographs, glasses, and special optical materials. These materials may be used to determine testing performance for specific subparts of the test method.

3.4.4 If an accredited laboratory fails a round of regularly scheduled proficiency testing, to

maintain its accreditation, it shall:

a) provide to NVLAP within 30 days of notification of the failure, detailed, written documentation that includes an analysis of why the laboratory failed, and what corrective action(s) it has taken (analyst training, revised procedures, quality assurance activities, etc.) to resolve analytical problem(s) to avoid similar errors in the future;

b) provide documentation to show that the corrective action(s) has been effective implemented; and

c) pass the next round of regularly scheduled proficiency testing or the next retest round of proficiency testing available.

NOTE The retest round of proficiency testing, provided by the proficiency testing provider in between any two consecutive proficiency testing rounds regularly scheduled, is optional and considered a make-up round to the most recent proficiency testing round regularly scheduled that the laboratory failed.

(1) If the laboratory failed the most recent regularly scheduled proficiency testing round but passed the following retest round, it is considered that the laboratory passed the most recent proficiency testing round regularly scheduled that it had failed prior.

(2) If the laboratory failed both the most recent regularly scheduled proficiency testing round and the following retest round, it is only considered that the laboratory failed the most recent proficiency testing round regularly scheduled.

3.4.5 If an accredited laboratory fails any two consecutive rounds of regularly scheduled proficiency testing, its accreditation will be immediately suspended. To have the accreditation reinstated, the laboratory shall pass the next regularly scheduled round of proficiency testing or the next retest round of proficiency testing available.

NOTE The laboratory may undergo a complete onsite assessment to determine the cause of the nonconformities. Failure to perform satisfactorily at the onsite assessment will result in continued suspension of the accreditation. The full cost of any reassessment must be paid in advance. NVLAP staff will make every effort to expedite these extraordinary assessments to give a laboratory every reasonable opportunity to demonstrate competence to perform the test method and regain accreditation.

3.4.6 Failure to participate in the latest round of proficiency testing regularly scheduled will result in the immediate suspension of accreditation. To regain accreditation, the lab shall (i) provide evidence of corrective action, including root cause of failure to participate and implementation, to NVLAP within 30 days, and (ii) pass the next regularly scheduled round of proficiency testing.

4 General requirements

4.1 Impartiality

There are no requirements additional to those set forth in ISO/IEC 17025.

4.2 Confidentiality

There are no requirements additional to those set forth in ISO/IEC 17025.

5 Structural requirements

5.1 A laboratory operating as a sub-facility shall be technically dependent on the main facility. The main facility shall provide technical management and supervision in accordance with the following requirements:

a) the nature, scope, and frequency of onsite quality assurance reviews by the main facility shall be clearly defined in the management system and be appropriate for the nature and scope of work performed by the sub-facility;

b) copies of all permanent quality assurance and personnel records shall be retained at the main facility;

c) quality assurance data from each sub-facility shall be routinely compared both to the main facility's data and data from other sub-facilities; and

d) records of such comparisons shall be retained in quality assurance records along with the actions taken to evaluate and resolve nonconformities.

NOTE NVLAP no longer accepts new sub-facilities for accreditation. Those laboratories currently listed as a sub-facility were *"grandfathered"* into the program.

5.2 NVLAP accreditation of a laboratory main facility does not extend to accreditation of its sub-facility(-ies) unless the sub-facility (-ies) has/have been evaluated separately. The sub-facility(-ies) is/are uniquely identified in the NVLAP accreditation documents.

5.3 Analysts at a sub-facility shall participate in proficiency testing and records shall be maintained of individual analyst results.

5.4 A NVLAP-accredited laboratory shall not represent test data produced at a non-accredited sub-facility as having been produced by an accredited laboratory.

6 Resource requirements

6.1 General

There are no requirements additional to those set forth in ISO/IEC 17025.

6.2 Personnel

6.2.1 General

6.2.1.1 Staff positions shall include, but not limited to, the followings:

a) NVLAP authorized representative;

b) NVLAP approved signatory(ies);

c) laboratory director;

d) technical manager;

e) quality manager;

f) analyst(s); and

g) sample coordinator.

