~~Designation:E2356–09~~ Designation: E2356 – 10

Standard Practice for Comprehensive Building Asbestos Surveys[1]

This standard is issued under the fixed designation E2356; 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.

1. Scope

1.1 This practice describes procedures for conducting comprehensive surveys of buildings and facilities for the purpose of locating, identifying, quantifying, and assessing asbestos-containing materials.

1.2 The results of a Comprehensive Building Asbestos Survey are intended to be used for ongoing management of asbestos-containing materials, including Operations and Maintenance (O&M), removal, and other response actions. This includes response actions associated with renovations. A Comprehensive Building Asbestos Survey is also intended to provide information required for removal of asbestos-containing materials prior to demolition of a building or facility.

1.3 This practice discusses three types of surveys: Baseline Surveys, Project Design Surveys, and Pre-Construction Surveys.

1.4 This practice discusses the following activities for each of the above types of surveys:

1.4.1 Planning the survey to meet defined objectives;

1.4.2 Obtaining and reviewing information on the building or facility including previous surveys and response actions;

1.4.3 Conducting the physical activities of inspecting the premises and collecting bulk samples of suspect materials;

1.4.4 Analyzing the bulk samples for asbestos type and content;

1.4.5 Assessing the Current Condition and Potential for Disturbance of asbestos-containing materials; and

1.4.6 Preparing a report that includes a narrative discussion of the findings, tabulations of inspection, sampling and analysis results, graphical depiction of the areas inspected, and the results of the assessment.

1.5 A Comprehensive Building Asbestos Survey provides sufficient information about the asbestos-containing materials in a building or facility for purposes of a real property transaction. In situations where the amount of information required by a party to the transaction is minimal, a Limited Asbestos Screen (see Practice E2308) may suffice in place of the Comprehensive Building Asbestos Survey.

1.6 This practice does not include air sampling or surface (dust) sampling for purposes of evaluating a potential exposure hazard from airborne asbestos fibers.

1.7 **Warning—**Asbestos fibers are acknowledged carcinogens. Breathing asbestos fibers can result in disease of the lungs including asbestosis, lung cancer, and mesothelioma. Precautions in this practice should be taken to avoid creating and breathing airborne asbestos particles from materials known or suspected to contain asbestos. See 2.2 for regulatory requirements addressing asbestos.

1.8 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.9 *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 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

E736 Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members

E1368 Practice for Visual Inspection of Asbestos Abatement Projects

E1494 Practice for Encapsulants for Spray- or Trowel-Applied Friable Asbestos-Containing Building Materials

[1] This practice is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.24 on Building Preservation and Rehabilitation Technology.

~~Current edition approved Nov. 1, 2009. Published June 2010. Originally approved in 2004. Last previous edition approved in 2004 as E2356–04ε1 . DOI: 10.1520/E2356-09.~~

Current edition approved Oct. 1, 2010. Published December 2010. Originally approved in 2004. Last previous edition approved in 2009 as E2356 – 09. DOI: 10.1520/E2356-10.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E2308 Guide for Limited Asbestos Screens of Buildings
E2394 Practice for Maintenance, Renovation and Repair of Installed Asbestos Cement Products
MNL-23 Manual on Asbestos Control: Surveys, Removal, and Management – Second Edition, 2005
2.2 *Other Documents:*
29 CFR 1910.1001 Occupational Exposure to Asbestos (OSHA General Industry Standard)[3]
29 CFR 1915.1001 Occupational Exposure to Asbestos (OSHA Shipyard Standard)[3]
29 CFR 1926.1101 Occupational Exposure to Asbestos (OSHA Construction Standard)[3]
40 CFR Part 61 National Emission Standards for Hazardous Air Pollutants: Subpart M—Asbestos[3]
40 CFR Part 763 Subpart E—Asbestos-Containing Materials in Schools (EPA AHERA Regulations)[3]
40 CFR Part 763 Subpart E, Appendix C (EPA Model Accreditation Plan)[3]
Asbestos Abatement and Management in Buildings: Model Guide Specification [4]
EPA 20T-2003 Managing Asbestos in Place: A Building Owner's Guide to Operations and Maintenance Programs for Asbestos-Containing Materials ("Green Book"), July 1990[3]
EPA 560/5-85-024 Guidance for Controlling Asbestos-Containing Materials in Buildings ("Purple Book"), 1985[3]
EPA 560/5-85-030A Asbestos in Buildings: Simplified Sampling Scheme for Surfacing Materials ("Pink Book"), 1985[3]
EPA 600R-04/004 Research Method for Sampling and Analysis of Fibrous Amphibole in Vermiculite Attic Insulation, January 2004[3]
EPA 600/R-93/116 Method for the Determination of Asbestos in Bulk Building Materials, June 1993[3]
Guidance Manual: Asbestos Operations and Maintenance Work Practices [4]
State of New York Environmental Laboratory Approval Program (ELAP) Certification Manual, Item No. 198.1 Polarized Light Microscopy Method for identifying and Quantifying Asbestos in Non-Friable Organically Bound Bulk Samples, May 15, 2000[5]
State of New York Environmental Laboratory Approval Program (ELAP) Certification Manual, Item No. 198.4 Transmission Electron Microscopy Method for identifying and Quantifying Asbestos in Non-Friable Organically Bound Bulk Samples, March 1, 1997[5]

3. Terminology

3.1 *Definitions*—For definitions of building terms, see Terminology E631.
3.2 *Terms Defined in Practice E1368*—The user is referred to Practice E1368 for terms specifically related to asbestos abatement for purposes of a Project Design Survey.
3.2.1 *asbestos-containing materials*, *n*—material containing more than one percent asbestos.
3.2.1.1 *miscellaneous materials, n*—material, other than surfacing material and thermal system insulation, on interior and exterior structural, mechanical, electrical, or architectural components, and surfaces. Miscellaneous material includes but is not limited to ceiling tiles, gaskets, floor coverings and mastics, wallboard joint compound, roofing materials, and cementitious products.

3.2.1.2 *surfacing material, n*—material that is sprayed, troweled-on, or otherwise applied to interior and exterior structural and architectural surfaces. Surfacing material includes acoustical plaster on ceilings, fireproofing on structural members, textured paint and exterior stucco, and other materials applied to surfaces for acoustical, decorative, fireproofing, and other purposes.
3.2.1.3 *thermal system insulation, n*—material which is applied to interior and exterior mechanical components to reduce heat gain or loss. Thermal system insulation includes insulation on pipes, fittings, boilers, breeching, tanks, ducts, and other mechanical components.
3.2.2 *crawl space*, *n*—an accessible area that may have a dirt floor, usually with low head room.
3.2.3 *dust and debris*, *n*—visible particles, fragments, or chunks of material, large enough to have settled in the work area by virtue of their weight, that are presumed to have originated from the material abated by the response action, or from a fiber release episode.
3.2.4 *fiber release episode*, *n*—uncontrolled or unintentional disturbance of asbestos-containing materials which results in the generation of dust and debris.
3.2.5 *friable material*, *n*—material easily crumbled or powdered by moderate (hand) pressure.
3.2.6 *response action*, *n*—a method of abatement (such as removal, encapsulation, or enclosure) or operations and maintenance (such as repair, clean-up, or preventive measures) of asbestos-containing material in any form, for any purpose whatsoever.
3.2.7 *visual inspection process*, *n*—the activities before, during, and at the conclusion of a response action that are associated with detecting the presence of visible residue, dust and debris, or unremoved material and verifying the absence thereof at the completion of a response action.

[3] Available from United States Environmental Protection Agency (EPA), Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov.
[4] Available from National Institute of Building Sciences (NIBS), 1090 Vermont Avenue, NW, Suite 700 Washington, DC 20005, http://www.nibs.org.
[5] Available from the Environmental Laboratory Approval Program (ELAP), Wadsworth Center, P.O. Box 509, Albany, NY 12201, http://www.wadsworth.org/labcert/elap/elap.htm.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *asbestos*, *n*—the asbestiform varieties of: chrysotile (serpentinite); crocidolite (riebeckite); amosite (cummingtonite-grunerite); anthophyllite; tremolite; and actinolite.

3.3.2 *accessible location*, *n*—a functional space or part thereof that can be inspected without requiring destructive testing or presenting an unacceptable health or safety risk to the inspector, and where entry is not prohibited by security or other institutional restrictions.