NOTE A person may fill more than one position.

6.2.1.2 The laboratory shall maintain personnel records for each staff member including, as appropriate:

a) position description/job responsibilities;

b) résumé of qualifications;

c) results of periodic quality assurance testing reviews including intra-operator tests, inter-operator tests and interlaboratory tests; and

d) results displaying accuracy, precision summary data, and error data.

6.2.1.3 The laboratory shall be able to demonstrate that the sample workload required for each analyst is consistent with accurate and precise analytical measurement.

6.2.2 Training

6.2.2.1 The laboratory shall have a written description of its training program for new and current staff members, which includes training with standards, blind testing and reference materials available in the laboratory to determine competency and criteria for successful completion.

6.2.2.2 Analysts and technical supervisors shall participate in an appropriate form of continuing education, such as formal coursework, in-house education, and scientific or technical meetings, and shall have access to journals that describe advances in the field of polarized light microscopy and/or asbestos analysis.

6.2.2.3 Reference documents, texts, journals, and current scientific and industry periodicals shall be made available to all analysts to keep their knowledge up-to-date and shall include, as a minimum, the documents listed in section 1.4 of this handbook.

6.2.2.4 The laboratory shall establish and document performance criteria to determine when a new analyst is qualified to work independently. The laboratory training shall include:

a) criteria for successful completion and a documented training plan outlining the on-going process of practice and professional development;

b) training with blanks and blind testing;

c) comparison with either an experienced analyst (with an acceptable error rate), or by an independent technique, until the analyst has attained an acceptable error rate;

d) the cumulative error rate must be below 1% as calculated by the total errors (sum of false positive, false negative and type error) divided by the total quality assurance (QA) samples of both the new analyst and the verifying analyst;

e) all training-related test results recorded in the personnel folder or equivalent of each staff member. Testing techniques may include, but not be limited to, reanalysis of materials, intra- and inter-laboratory comparison, analysis of standards, reference materials, NVLAP proficiency testing materials, and blind testing;

f) routine testing conducted to ensure performance and quality analyses. Test specimens should include asbestos-containing and look-alike materials routinely examined by the analysts, and those not often encountered; and

g) issues identified with competence and/or training shall be documented in the monthly quality assurance summary and discussed with the analyst and corrected according to documented procedures. Subsequent quality assurance tests shall determine whether the problem has been corrected.

6.2.3 Technical director and analyst

6.2.3.1 The laboratory shall ensure that the technical personnel (technical director and analysts) utilizing polarized light microscopy understand the technique and:

a) its application to crystalline materials sufficiently to conduct analysis;

b) what the various optical properties are, how they are measured or observed in the microscope, and how the data are used to form a conclusion about the identity of the component, *(e.g., an analyst using central and/or annular focal screening (dispersion staining) to measure refractive index must be able to explain what produces the observed color and how that color is used to determine refractive index)*;

c) are able to properly align the microscope and identify all crucial parts;

d) are able to measure all optical properties required for the identification of regulated asbestos types, including the index of refraction by the immersion method;

e) knowledge of several techniques of refractive index measurement (e.g., Becke line, dispersion staining and oblique illumination); and

NOTE Other analytical methods (e.g., x-ray diffraction, transmission electron microscopy, and scanning electron microscopy) may also be helpful.

f) the analytical results produced by new staff members shall be checked by an analyst whose performance has been demonstrated to be acceptable, or by using an independent technique, until the new staff member demonstrates the required level of performance.

6.2.3.2 Technical directors shall have a fundamental knowledge of the test method to ensure the quality of the laboratory's results.

6.3 Facilities and environmental conditions

6.3.1 Functional spaces for designated sample preparation and analysis shall be separated effectively to assure the quality of the results and to limit cross-contamination.

6.3.2

6.3.2.1 The workspace shall be monitored for asbestos contamination on a routine basis.

6.3.2.2 The laboratory shall have procedures for the use of blanks of asbestos- and fiber-free material to determine the presence, quantity, and consistency of asbestos contamination in their analytical process.

6.3.2.3 Laboratory blanks shall be prepared and analyzed with adequate frequency to detect

contamination of laboratory equipment or supplies, including, but not restricted to, glass slides, cover slips, refractive index liquids, sampling instruments, analytical instruments (microscopes), workstations, and cleaning fluids.

6.3.2.4 Safe working conditions shall be maintained while handling bulk asbestos samples.

6.4 Equipment

6.4.1 Samples retained for the purpose as reference materials shall be stored so that identification is properly maintained and be readily retrieved.

6.4.2 Polarized light microscope shall have the following characteristics:

a) binocular or monocular with crosshair reticle or functional equivalent that locks into position, or is marked, and that does not rotate during normal operation of the microscope;

b) one of the oculars must have a magnification of at least 10X;

c) low (≥ 5X and ≤ 15X), medium (> 15X and < 40X), and high (≥ 40X) objectives, or similar magnifications;

d) light source;

e) 360-degree rotatable stage;

f) substage condenser with iris diaphragm;

g) polarizer and analyzer that can be placed at 90 degrees to one another; both the polarizer and the analyzer shall have a locking mechanism so that their relative positions can be fixed to avoid any unintended changes during the analysis;

h) accessory slot at 45° to polarizers for wave plates and compensators;

i) first order red (or λ) compensator (530-550 nm retardation);

j) dispersion staining objective complete with accessories if the dispersion staining method is used for determining the refractive index; and

k) test slide of orthorhombic fibers, such as anthophyllite from SRM 1867, or other straight fibers of parallel extinction, such as polypropylene, polyethylene, etc., for aligning crosshairs with the privileged directions of the polarizer and analyzer.

6.4.3 The laboratory shall ensure the optical system is in proper working condition, including objectives, condensers, polarizers, etc., which shall not be damaged or modified in any way that would affect microscope resolution or depolarize the light (i.e., the lens is relatively free of scratches, nicks, corrosion, signs of impact, etc., and there is no stop in the back focal plane other than for dispersion staining objectives).

6.4.4 The laboratory shall have the following equipment and materials:

a) low-power binocular or stereomicroscope, approximately 10-45X, with light source;

b) biohazard hood of Class I or better for sample receipt, processing and preparation;

NOTE A Class I Biohazard Hood or recirculating hood with a HEPA filter is required for the safe and non-contaminating handling of bulk asbestos materials in the laboratory. For the accreditation program, the purpose of the hood is to protect the laboratory environment from contamination with the potentially large quantities of asbestos handled during routine preparation and macroscopic examination of building materials. A Class I hood is a ventilated cabinet for personnel and environmental protection, with an inward airflow away from the operator. The cabinet exhaust air must be treated to protect the environment before it is discharged to the outside atmosphere or must exhaust HEPA-filtered air back into the laboratory. A minimum inward velocity of air into the hood opening of 75 fpm is recommended. [Reference: NSF/ANSI 49, NSF International, P. O. Box 130140, 789 N. Dixboro Road, Ann Arbor, MI 48105, (734) 769-8010 or <info@nsf.org>.]

c) sampling utensils (tweezers, razors, knives, forceps, probe needles, pliers, etc.);

d) sample containers (glassine paper, glass plates, ceramic bowls, petri dishes, etc.);

e) microscope slides and cover slips;

f) agate mortar and pestle;

g) thermometer with a valid calibration document (produced internally or provided by an outside source) that will allow the laboratory to meet NVLAP requirements;

h) refractive index liquids: 1.490-1.570, 1.590-1.720 in increments of less than or equal to 0.005 and calibrated with an accuracy of ± 0.004;

i) NIST-traceable standards for the major asbestos types (SRM 1866 and 1867) or equivalent; and

j) calibrated refractive index solids or refractometer (or access to one) for the calibration of refractive index liquids.