3.3.3 *building asbestos survey*, *n*—an activity to determine the presence, location, condition, and quantity of asbestos-containing materials in a building or facility, or on the property containing the building or facility.

3.3.4 *bulk sample*, *n*—a sample of suspect asbestos-containing material collected for identification of asbestos and determination of the percent of the components in the sample.

3.3.5 *concealed space*, *n*—a location requiring destructive testing for penetration of a building or component surface for inspection and, if necessary, sampling of suspect material. Concealed spaces include, but are not limited to, cavities inside soffits, walls and chases, plenums above solid ceilings, sub-floor ducts and cable runs, and the interior of HVAC equipment.

3.3.6 *destructive testing*, *n*—inspection procedures that necessarily involve objectionable or noticeable damage to building surfaces, or require penetration of a surface such as a wall, ceiling, chase, or shaft to gain access to a concealed space. Lifting a ceiling tile or opening a hatch is not destructive testing.

3.3.7 *excluded area*, *n*—a functional space or part thereof where entry is prohibited by security or other institutional restrictions.

3.3.8 *functional space*, *n*—an area within a building or facility that is used for a specific purpose. Examples include a warehouse in a manufacturing plant and a conference room in an office building. A functional space can be vertical in extent, such as a pipe chase, and span several floors.

3.3.9 *homogeneous area*, *n*—surfacing material, thermal system insulation material, or miscellaneous material that is uniform in color and texture and apparent or known date of installation.

3.3.10 *laboratory*, *n*—an entity that is equipped and qualified to perform one or more of the following analyses, using approved methods: *(1)* identify and quantify asbestos in bulk samples by Polarized Light Microscopy, *(2)* identify and quantify asbestos in bulk samples by Transmission Electron Microscopy, and *(3)* identify and quantify airborne fibers with Phase Contrast Microscopy.

3.3.11 *limits of abatement*, *n*—an area where asbestos-related activities will be conducted before, during and at the conclusion of the project, that is contiguous with and includes the limits of construction for an associated renovation or demolition project.

3.3.12 *non-friable organically bound (NOB) materials*, *n*—materials that are not friable and that consist of fibers and other particulate matter embedded in a solid matrix of asphaltic, vinyl or other organic substances.

3.3.13 *operations and maintenance (O&M) program*, *n*—a proactive management program to provide periodic surveillance of asbestos-containing materials, maintain them in good condition, mitigate fiber release from existing asbestos-containing materials, and clean up asbestos-containing dust and debris that has been released, in order to minimize worker or occupant exposure to asbestos fibers.

3.3.14 *polarized light microscopy (PLM)*, *n*—a method of analytical mineralogy that uses an optical microscope to determine the optical properties of sample constituents and, in the case of bulk sample analysis for asbestos, to provide positive identification of suspect fibers as asbestos and to quantify the percent of asbestos in the sample.

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3.3.15 *skim coat*, *n*—a thin finish coat applied to an existing plaster surface or other substrate to improve appearance or other reasons.

3.3.16 *suspect material*, *n*—material that is sampled or is presumed to contain asbestos on the basis of its location, purpose, appearance, and other factors considered by the inspector.

3.4 *Acronyms:*

3.4.1 *ACM*—Asbestos-containing material(s)

3.4.2 *AHERA*—Asbestos Hazard Emergency Response Act

3.4.3 *EPA*—U.S. Environmental Protection Agency

3.4.4 *HEPA*—High Efficiency Particulate Air

3.4.5 *NAD*—No Asbestos Detected

3.4.6 *NESHAP*—National Emission Standards for Hazardous Air Pollutants; specifically, the National Emission Standard for Asbestos (40 CFR Part 61, Subpart M)

3.4.7 *NOB*—Non-friable organically-bound

3.4.8 *OSHA*—U.S. Department of Labor, Occupational Safety and Health Administration

3.4.9 *PPE*—Personal Protective Equipment

3.4.10 *PLM*—Polarized Light Microscopy

3.4.11 *TEM*—Transmission Electron Microscopy

3.4.12 *VAI*—Vermiculite Attic Insulation

4. Significance and Use

4.1 Management of asbestos-containing materials in buildings and facilities requires knowledge of the location, type, quantity, and condition of the material. The more complete and accurate the information available, the more appropriate and cost-effective

are the control measures used to reduce possible exposure to airborne asbestos fibers. This is true whether the asbestos-containing materials remain undisturbed and completely intact, are selectively removed for maintenance or prior to renovation, or are removed to the greatest extent feasible before demolishing the building or facility.

4.2 This practice describes three types of surveys that support different objectives. These are the Baseline Survey, the Project Design Survey, and the Pre-Construction Survey.

4.2.1 The Baseline Survey is a building-wide or facility-wide inspection that provides a general sense of the overall location, type, quantity, and condition of asbestos-containing materials present. It is thorough in that most accessible functional spaces are inspected and bulk samples taken of suspect materials observed. The baseline survey provides information for long-term management of asbestos-containing materials and prioritization of response actions. The presence of asbestos in suspect materials may be assumed or presumed in some cases without bulk samples being taken or analyzed. However, the baseline survey is unobtrusive in that samples are not taken where doing so would result in objectionable damage to surfaces or where institutional barriers preclude access. In a baseline survey, destructive testing is avoided. Posting of signs and labels required for compliance with OSHA regulations would use the information generated during a Baseline Survey.

NOTE 1—A Baseline Survey is sometimes called an "AHERA" survey because it provides the type of information used for management of asbestos-containing materials in schools. However, the baseline survey described in this practice requires inspection, bulk sampling, quantification, and assessment of suspect materials that are excluded by virtue of their type and location from the AHERA regulations for schools.

NOTE 2—Suspect material subject to disturbance by planned or emergency maintenance may not always be identified as to asbestos content in a Baseline Survey. Collecting a single bulk sample, or a small number of samples, to determine if the material contains asbestos does not constitute a survey within the meaning of this practice. Nonetheless, the sample(s) should be collected in accordance with the methods described in Appendix X1 (this must be done by a properly-credentialed individual) and analyzed as set forth in 6.5.

4.2.2 The Project Design Survey is more focused than a Baseline Survey and is used to provide information to the Project Designer for preparing abatement plans and specifications. The locations inspected are limited to the areas that will be affected by the abatement project. If the project is being done prior to renovation or demolition, the construction plans or at least a clear statement of the scope of the renovation or demolition work are required for a proper Project Design Survey. Destructive testing is often required for a Project Design Survey. The presence of asbestos in suspect materials is always confirmed in a Project Design Survey rather than being assumed or presumed. Other information required for the Project Design is collected during the survey.

4.2.3 The Pre-Construction Survey is performed in anticipation of renovation or demolition where a Baseline Survey has not been conducted and there is no information, or insufficient information, as to the existence of asbestos-containing materials within the planned limits of construction. The Pre-Construction Survey requires destructive testing if concealed spaces are to be breached during construction. If asbestos-containing materials are found, a Project Design Survey is conducted to provide information for preparing the plans and specifications. The Pre-Construction Survey satisfies the EPA NESHAP requirements for renovation or demolition to "thoroughly inspect the affected facility" or the requirements of governmental agencies for issuance of a building permit.

4.3 The inter-relationships among the three types of surveys and with other ASTM asbestos control standards is shown in Fig. 1.

4.4 This practice emphasizes the concept that a Comprehensive Building Asbestos Survey consists of more than the collection and analysis of samples, and the report is more than a compilation of laboratory results. It is important to inspect as many functional spaces as possible and to document the reasons why certain functional spaces were not inspected and locations where no suspect materials were observed and, consequently, no samples were taken. Reasons might include access limitations, the absence of materials to sample, the existence of information from previous surveys, or the availability of reliable documentation such as Material Safety Data Sheets.

4.5 A Comprehensive Building Asbestos Survey is not limited to the class of materials commonly referred to as asbestos-containing building materials (ACBM), defined in the AHERA regulations as "... found in or on interior structural members or other parts of a building." Items that are difficult to distinguish as such may include cooling towers, laboratory hoods, gaskets, chalkboards, and other articles. These may be installed in, attached to, or adjacent to the building or facility but are not as clearly a part of the building or facility as fireproofing or floor tile. Nonetheless, such items still fall within the scope of an asbestos management program and therefore are addressed in this practice. Locations outside the building, in particular equipment in industrial facilities and power plants, and crawl spaces underneath the building are within the scope of a Comprehensive Building Asbestos Survey.