6.4.5 When a laboratory produces its own refractive index liquids to meet the requirement of 6.4.4h, the product must also meet the following requirements:

a) a lab that makes its own refractive index liquids shall demonstrate its ability to do so. It shall meet the requirements as set forth in the NIST Handbook 150 and Handbook 150-3 for references and standards;

b) the accuracy and precision of the refractive index liquid shall be calibrated or measured at ± 0.0005 or better;

c) the temperature coefficient shall be obtained by actual measurements of the refractive indices of the liquid at least to consider the laboratory's ambient temperature variations, and the accuracy of the refractive indices' measurements shall meet the requirement of 6.4.4b;

d) a laboratory that utilizes the dispersion staining method to measure the refractive indices of the asbestos minerals shall measure the dispersion coefficient (i.e., nF-nC); and

e) the dispersion coefficient (nF-nC) shall be obtained by actual measurements of the refractive indices of both the Fraunhofer F and C lines in the light spectrum, and the accuracy and precision of the refractive index measurement shall be at ± 0.001 or better.

6.5 Metrological traceability

6.5.1
The laboratory shall have reference materials and, if available, NIST Standard Reference Materials (SRMs) with certificates for chrysotile, amosite, crocidolite, tremolite, actinolite, anthophyllite and glass fiber.

6.5.2 The laboratory shall have a written procedure describing how reference materials are used to verify the accuracy of an analyst's ability to correctly determine the optical properties of asbestos. The difference of the refractive index measurement by the analyst to the NIST SRM asbestos minerals shall be controlled within ± 0.004 of the NIST SRM fit value.

6.5.3 The laboratory shall have a written procedure describing how the refractive index liquids used are calibrated by utilizing reference materials.

6.6 Externally provided products and services

6.6.1 A laboratory that subcontracts AHERA work shall do so with another NVLAP-accredited laboratory for bulk asbestos analysis.

6.6.2 A laboratory shall not represent test data produced at a non-accredited laboratory as having been produced by an accredited laboratory.

7 Process requirements

7.1 Reviews of requests, tenders and contracts

There are no requirements additional to those set forth in ISO/IEC 17025.

7.2 Selections, verification and validation of methods

7.2.1 Selection and verification of methods

a) the laboratory shall use the U.S. Environmental Protection (EPA) Agency's *Interim Method for the Determination of Asbestos in Bulk Insulation Samples*, as found in 40 CFR, Part 763, Subpart E, Appendix E, or the current EPA method for the analysis in building materials;

b) if departures from the test method are made, the laboratory shall have written procedures detailing how the analyses are conducted;

c) the laboratory shall have a written procedure for the analysis of samples and methods to ensure the accuracy and precision of analyses. The analytical procedure shall detail the PLM test method, including the measurement of each of the required optical/physical properties, as it is applied in the laboratory (a copy of the AHERA test method is not adequate);

d) the laboratory shall have a clear and documented definition of each asbestos type that includes the acceptable optical properties (e.g., such as the range in refractive indices) that the fibers can exhibit and still be identified as a specific type of asbestos, and what constitutes asbestiform morphology;

e) the laboratory shall determine the identification of fibrous materials by measuring the optical properties;

f) the laboratory shall have a written procedure for dealing with samples in which the fibers are heavily coated with binder that hinders analysis;

g) the laboratory shall maintain a list of non-asbestos fibers that can be confused with asbestos and the specific optical properties for each that can be used to distinguish between asbestos and non-asbestos;

h) the laboratory shall measure and record at least one optical property for non-asbestos fibers that serves to distinguish them from asbestos;

i) the laboratory shall have specific sample preparation techniques for dealing with samples that are semi- or non-friable;

j) the laboratory shall use the point-count technique or a technique that is demonstrated, and documented, to be equivalent for quantitative analysis;

k) the laboratory shall homogenize the sample in some way, or analyze enough sub-samples, to obtain a representative analysis (at least three sub-samples for negative samples, as per the Federal Register Notice, August 1, 1994); and

l) the laboratory shall have a working definition of trace and be able to distinguish between trace concentrations of asbestos and concentrations near 1 %.