4.6 This practice is intended to be used by individuals who are conducting a Comprehensive Building Asbestos Survey for the owner or manager of a building or facility under a contractual arrangement for services as well as by employees of the owner or manager. If the individual is conducting the survey under a contractual arrangement (which may be with the firm employing the individual), the owner or manager of the building is still responsible for certain activities as described in this practice.

5. Qualifications and Responsibilities

5.1 This section describes the qualifications and responsibilities of the individuals who participate in the Comprehensive Building Asbestos Survey. The requirement for accreditation as an Inspector in accordance with the Model Accreditation Plan applies to the activities covered by this practice. Additional accreditations may be required, and qualifications may be imposed by state licensing requirements or the policies of the owner or manager of the building or facility that are beyond the scope of this

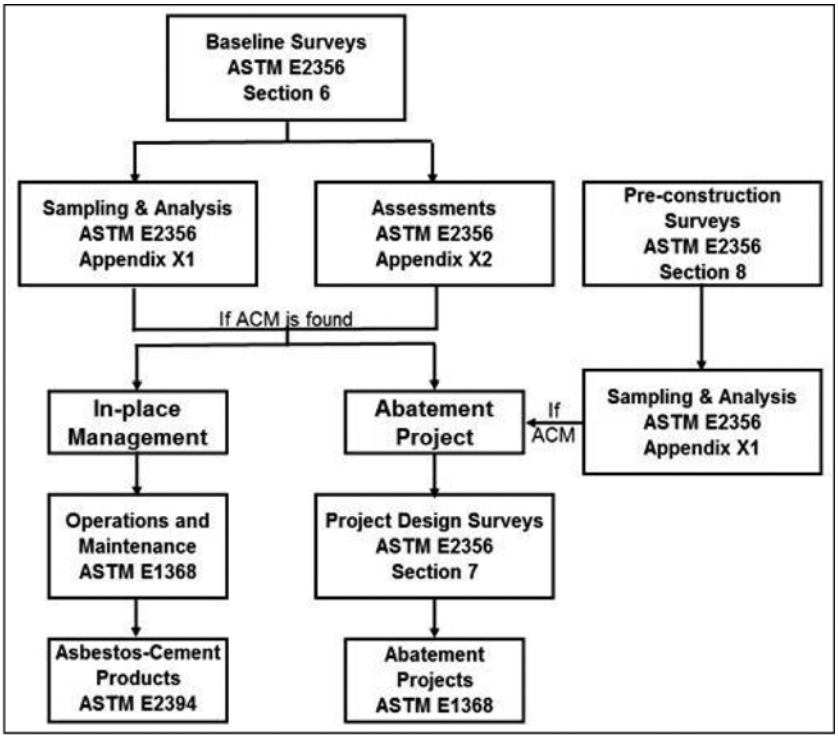

FIG. 1 Relationship Between E2356 Surveys and Other Standards

practice. Field experience in performing asbestos building surveys as described in this practice is of paramount importance.

5.2 Not all of the qualifications discussed herein will be required for every Comprehensive Building Asbestos Survey conducted, and in many cases one individual (usually the accredited inspector) will have more than one, and possibly all, of the required credentials.

5.3 Qualifications and responsibilities of individuals conducting the survey:

5.3.1 *Accredited Inspector*—For both types of surveys, accreditation as an Inspector is required for the individual who takes the bulk samples and otherwise performs the physical activities comprising the survey. This includes review of relevant building documentation and preparation of the survey report.

5.3.2 *Management Planner*—For a baseline survey, accreditation as a management planner is only required for hazard assessment and determination of response actions if the survey is performed in a school, but is a desirable credential for all buildings and facilities.

5.3.3 *Project Designer*—For a project design survey, accreditation as a project designer is desirable because this survey will provide information for the plans and specifications to be used on an abatement project.

5.3.4 *Contractor/Supervisor*—For a project design survey, accreditation as a contractor/supervisor would be helpful because of the knowledge of abatement processes such an individual possesses.

5.4 In addition to the above accreditations, the following credentials are evidence of the ability to perform one or more of the aspects of a Comprehensive Building Asbestos Survey.

5.4.1 Credentials that indicate knowledge of building design include experience in building design, construction, or operations and academic degree(s), licensure, or registration as an architect or engineer. Academic degree(s) or certification in industrial hygiene, occupational safety or a related field indicates knowledge of the hazardous properties of asbestos and other substances as well as the means of controlling the hazards.

5.4.2 Credentials that indicate knowledge of building construction and operations include field experience in building construction, renovation, demolition, or maintenance, or a combination thereof; or formal or on-the-job training in construction technology or management.

5.5 *Qualifications and Responsibilities of Owner or Manager of Building or Facility*—To be able to provide the necessary information, access, and other support to the inspector(s), the staff of the building or facility owner or manager should have taken at least a two-hour Asbestos Awareness course.

5.6 Laboratories analyzing the samples shall possess one or more of the following qualifications in addition to, or as part of, any applicable state licensing requirements.

5.6.1 For bulk sample analysis using Polarized Light Microscopy:

5.6.1.1 Accreditation by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST),

5.6.1.2 Participation in the American Industrial Hygiene Association (AIHA) Bulk Asbestos Proficiency Analytical Testing Program,

5.6.1.3 Certification under the State of New York Environmental Laboratory Approval Program (ELAP), [5] and

5.6.1.4 Participation in a proficiency testing and certification program similar to 5.6.1.1-5.6.1.3.

5.6.2 For bulk sample analysis of NOBs using Transmission Electron Microscopy, the laboratory shall be certified under the State of New York Environmental Laboratory Approval Program (ELAP) or provide other evidence of capability and experience with the ELAP method[5] or its equivalent acceptable to the consultant.

5.6.3 Air samples are not collected or analyzed as part of a Comprehensive Survey.

6. Baseline Surveys

6.1 *Planning the Survey*—It is essential that the planning stage of an asbestos survey be complete in addressing the following issues and be defensible. A well-planned survey will consult other appropriate professionals, trades, or knowledgeable individuals who may provide valuable information regarding systems included in the survey.

6.1.1 *Establishing the Purpose of the Survey*—The purpose of the Baseline Survey is to identify suspect asbestos-containing materials as defined in the scope of the survey. Management of the ACM will include normal O&M activities over a long term and will include prioritizing asbestos hazards for the purpose of planning future abatement activities. If the inspection is for pending demolition or renovation activities, see Section 7 on Project Design Surveys.

6.1.2 *Deciding Who Conducts the Survey*—Whether the inspection is conducted by an outside consultant or in-house staff, the inspector shall be properly-credentialed as an asbestos building inspector by either federal EPA or an EPA approved state program under the Model Accreditation Plan. The inspector may also be required to be licensed by the state, city, or local jurisdiction of the inspection, or combination thereof.

6.1.2.1 In-house staff should have a more intimate knowledge of the locations of suspect materials and the use and occupancy of the areas containing those materials. Bulk sample collection by in-house inspectors may be useful when dealing with emergency repairs or planning operations and maintenance activities when only a few bulk samples are required. However, in-house staff usually has other responsibilities that may preclude the timely completion of a baseline survey, and they may not have the experience necessary to perform a thorough survey.

6.1.2.2 The outside consultant should have insurance covering asbestos operations to insulate the owner from potential liability. In most cases, conflict of interest issues would be best avoided by using an outside consultant. Typically, outside consultants can complete a survey in a more timely fashion and provide a more thorough and unbiased report than in-house personnel. Additionally, building owners and managers can benefit from the consultant's experience gained while inspecting other facilities.

6.1.3 *Establishing the Scope of the Survey*—It is essential that the inspector have documented, in writing, the exact scope of work for which he is responsible. A Baseline Survey would normally be comprehensive in nature. However, if the inspection is to be limited to certain buildings, or portions of buildings, the specific areas to be inspected must be documented in order for the inspector to achieve substantial completion of the contract, and not be held responsible for further work. One of the most important functions in-house personnel can provide is to participate in determining the purpose of the survey, planning the survey and reviewing the results of the inspection done by the outside consultant. In-house personnel should also play a role with providing access to all areas of the building/facility to the survey team(s) and be available to answer questions posed by the survey team and the building occupants.

6.1.3.1 Identify buildings, or portions of buildings, to be inspected. Each individual building shall be inspected separately and all functional spaces inspected, whether or not bulk samples are taken therein. A separate set of homogeneous areas of suspect material shall be identified, sampled or assumed, and determined to be ACM or non-ACM per building. A homogeneous area may not be extended to include more than one building, but may include components exterior to a building such as cooling towers, vessels, and piping. Data forms, supplies, and equipment must be sufficient to address multiple buildings if necessary.

6.1.3.2 ACM should be identified in the Baseline Survey regardless of whether it is used as a construction material or not, and whether located inside, outside or underneath the building, as long as the area inspected is within the scope of survey. This should specifically include stored materials such as gaskets, packing, or insulation not yet installed in or on the facility.

6.1.3.3 In some industrial facilities, there may be gaskets, packing, and other ACM installed in equipment (such as furnaces) that are not part of the building systems (such as HVAC). The equipment may be in operation at the time of the survey, or the suspected ACM may be inaccessible for other reasons. For example, the inspector may lack the tools and skills to properly disassemble the equipment for access to the suspected ACM. The scope of work for the survey should be clear as to whether this equipment is to be inspected and under what circumstances. The most convenient, and often the safest, time to inspect such equipment is when it is out of service for maintenance or while production is interrupted. The plant manager should make a list of equipment with suspect ACM and the plant's O&M plan should specify if and when gaskets, packing, etc., are to be sampled.

NOTE 3—Gaskets are usually installed in bolted flange fittings. If only one or two fittings are being worked with, the gaskets can be presumed to be asbestos-containing material (PACM) and the employee instructed to follow appropriate procedures. For such small-scale work, it may be faster and cheaper to follow these procedures rather than to sample and analyze the gaskets. If an inspector were to sample for demolition purposes, the same restrictions would apply. In a demolition situation, it makes more sense to cut the pipe, leave the fittings intact, and dispose of them.

6.1.4 *Inspection Requirements*—A typical scope of work for an asbestos survey will address the following topics: survey protocol, what materials will be sampled, what materials will be presumed/assumed (floor tiles, floor tile mastic, roofing materials,

gaskets, and packings), what materials will not be included in the survey, quantification of materials, areas of the building/facility to be surveyed, access to specific areas of the building/facility (high ceilings, vaults, computer rooms, roofs, etc.), areas of the building/facility not to be surveyed (pipe chases, wall cavities, roofs), numbers of samples, quality control, follow-up analyses (point-counting, TEM), time schedules, and deliverables (reporting, reporting format, floor plans or drawing, and so forth). Bulk sampling shall be done to prove that the material in question is not ACM. Otherwise the suspect material shall be presumed to be ACM, and documented and managed accordingly. (See Appendix X1, Sampling Techniques and Equipment)

6.1.4.1 Under this practice, a minimum of three bulk samples representative of each different homogeneous area of suspect material to be sampled shall be collected and analyzed to prove that the material sampled is not ACM. See 6.4.6.1 for specific minimum numbers of samples by type of suspect material. Situations that call for more than the accepted minimum should be called to the attention of the building owner.

6.1.4.2 Field notebooks should include forms for the collection of information as follows: a complete list and location of functional spaces to be inspected (see 6.4.2); bulk sample logs (see 6.4.3); a complete list and location of suspect materials and homogeneous areas (see 6.4.5); chain of custody (see 6.4.9.1); assessment information (see 6.6). Samples of forms are provided in Appendix X3, Field Data Collection Forms.

6.1.4.3 Destructive testing is not performed on a Baseline Survey and therefore suspect materials in concealed spaces are not directly sampled, assessed or quantified. However, the inspector may, if specifically requested by the building owner, indirectly infer the location, quantity and condition of concealed suspect materials on the basis of information from accessible confirmed ACM that appears to be part of the same homogeneous area. In this case the concealed material will be treated as ACM. The assumptions on which such extrapolations are based should be clearly spelled out in the survey report.

6.1.5 *Analytical Requirements*—At a minimum, Polarized Light Microscopy (PLM) shall be used to analyze bulk samples, as described in 6.5.1.1. A laboratory qualified in accordance with 5.6.1 shall be used. If confirmation of negative PLM results by gravimetric analysis and quantitative Transmission Electron Microscopy (TEM) may be required, a laboratory with those capabilities must be selected. A determination shall be made initially that all samples required to be collected will be analyzed unless the "positive stop" approach described in 6.5.5 is used.

6.1.6 *Survey Report*—A survey report will be generated that should include; at a minimum; the date of the inspection and report; the accreditation number and dates of accreditation for the inspector(s) conducting the survey; identification, quantification, and location of all suspect material; an indication of whether the material is ACM or non-ACM; assessment information on condition of ACM; and how the ACM relates to building function. The survey report will include a complete laboratory report detailing the analysis of each bulk sample analyzed. Applicable sections of this practice, including appendices, should be referenced in the report (see 6.7). Preparation of the survey report will be facilitated if the forms used for data collection in the field are designed so they are consistent in format with corresponding tables in the report. If information is recorded electronically in the field it may be possible to import the files directly into the survey report.

6.1.7 *Schedule*—A schedule must be coordinated with the building owner that will provide access as necessary for a preliminary site visit, as well as the performance of the comprehensive survey. Contractual issues on completion of work and submission of report must also be addressed as planning issues.

6.1.7.1 Preliminary site visits may be scheduled at any time and should give the inspector an indication of the type and variety of suspect materials present, the scope or extent of the work, and normal use and occupancy of various areas of the facility. Typically the preliminary site visit provides the inspector(s) the opportunity to become familiar with a building/facility and provides an opportunity to ask questions affecting the performance of the survey to develop a cost proposal for the completion of the survey.

6.1.7.2 Bulk sampling activities should be scheduled when the functional spaces to be inspected are unoccupied. This may mean night or weekend work, as the case may be. An inspector shall not disturb suspect material in the unprotected presence of building occupants. Facilities that operate on a 24-h basis may have to isolate or demarcate areas for sampling or may assume all identified suspect materials in areas that may not be isolated to be ACM. Because OSHA regulations requires respirator and protective clothing use in the absence of a negative exposure assessment, sampling in unoccupied areas is least troublesome to both the building owner as well as the inspector. Security systems or escort, or both, may also have to be coordinated with the owner.

6.2 *Estimating the Cost of the Survey—Estimated Cost of Survey*—Many factors affect the cost of performing a comprehensive asbestos survey. Some of these factors may vary over time and may be dependent upon regional, state, or other economic factors such as salaries, benefits, cost of living, and the economic condition of the companies, or individuals performing the survey or laboratory analyses. This practice does not attempt to identify or address those issues. This practice attempts to identify, but not quantify, the most common components that affect the cost of performing a comprehensive asbestos survey. Companies or individuals purchasing asbestos survey services should clearly define the scope of services to obtain the most accurate and comprehensive price.

6.2.1 The preliminary site visit may or may not affect the price of the survey. Depending upon the contractual arrangement and the company providing the proposal, the time and expense of the preliminary site visit may be absorbed into the cost of doing the survey or provided without charge.

6.2.2 *Document Review*—The review of construction documents including specifications, blueprints and possibly product receipts provide information regarding asbestos-containing products, locations, and quantities. This review is typically performed

after the survey contract is awarded; however, a preliminary review of these documents may be helpful in determining the number of samples necessary. The extent and ultimate cost of the review will be dependent upon the scope of the survey, the size of the facility being inspected, organization/accessibility of the documents, and the amount of documents to be reviewed.

6.2.3 *Survey Preparation and Mobilization*—Prior to beginning the survey a number of technical and logistical tasks are required to prepare for the survey. Time is required to gather field supplies and coordinate travel. When surveys require air travel, it may be most cost-effective to ship supplies and materials to the survey site in advance. In this case, shipping fees would apply. If materials are not shipped, additional baggage fees may apply when baggage limits are exceeded, and extra time may be needed to clear airport security.

6.2.4 *Travel*—Travel time is a factor in developing the cost of the survey. The cost may be included in the billing rate of the consultants performing the survey or may be billed at a full rate, or reduced hourly/daily rate.

6.2.5 *Survey Personnel*—Surveys should preferably be performed in teams of two or more individuals in order to provide a more thorough inspection and to provide an added safety for the team members. Persons involved in the survey may include a Principal or Technical Director, Project Manager, and Survey Team Members, or individuals with equivalent titles.