NOTE It is important to differentiate the following two cases for a very practical reason: whether additional analysis by a different method is warranted to ascertain the asbestos concentration reported by the PLM analyst.

i. When reporting the asbestos content as "trace," the analyst ascertains that although there are asbestos fibers in the sample, its concentration is so low that it is far from the level of 1 % by calibrated visual estimate (CVE) or point counting. In this case, the analyst is confident that it is not necessary to make a recommendation to the customer results.

ii. When reporting the asbestos content as near to, but less than 1 %, the analyst ascertains that the asbestos concentration is not equal to, or higher than, 1 % by CVE or point counting. Due to the inherent uncertainty of the quantification technique(s) employed during analysis, the analyst should recommend to the customer that verification of the results is necessary by a more accurate and precise method.

7.2.2 Validation of methods

If an estimation technique is used that is equivalent to point counting, the laboratory shall use one or more of the following for validation of the method and have data to show equivalency:

a) bulk standards: (Percent asbestos in these standards shall have been determined by non-visual estimation method(s). This could include repeat analysis by point counting, by quantitative XRD, or by gravimetric measurement of asbestos during sample formulation);

b) prepared (permanent) slides that have been point-counted;

c) photomicrographs of grain mounts that have been calibrated for relative area; and

d) other appropriate standards.

7.3 Sampling

Specific sampling procedures shall be documented, especially for samples containing multiple layers.

NOTE All requirements of ISO/IEC 17025 for sampling apply to sub-sampling.

7.4 Handling of test or calibration items

7.4.1 The laboratory shall have a written procedure and a sample log system used to uniquely identify the test item and document the action. The log shall include:

a) the date of receipt of the test item;

b) the condition of the test item;

c) documentation of acceptance or rejection of the test item, reasons for rejection (e.g., air samples mixed with bulk samples, etc.);

d) a unique laboratory identification number for each test sample;

e) the client identification number, which is the number that the client (or sample taker) assigned to the test item; and

f) the initials of the person making the above entries in the sample log system.

7.4.2 When there is any doubt as to the test item's suitability for testing (e.g., sample size too small, a mismatch between identification and description, or whether it is of a type which cannot be analyzed by the laboratory), the laboratory shall have a procedure for informing the client and resolving the problem. This action shall be documented.

7.4.3 The laboratory shall have a written procedure(s) describing the following:

a) sample custody and handling (i.e., sample receipt, log-in, storage and disposal);

b) proper storage of materials to prevent damage or cross contamination;

c) sample retention (hold samples for a minimum of thirty days after analysis unless earlier return is requested by the client or prevented by law or regulation);

d) disposal/return of bulk samples (including retaining the documentation with all other data and information regarding the sample); and

e) safe disposal of bulk samples and in accordance with any, and all, federal, state and local regulations.

NOTE Because of the legal issues surrounding asbestos analysis, laboratories may consider keeping samples indefinitely or returning the samples to the client with a signed chain-of-custody form.

7.5 Technical records

7.5.1 The laboratory shall record the stereomicroscopic data for bulk examination to include:

a) homogeneity;

b) texture;

c) color; and

d) concentration of asbestos.

7.5.2 The laboratory shall record the following data for the asbestos type(s) identified by PLM examination and shall not be automatically generated by the LIMS software:

a) morphology;

b) color and pleochroism;

c) indices of refraction (n_D) parallel and perpendicular for each asbestiform;

d) birefringence;

e) extinction characteristics including measurement of extinction angles if observed;

f) sign of elongation;

g) concentration of asbestos;

h) temperature at the workstation at the time of analysis;

i) result of the analysis;

j) identification of the analyst; and

k) date of the analysis.

7.6 Evaluation of measurement uncertainty

7.6.1 The laboratory shall determine the precision and accuracy of the analyses on the types of samples received for analysis.

7.6.2 Precision and accuracy shall be determined for quantitative analyses.

7.6.3 For qualitative analyses, the laboratory shall determine whether multiple analyses of the same sample, either by the same or different analysts, and/or by different analytical techniques, yield the same results (asbestos present or not, and type of asbestos) and whether they are correct.