6.2.5.1 The Principal/Technical Director has the overall authority and responsibility for the successful completion of the survey. The Principal/Technical Director should insure that the scope and technical aspects of the survey conform to regulatory and professional standards. The Principal/Technical Director is also responsible for the fiscal aspects of the survey and should insure that the budget for the survey is appropriate. The Principal/Technical Director typically has the highest billing rate of the personnel on the survey. His involvement is necessary at the beginning of the survey to review the proposed scope of work and budget, during the survey to review technical and budgetary progress, and at the completion of the survey to review the final work product to insure it is technically sound. On large surveys, the Principal/Technical Director may want to attend the Preliminary Site Visit (see 6.1.7.1).

6.2.5.2 The Project Manager has the responsibility for the survey team and the performance of the scope of work. The Project Manager should possess the experience and knowledge to complete the survey in the given survey environment. Accordingly, the Project Manager will have the highest billing rate for those in the field performing the work. The Project Manager is utilized in all phases of the survey.

6.2.5.3 Survey Team Members work with the Project Manager on-site to complete the scope of the survey. Team Members typically, have a lesser degree of experience than the Project Manager and as such have a lower hourly/daily rate. The Team member is utilized during the field survey and may be used to prepare sections of the report.

6.2.6 *Sample Login*—Sufficient time should be allowed to perform sample login following each sampling shift to insure that all samples are accounted for and proper chain-of-custody is maintained. Shipping to the laboratory will be determined by the time schedule of the survey or by the need to identify specific asbestos, or non-asbestos-containing material (see 6.4.9).

6.2.7 *Quantifying Asbestos-containing Materials*—Asbestos-containing materials (presumed and confirmed) should be quantified as part of the comprehensive asbestos survey. It may be possible to reduce the budget of the survey by postponing the quantification process until the laboratory reports are received allowing for the quantification of only the confirmed ACMs rather than all suspect materials. However, it may be most cost effective to develop quantities of limited homogeneous areas or when limited numbers of suspect ACMs are sampled, rather than returning to the survey site a second time. The Project Manager should determine the most cost-effective method of quantification of ACMs based on the specifics of the survey.

6.2.8 *Assessing Asbestos-Containing Materials*—Physical and hazard assessments should be performed for asbestos-containing materials (presumed and confirmed) as part of the comprehensive asbestos survey. It may be possible to reduce the budget of the survey by performing these assessments after the laboratory reports are received so that only the confirmed ACMs are assessed rather than all suspect materials. However, it may be more cost effective to perform these assessments at the time of the survey when limited functional spaces, homogeneous areas or numbers of suspect ACMs are identified. The Project Manager should determine the most cost-effective method of assessment of ACMs based on the specifics of the survey.

6.2.9 *Data Review and Interpretation*—It is important to provide sufficient time to review the survey laboratory data and interpret the results. Time is needed to determine if appropriate homogenous areas have been identified and to identify the need for follow up analyses such as PLM point count or confirmatory TEM.

6.2.10 Report preparation is performed by the Project Manager and the Survey Team members. Other individuals that may be utilized during report preparation include a draftsman/computer aided drafting designer and clerical staff. Completed reports should always be reviewed by a Principal/Technical Director or the Project Manager to insure compliance with the scope of work, standards of the industry, and technical competence.

6.2.11 *Laboratory Fees*—Complete budgets for comprehensive surveys should include all analyses required for the completion of the survey. Laboratory fees will vary depending upon the location of the laboratory, the workload of the laboratory, the number of samples being submitted, the type of analyses requested, and the turn-around time for the results. Some laboratories charge by the sample, while others charge to analyze each individual component of a layered sample such as floor tile and mastic. PLM analyses for a comprehensive building survey will include visual estimation at a minimum, and may include point count analyses. Quality control for PLM visual estimation will include sending duplicate samples to a second accredited laboratory.

6.2.11.1 *PCM Air Sample Analyses*—Personal air samples are required to comply with the OSHA asbestos in construction

standard (29 CFR 1926.1101) for individuals who take bulk samples (see 9.2). Collection and analysis of air samples is outside the scope of this practice.

6.2.11.2 *TEM Bulk Sample Analyses*—TEM analyses of bulk samples may be necessary for surveys located in specific cities or states. Additionally, TEM analyses is commonly used to verify a reported no asbestos detected result for non-friable materials by PLM.

6.2.12 *Travel/Subsistence Expenses*:

6.2.12.1 Survey budgets should identify appropriate travel costs. The cost to travel between locations will depend upon many factors, the main issues being the type of travel, the amount of travel time required and the billing rates of the individuals, and the distance traveled.

6.2.12.2 *Subsistence*—Subsistence is typically provided through a daily per diem for those traveling, which may or may not include lodging costs. The government rate of per diem for each city in the country is useful for planning purposes.

6.2.13 *Miscellaneous Expenses*—Additional factors contributing to the cost of a comprehensive survey include:

6.2.13.1 *Ladders, Lifts, Scaffolds*—It may be necessary to rent such equipment or to hire contractors with specialized equipment or expertise to access elevated materials or areas.

6.2.13.2 *Electricians*—It may be necessary to contract an electrician to de-energize systems prior to sampling, subject to the approval of the building owner.

6.2.13.3 *Abatement Contractors*—Abatement contractors may be utilized to assist with the construction of mini-enclosures to control fibers during sampling. Additionally, contractors may be hired to assist with abatement/removal budgets.

6.2.14 *Survey and Reporting Expenses*:

6.2.14.1 *Shipping*—It may be necessary to ship equipment and supplies to and from the survey site. The budget should also include sufficient resources to ship samples to the laboratory.

6.2.14.2 *Copying*—The survey budget should provide resources for copying the appropriate number of reports. The building owner may request the use of color in drawings and photographs, in which case it would be necessary to include appropriate reproduction charges.

6.2.14.3 *Film and Photograph Processing*, including preparation of digital files for a report in electronic format.

6.2.14.4 *Sampling Equipment and Supplies*, in accordance with X1.1.

6.3 *Obtaining and reviewing information*—The following information may be provided in hard copy or electronic format. Provisions may be necessary for reproduction and for opening and manipulating electronic files in different formats.

6.3.1 *Building or Facility Information*—Floor plans and drawings, records of construction, renovation and maintenance, and lists of equipment and furnishings should be reviewed when readily available for information that may indicate the existence of suspect ACM in functional spaces.

6.3.2 Records of asbestos activities, including previous surveys and occasional bulk sampling, should be reviewed. If samples taken during a previous survey confirmed the presence of more than one percent asbestos in a material, there is no need to re-sample that material during the present Baseline Survey, providing a sufficient number of samples were taken. For a material where samples taken during a previous survey reported less than one percent asbestos for the samples collected for the homogeneous area, the accredited inspector should determine whether there is a need to re-sample that material during the present Baseline Survey. The decision should take into account whether a sufficient number of samples were previously taken and if analytical methods were adequate.

6.3.3 Records of abatement and O&M work should be reviewed briefly for an indication of where ACM may have been removed or repaired. However, statements by the building owner regarding the absence of ACM due to previous abatement should be viewed with skepticism in the absence of suitable documentation and not used as the sole reason to dispense with inspecting any functional spaces.

6.4 *Conducting Field Work*:

6.4.1 *Mobilizing Equipment and Supplies*—See Appendix X1 for a detailed list of equipment needed for a sampling inspection. Respirators and other personal protective equipment needed are discussed in Section 9, and standard forms on which to gather information are presented in Appendix X3. The needs will be determined by the Preliminary Site Visit discussed in 6.1.7.1.

6.4.2 *Identifying and Inspecting Functional Spaces*—Functional spaces are identified for the purpose of locating homogeneous areas of suspect ACM and non-ACM, and the subsequent management of the ACM in a building. All functional spaces must be identified and located, with occupancy and use data if possible. Functional space identification should be by normal use label, or by blueprint identification. The labeling system used should be one familiar to building management.

6.4.3 *Identifying Suspect ACM*—It is important that suspect materials be classified as Surfacing Material, Thermal System Insulation (TSI) or Miscellaneous Material as determined by direct application of the definitions in 3.2, as EPA and OSHA compliance depend on these classifications. Any other regulatory determination that may vary these classifications may be applied in addition to the referenced definition as a specific case may require.

6.4.3.1 Most building materials shall be considered suspect ACM and any person may assume that a suspect material contains asbestos. However, EPA and OSHA regulations permit only an accredited inspector to determine that thermal system insulation is fiberglass, foam glass, rubber, or other non-ACM without bulk sampling. The inspector must use his judgment in excluding apparently obvious non-asbestos materials such as glass, steel, concrete, porcelain, and wood from sampling. The complete

identification and location of all suspect materials in a building is basic and essential to a comprehensive building asbestos survey, and if in doubt as to possible asbestos content, the inspector should sample the material.

6.4.3.2 Record the date, manner of sampling, sample identification number, exact sample location, and sampling inspector identification and certification. The location of each bulk sample shall be recorded on a sample log and a schematic drawing of the building or space of the building from which the sample was collected if available. The sample location description should provide sufficient detail that a person unfamiliar with the building could locate the exact sample location without undue difficulty.

6.4.3.3 The suspect material must also be described in a useful and functional way, such as: floor tile, fireproofing, or pipe insulation. Avoid the use of in-house, company, or construction industry acronyms in the report documents. Use material descriptions that will be meaningful to a person who may not be familiar with construction terminology.

6.4.4 *Quantifying Suspect ACM*—All suspect ACM must be quantified for bulk sampling procedures and for regulatory applicability and compliance purposes under the various federal regulations. Since the NESHAP regulation specifies a quantification standard applicable to renovation and demolition and annual O&M reporting, all suspect ACM inspected for compliance with the NESHAP regulation shall be quantified in accordance with that standard. This will facilitate preparing an annual O&M notification as well as laying the foundation for a possible Project Design Survey in event of an abatement project. The NESHAP requirements are as follows:

6.4.4.1 Pipe insulation must be quantified in linear feet (metres) and a notation made if fittings are included or quantified separately.

6.4.4.2 Other thermal system insulation, miscellaneous material, surfacing material and all other suspect material on facility components must be quantified in square feet (square metres).

6.4.4.3 Bulk waste or material not installed on facility components must be quantified in cubic feet (cubic metres).

6.4.5 *Identifying Homogeneous Areas and Sampling Locations*—All suspect ACM must be identified by homogeneous area of material. A homogeneous area consists of material that is the same in color, texture, date of application and general appearance, and it may overlap adjacent functional spaces. It must either be assumed to be ACM and managed as such, or sampled and proven to be ACM or non-ACM. The homogeneous area is the basis of identification of suspect ACM. To aid in determining homogeneous areas the color, texture, and appearance of the suspect materials should be described for all layers of the material when viewed from different vantage points. For example, when describing a suspect ceiling tile, the inspector should provide a description of the exposed surface when viewed from below, the composition of the interior of the ceiling tile and the concealed (top) portion of the ceiling tile. An appropriate description in this example could be: white 2 ft by 4 ft ceiling tile with small gouges and small holes producing a flower pattern on the exposed surface of the ceiling tile visible from beneath. The interior of the ceiling tile is tan with visible fibrous material. The top of the tile is red in color.

6.4.5.1 *Sample Locations*—Where feasible, the manner used to determine sample locations for any suspect material within a homogeneous area shall be a random sampling method described in the sampling plan.

6.4.5.2 Without compromising safety, disturbing occupants or aesthetically damaging surfaces, use random sample locations for materials that may have been batch-mixed at the site. Such materials, which may vary in asbestos content throughout a homogeneous area, include fireproofing, ceiling and wall texture, acoustical plaster, hard plaster and pipe fitting insulation.

6.4.5.3 Flat surfaces such as floors, walls and ceilings may be divided into a grid, the cells of the grid numbered, and random numbers used to select cells in which to take the samples.[6] For large cylindrical objects such as tanks and vessels, an equivalent "flat" surface is an area defined by the height or length of the object and its circumference. For homogeneous areas that are one-dimensional (linear), such as pipe insulation and fireproofed beams and columns, use a random number table to select sampling locations along the length of the item.

6.4.5.4 Random sample locations are less important for homogeneous areas where the asbestos content is expected to be relatively uniform due to product specifications. Such materials include floor tile and mastic, ceiling tiles, straight runs of pipe insulation and asbestos-cement products. Sheet vinyl flooring should be sampled randomly due to the uneven absorption of adhesive by the backing.

6.4.6 *Collecting Bulk Samples* (also see Appendix X1). Bulk sample collection and analysis is used to determine the asbestos content of suspect materials identified during a survey. Sampling and analyses also distinguishes between suspect materials that appear identical in the field but may actually be different products. The proper homogeneous determination is of utmost importance to the person developing asbestos O&M programs and designing removal projects and other response actions. A sufficient number of bulk samples should be collected of suspect materials throughout a facility to thoroughly characterize the asbestos content. The samples should be spaced throughout the facility in such a manner to adequately cover all elevations, wings, additions, and renovations.

6.4.6.1 *Number of Samples to be Collected*—This practice encourages the collection of samples beyond the minimum numbers required below to ensure that homogeneous areas are defined as accurately as practical. The following requirements meet or exceed those in the AHERA regulations at 40 CFR Part 763, §763.86, which are also referenced for surfacing material and thermal system insulation in the OSHA construction standard at 29 CFR 1926.1101(k)(5). The number of negative samples required to exclude a material from treatment as asbestos-containing depends on the type of material and, for surfacing material, the area. Compliance

[6] A random sampling scheme for flat surfaces is described in the EPA 560/5-85-030A"Pink Book."

with these requirements may dictate analysis of all samples collected to verify the absence of asbestos.

6.4.6.2 A minimum of three bulk samples representative of each distinct homogeneous area of suspect thermal system insulation material (TSI) should be collected. One sample should be collected of each TSI patch. For the purpose of this practice, a patch is a distinct location or replacement or repair which is less than or equal to 6.0 ft (1.82 m) or 6.0 ft^2(0.557m^2).

6.4.6.3 A minimum of three bulk samples shall be collected of each homogeneous miscellaneous material, except that a single sample may suffice for small manufactured items such as HVAC vibration dampeners, gaskets and friction products. This exception applies to individual components of less than 6 ft^2 (0.557 m^2) in size and not to multiple installations of similar components.

6.4.6.4 A minimum of three bulk samples shall be collected of surfacing materials of less than 1000 ft^2 (93 m^2). A minimum of five bulk samples shall be collected of homogeneous surfacing materials ranging between 1000 to 5000 ft^2 (93 to 465 m^2) and a minimum of seven bulk samples shall be collected of surfacing material >5000 ft^2 (465 m^2). The inspector should attempt to collect samples of surfacing from each wing, floor, or level of large facilities, or combination thereof.

6.4.6.5 Collection methods and equipment are provided in Appendix X1 for a wide range of suspect materials. For many materials, disposable coring devices are the most practical means of talking a bulk sample. Maintaining the integrity of layered samples, sample containers for friable and non-friable materials, labeling of sample containers, sample packaging and sample labeling are discussed in detail in Appendix X1.

6.4.7 *Identifying Presumed/Assumed ACM*—When conducting a baseline survey for asbestos management and planning in a building that will remain occupied, it may be more appropriate to assume that some suspect materials are ACM, rather than sample to prove that they are not. When this is done, these materials must be listed in the report as "Assumed ACM" rather than "ACM." This means that they have never been sampled, but must be treated as ACM. In most cases, they would then be sampled later in a Project Design Survey (see Section 7). It may be more appropriate to assume rather than sample when maintaining the integrity of a fire rated assembly, maintaining an undamaged aesthetic appearance, complying with restrictions on sampling for safety reasons, or if access is not provided to a functional space or a concealed space. An example of such an assumption for a concealed space would be an inaccessible chase where the insulation on the pipes in the chase resembles that on the pipes to which they connect in the plenum and the insulation of the pipes in the plenum is confirmed, assumed or presumed to be ACM." Regulatory requirements on presuming (OSHA) or assuming (EPA) materials to contain asbestos must be followed.

6.4.8 *Documentation of Field Work*—If information is being recorded manually in the field, the sample forms in Appendix X3 may be used. These are non-mandatory and may be modified as needed to suit the needs of a particular survey. Because the survey report will probably be prepared and submitted in electronic format, any data collection and information recording system used in the field must be compatible with the electronic formats to which it will eventually be converted.

6.4.8.1 Field notes shall contain the following information for each bulk sample: location of sample; material category: surfacing material, thermal system insulation, miscellaneous material; description: for example, fireproofing, floor tile and size, if applicable; friable or non-friable; color, homogeneity (layers) and texture; asbestos content by type and percent (or No Asbestos Detected); quantity of material; assessment of current condition; and potential for disturbance with reason for rating. If the assessment is performed after the samples are analyzed these ratings can be omitted from the field notes during sample collection and added later.