7.6.4 For quantitative analyses, the laboratory shall determine an average value for the concentration of asbestos in the sample, with an associated measurement uncertainty.

7.6.5 To document the positive identification of asbestos in a sample, the laboratory shall record the average optical properties for the population (multiple fibers) of each asbestos type, including morphology, color and pleochroism, indices of refraction (n_D), birefringence, extinction characteristics, sign of elongation, and any other distinguishing characteristics observed. These properties shall not be automatically produced by an automated system.

a) For chrysotile and amosite, refractive indices shall be determined parallel and perpendicular to elongation with an accuracy of ± 0.005.

b) For anthophyllite, tremolite, and actinolite, α and γ, instead of refractive indices parallel and perpendicular to elongation, shall be measured. The refractive indices shall be determined parallel and perpendicular to elongation with an accuracy of ± 0.005.

c) For crocidolite, the refractive indices shall be determined parallel and perpendicular to elongation with an accuracy of approximately ± 0.01.

7.7 Ensuring the validity of results

7.7.1 The laboratory shall have a qualitative error rate of less than 1 % for each analyst, which is calculated by dividing the number of qualitative errors (false negatives, false positives, and asbestos types) by the total number of QA samples (excluding any laboratory blanks).

7.7.2 The laboratory shall identify problem samples, such as floor tiles, that are difficult to analyze qualitatively and shall have a specific written procedure to deal with problem samples to reduce errors to less than 1 %.

7.7.3 The laboratory shall determine precision on the quantitative analyses of samples by:

a) repeatability: repeat analyses by the same analyst;

b) comparison of results from multiple slide mounts of the same material;

c) reproducibility: analysis of samples by multiple analysts if possible (single analyst laboratories require more interlaboratory data, such as participating in more than one exchange program); and

d) interlaboratory analysis: analysis of samples by other laboratories.

7.7.4 The laboratory shall determine the accuracy of the qualitative and quantitative analyses

of samples by:

a) analysis of proficiency testing materials;

b) analysis of standards, either prepared in-house or purchased; and

c) analysis of samples using independent methods (e.g., XRD, gravimetry, etc.).

7.7.5 The laboratory shall ensure that the quality assurance analyses represent at least 10 % of the total number of analyses performed.

7.7.6 Quality assurance analyses shall be performed regularly covering all time periods, sample types, instruments, tasks, and personnel. The number of QA samples per period shall be identical and proportional to the sample workload to avoid intentional dilution of the error rate.

7.7.7 The selection of QA samples shall be semi-random, focusing more on positive samples and when possible, the checks on personnel performance executed without their prior knowledge.

7.7.8 The laboratory shall maintain and summarize all quality assurance activities at least monthly to include:

a) contamination checks using asbestos-free, non-fibrous material;

b) internal and NIST proficiency testing for each analyst;

c) overall accuracy and precision for each analyst for qualitative and quantitative analyses as defined in its management system;

d) control charts for accuracy and precision;

e) identification of any sample custody errors, such as mixing up samples, losing samples, etc.;

f) comparison of results of independent techniques with PLM results, if appropriate;

g) deficiency corrections; and

h) the total qualitative error rate of the laboratory and for each analyst.

7.7.9 For qualitative analyses, the laboratory shall determine whether multiple analyses of the same sample, either by the same or different analysts, and/or by different analytical techniques, yield the same results (asbestos present or not, and type of asbestos) and whether

they are correct.

7.7.10 The laboratory shall have a documented procedure for constructing control charts, including the algorithms for calculating warning and control limits. If the data reaches or exceeds the laboratory's own control limits, a corrective action shall be initiated.

7.7.11

a) The laboratory shall have a written procedure for handling, analysis, and use of proficiency testing materials.

b) The procedure shall include that the proficiency test samples be analyzed and entered in the laboratory's sample log as client samples.

c) The laboratory shall have a written procedure for performing calculations and for independently checking the reported values prior to submittal to the proficiency testing provider.