6.4.8.2 In addition to bulk sample information, the field notes shall contain a complete list of functional spaces inspected where no samples were taken, including inaccessible locations and excluded areas with the reasons they were not inspected.

6.4.9 *Sample Processing*—After the samples are collected, they must be processed for shipment to the laboratory.

6.4.9.1 *Chain of Custody*—The control and custody of the bulk samples from collection to submission to an accredited laboratory should be documented with a chain-of-custody document. The bulk sample numbers for each sample set should be entered on the chain of custody. The action taken on the sample at the time when the custody of the samples change should be documented and attested to by the signature by those participating in the custody change. This practice understands that shipping of bulk samples to laboratories is common practice. Prior to shipping the samples should be properly labeled and sealed to prevent tampering or inadvertent opening by those other than the intended recipient. It is not necessary for the courier to sign the original chain of custody as their handling of the samples is documented with the routing paper work provided through billing. When samples are shipped, it is the recipients' responsibility to inspect the sample packaging to ensure that tampering has not taken place. A signature of receipt signifies that the package was inspected and the samples had not been damaged or tampered during shipping.

6.4.9.2 Quality control samples, split samples and archived samples should be prepared during sample processing and sent to the proper laboratories for analysis or stored in a secure location under the control of the accredited inspector.

6.5 *Bulk Sample Analysis*—Analysis of the bulk samples must consider the material being analyzed in selecting the type(s) of analysis to be performed. Confirmation of results is an important part of this process. Reporting of laboratory results is an integral part of the analytical effort. Finally, one must consider whether it is necessary to analyze all of the samples collected.

6.5.1 *Analytical Methods*—For most materials, the analytical procedures in EPA/600/R-93/116 Method for the Determination of Asbestos in Bulk Building Materials, will suffice. These methods use a combination of Polarized Light Microscopy (PLM) and Transmission Electron Microscopy (TEM).

6.5.1.1 *Polarized Light Microscopy*—PLM with dispersion staining uses the optical properties of the fibers and their morphology to establish the type of asbestos present in the sample. The analyst uses a technique known as visual estimation to quantify the asbestos content to a reasonable degree of precision. PLM and visual estimation of asbestos content may be relied on

to establish the presence of asbestos in amounts greater than one percent for any material, which means it must be treated as asbestos-containing. Additionally, analyses by PLM with visual estimation may be relied upon to conclude that certain suspect materials do not contain asbestos with a result of "no asbestos detected." In the event the laboratory reports a result of trace, less than one percent or one percent, additional analyses is necessary as discussed in 6.5.2.

6.5.1.2 *Transmission Electron Microscopy*—TEM uses a higher magnification (up to 20 000×) to detect fibers that are too short or thin to be reliably detected by PLM at a magnification of 100×. Fiber type is determined by Energy-Dispersive X-ray (EDXA) analysis of the sample. Gravimetric reduction is used to eliminate interfering substances that obscure the fibers. A variation of the EPA/600/R-93/116 method known as the " Chatfield method" is used frequently for floor tile analysis.

6.5.1.3 *EPA Research Method*—Sometimes referred to as the "Cincinnati Method," this is a combination of PLM and TEM techniques used to analyze vermiculite attic insulation for the presence of tremolite asbestos. The method is described in EPA 600R-04/004.

6.5.2 *Protocol for Confirmation of Results*—In order to exclude a material from treatment as asbestos-containing materials, the absence of asbestos fibers at the regulated level must be reliably demonstrated by analysis. Fig. 2 shows the steps taken to determine if a single sample is asbestos-containing material (ACM) or Non-ACM.

NOTE 4—"Non-ACM" means an asbestos content of one percent or less. If the laboratory reports a value for the asbestos content of a sample that is one percent or less, the reported value should be used in the survey report even though the material meets the definition of "non-ACM" for purposes of this practice. Some building owners may elect to treat materials with one percent or less asbestos as ACM.

6.5.2.1 "Non-friable Organically Bound" or "NOB" materials are analyzed in accordance with the left side of the chart. If asbestos fibers are detected and visual estimation or point-counting shows the asbestos content to be more than one percent, the sample is reported as ACM. If no asbestos fibers are detected, or if the content is one percent or less, the sample is analyzed with a combination of gravimetric methods and TEM. If this analysis identifies asbestos fibers with a content of more than one percent, the result is reported as ACM. Otherwise, the result is reported as "non-ACM" based on either "No Asbestos Detected" or "NAD" if no asbestos fibers were found, or it is reported as "non-ACM" and the asbestos content (which will be one percent or less) is given (see Note 4).

6.5.2.2 The most common application of this requirement is vinyl asbestos floor tile, but these procedures should be considered for any material where small fiber size and the presence of interfering substances render Polarized Light Microscopy unreliable for definitive confirmation of asbestos content below one percent. It is common for laboratories to include a disclaimer to this effect on the sample results. A sample of material that was not friable when manufactured and installed but has become friable through damage or deterioration is still considered non-friable for purposes of Section 6.

6.5.2.3 At least one sample of each distinct homogeneous area of NOB materials shall be reanalyzed by quantitative transmission electron microscopy with gravimetric reduction when all samples in the homogeneous area sample set are reported

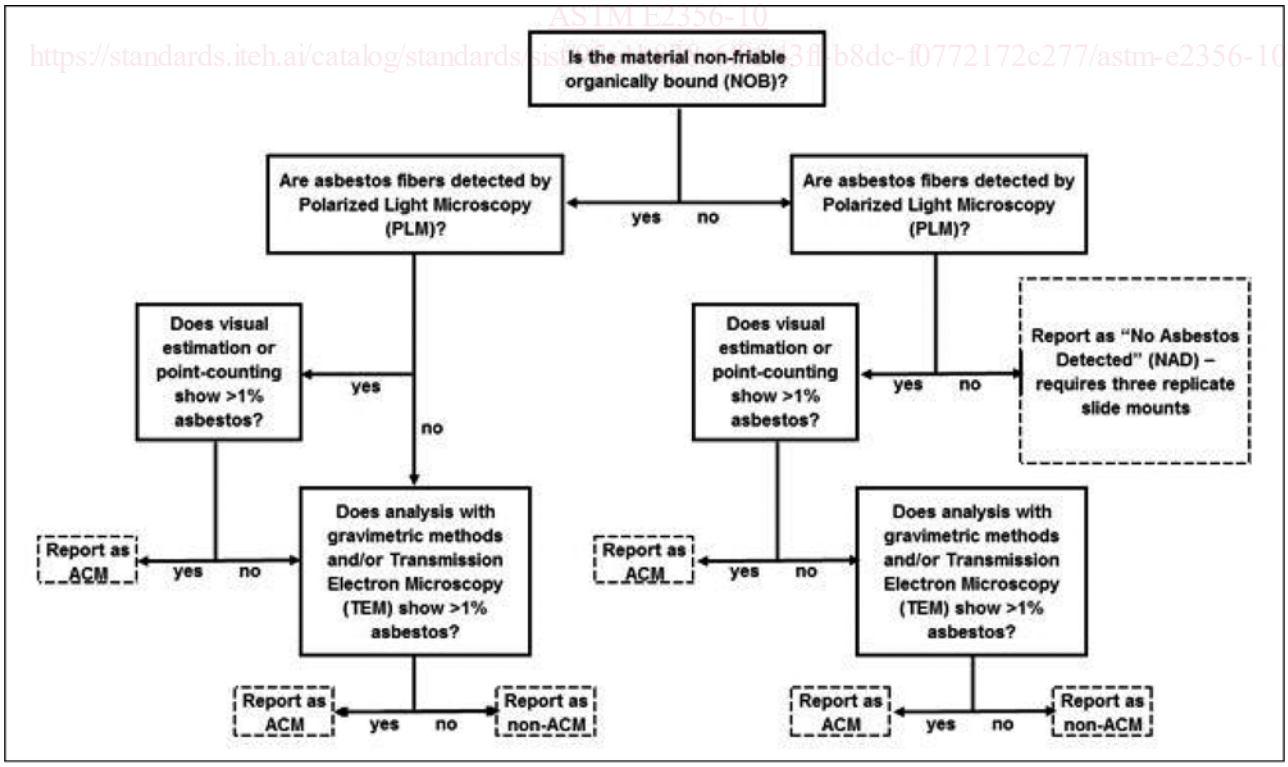

FIG. 2 Protocol for Analysis of Bulk Samples

to be one percent or less asbestos by PLM. The inspector should consider the factors in 6.5.5.1 and 6.5.5.3 in deciding whether to re-analyze one or more of the remaining samples, deferring to the regulations in the local, state, or county government in which the survey is being performed as some locales require all NOB samples to be analyzed by TEM.