7.8 Reporting results

7.8.1 Common requirements for reports (test, calibration or sampling)

7.8.1.1 Each test report shall include, but not limited to:

a) color (and any other information that serves to macroscopically identify and describe the sample);

b) presence or absence of asbestos;

c) type or types of asbestos present;

d) the area percent for each type of asbestos present;

e) identify of fibrous materials (if known);

f) the area percent of fibrous materials present;

g) identity of matrix materials (if known);

h) a statement to indicate if the sample is inhomogeneous and if sub-samples of the components were analyzed separately;

i) a description of any problems encountered in the analysis;

j) departures from the test method; and

k) an approved signatory's signature.

7.8.1.2 The laboratory shall report the results for samples containing one or more layers consistent with the most current EPA guidelines.

7.8.1.3 The laboratory shall ensure that any report issued electronically shall be in a tamper-resistant format.

7.8.1.4 The laboratory shall not composite the results for layered samples without reporting each individual layer as a separate sample unless a disclaimer is made clear on the report that the results are a deviation from the method. In either situation, each individual layer must be analyzed and recorded.

7.8.2 Specific requirements for test reports

7.8.2.1 The laboratory test reports shall include:

a) Indication of the presence or absence of asbestos and, if presence, the identification of each asbestos type;

b) the average area percentage (or weight percentage), accompanied by an estimate of the error rate, for each type of asbestos present;

c) identity and area percentage of other fibrous and matrix materials, if known; and

d) color and macroscopic description (and any other information that serves to identify and describe the sample).

7.8.2.2 Specific sampling procedures shall be described where appropriate. This is especially important for samples containing multiple layers.

7.9 Complaints

There are no requirements additional to those set forth in ISO/IEC 17025.

7.10 Nonconforming work

There are no requirements additional to those set forth in ISO/IEC 17025.

7.11 Control of data and information management

7.11.1 The laboratory shall not use computerized systems that provide default optical measurements and physical properties that are characteristic to identification (such as color, morphology, texture, etc.). Laboratories shall have documentation to show that analysts are measuring optical data by PLM examination.

7.11.2 If original data are entered using a computer, the laboratory shall record the determined refractive indices into the corresponding fields. A set of fixed default values of refractive indices for respective asbestos types automatically generated by the computer is not acceptable.

8 Management system requirements

8.1 Options

There are no requirements additional to those set forth in ISO/IEC 17025.

8.2 Management system documentation

If the laboratory documentation does not follow the outline of ISO/IEC 17025, a cross-reference document shall be developed and available to verify that the laboratory meets the requirements.

8.3 Control of management system documentation

There are no requirements additional to those set forth in ISO/IEC 17025.

8.4 Control of records

8.4.1 The laboratory shall retain all records for a minimum of three years, unless a longer time period is required by the client, regulation, or the laboratory's own procedures.

8.4.2 The records maintained by the laboratory shall include, but not limited to:

a) sample custody records;

b) original data collected (including all required optical data for each analysis it performs), signed (or initialed), and dated by the analyst;

c) contamination monitoring data;

d) calibration and verification data;

e) data and results of quality control;

f) equipment and maintenance records;

g) test reports;

h) records of proficiency testing results for each analyst; and

i) management system records identified by ISO/IEC 17025:2017.

8.5 Actions to address risks and opportunities

There are no requirements additional to those set forth in ISO/IEC 17025.

8.6 Improvement

There are no requirements additional to those set forth in ISO/IEC 17025.

8.7 Corrective actions

There are no requirements additional to those set forth in ISO/IEC 17025.

8.8 Internal audits

The laboratory shall conduct an internal audit, at a minimum, on an annual basis.

8.9 Management reviews

The laboratory shall conduct a management review, at a minimum, on an annual basis.

Appendix A Change log

The following main changes have been made to this handbook with respect to the previous edition:

- the numbering has been updated to reflect that used by ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*; (hereafter referred to as ISO/IEC 17025);

- all references to applicable international guides and standards have been updated;

- Laboratory Bulletins previously issued for clarification, have been incorporated into this edition of the handbook; and

- Onsite assessment checklists and the test method selection list are no longer included as they are provided as separate documents.