6.5.2.4 Materials other than "NOB" are analyzed in accordance with the right side of the chart. If no asbestos fibers are detected on three replicate slide mounts, the sample is reported as "NAD." If asbestos fibers are detected and visual estimation or point-counting shows the asbestos content to be more than one percent, the sample is reported as ACM. If the content is one percent or less by visual estimation or point-counting, the sample is analyzed with a combination of gravimetric methods and TEM. If this analysis identifies asbestos fibers with a content of more than one percent the result is reported as ACM. Otherwise, the result is reported as "non-ACM" based on either "No Asbestos Detected" or "NAD" if no asbestos fibers were found, or it is reported as "non-ACM" and the asbestos content (which will be one percent or less) is given (see Note 4).

6.5.2.5 The inspector may elect to bypass PLM analysis for NOB materials and proceed directly with quantitative transmission electron microscopy with gravimetric reduction. In deciding whether to analyze more than one sample from a homogeneous area, the inspector shall adhere to the constraints in 6.5.2.3.

6.5.3 *Reporting of Results*—The laboratory results should be very clear on what is meant by "trace" and "NAD" if these terms are used.

6.5.3.1 The accepted definition of "NAD" is that no asbestos fibers were identified on three replicate slide mounts from the same sample under Polarized Light Microscopy, or that no asbestos fibers were detected with TEM and EDXA on any of the grids analyzed.

6.5.3.2 "Trace" usually means that at least one asbestos fiber was identified in the sample but the amount was estimated at one percent or less. However, the use of this term varies among laboratories and the specific meaning assigned to the analytical results should be requested. In no case should a *Trace* result based on PLM with visual estimation or point counting be used to exclude material from treatment as asbestos-containing without confirmation by gravimetric or TEM analysis.

6.5.3.3 All discrete layers of a sample shall be analyzed separately and the results reported for each individual layer. The layers shall not be physically composited for analysis, nor shall the results be mathematically combined into a single result. For example, mastic on floor tile is a separate layer and the components of a wallboard system including the joint compound, tape and skim cost (texturizer) are all individual layers. An exception may be made for layers of paint that cannot be physically separated for analysis.

NOTE 5—EPA requires that layers of wallboard samples be analyzed and reported separately, but also allows a "composite" result to be reported for purposes of determining if a wallboard "system" contains more than one-percent asbestos for purposes of complying with the NESHAP. OSHA does not permit sampling or reporting of "composite" results for wallboard systems. Because of the need for information on the individual components of the wallboard system to comply with the OSHA regulations that apply to any work on the material, it is important to maintain the integrity of the separate components during analysis and report the results for separate layers. The laboratory may, at its option, report a composite result in addition to the results for individual layers.

6.5.4 *Vermiculite Attic Insulation*—Loose fill insulation containing vermiculite presents difficulties in the detection of amphibole asbestos using conventional PLM techniques. The EPA "Research Method," which is commercially available, consists of separating the amphibole fibers—usually tremoilite—from the vermiculite flakes by flotation and analyzing the settled fiber bundles by PLM. If no fibers are detected by PLM, fibers extracted from the flotation liquid by filtration are analyzed by TEM.

6.5.5 *Positive Stop*—The "positive stop" approach holds that one positive (more than one-percent asbestos) sample from a homogeneous area can be considered evidence that all suspect material in that homogeneous area contains asbestos without analyzing the remaining samples. Factors to consider in deciding whether to use this approach are illustrated in Fig. 3.

6.5.5.1 *The Inherent Homogeneity of the Material*—Straight runs of pipe insulation, resilient floor tile, ceiling tiles, asbestos-cement pipes, ducts, roofing and siding, for example, were manufactured to specifications that included the amount of asbestos in the product. Therefore, if one sample from such a material contained asbestos, the remaining samples from similar-appearing materials could reasonably be expected to do so as well. On the other hand, batch-mixed materials such as fireproofing, ceiling and wall texture, acoustical plaster, hard plaster and pipe fitting insulation ("mudded joints") are more likely to vary in their asbestos content. This will not be apparent to the inspector who is taking the samples, and is due to adding the asbestos fiber at the job site or mixing asbestos-containing products with other materials, thereby diluting the asbestos content. For this reason, a single positive sample may not be indicative of the overall homogeneous area and all samples should be analyzed to determine if more than one homogeneous area actually exists, including some where no asbestos is present. If the material is inherently inhomogeneous, all samples should be analyzed.

6.5.5.2 *The Uncertainty of Identifying Homogeneous Areas*—Identification of homogeneous areas is a matter of judgment, and using "positive stop" could result in treating material as asbestos-containing because it was incorrectly included in a homogeneous area from which only one sample was positive. If there is any doubt as to the homogeneity of a sampling area, all samples from that area should be analyzed. For example, fireproofing in a facility may appear identical in color and texture (tan color, high density); however, it is possible that the fireproofing in two locations may be distinct materials, one with intentionally added asbestos and the other a non-asbestos containing replacement product. In this example, the inspector might identify the two distinct materials (products) as one homogeneous area and could cause unnecessary expense to the facility owner by removing or performing other response actions on non-ACM materials. Complete and proper sampling of these materials should be performed to identify inconsistencies within designated homogeneous areas. If doubt exists, all samples should be analyzed.

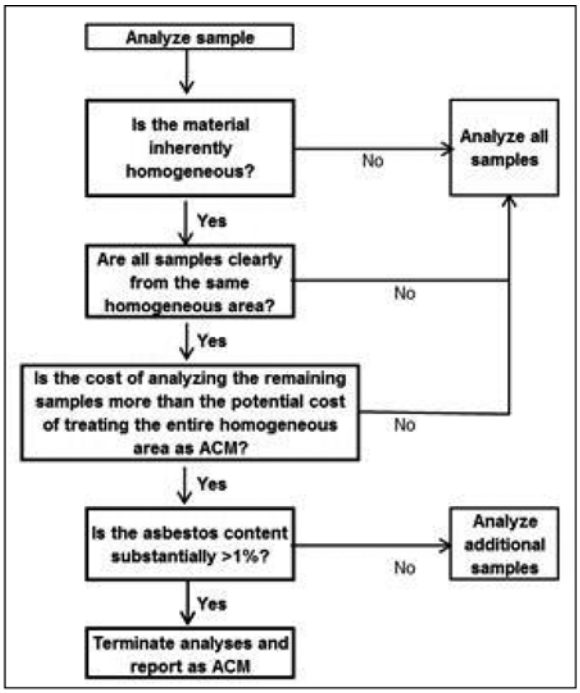

FIG. 3 Decision Chart for Positive Stop

6.5.5.3 *The Ultimate Value of the Information*—For purposes of managing asbestos, the elimination of functional spaces from consideration reduces the number of employees and contractors affected. The resultant cost saving and other intangible benefits can easily outweigh the additional analysis and documentation costs. If a decision is made to abate the ACM, reducing the quantities reported on the NESHAP notification will, in some jurisdictions, reduce the notification fees. Of course, other abatement costs will also be reduced. If the potential cost of treating the entire homogeneous area as asbestos-containing material exceeds the cost of analyzing the remaining samples, analyze the samples.

6.5.5.4 *The Relative Uncertainty of Analytical Results*—If a sample contains substantially greater than one percent asbestos, it is highly unlikely that other samples from the same homogeneous area will have one percent or less asbestos, or no asbestos at all. In that case, analyzing one sample may suffice (given that 6.5.5.1 and 6.5.5.3 are satisfied). As the reported asbestos content approaches one percent, the uncertainty of the result increases to the point where confirmation by analyzing more samples is advisable. The laboratory must receive clear instructions as to what constitutes "substantially greater than one percent asbestos" for purposes of terminating or continuing the analyses.

6.6 *Assessment of ACM*—For purposes of deciding whether to abate ACM or continue managing it in place, and to select the appropriate response actions, the ACM must be assessed in accordance with one of the protocols in Appendix X2. Particularly when a large number of functional spaces and homogeneous areas are included in the survey, assessments are a valuable tool in setting priorities for response actions. Assessments complement, but do not replace, experience and common sense when determining priorities for response actions.

6.6.1 Qualitative assessments include the "AHERA" categories (undamaged, damaged, significant damaged, potential for damage, potential for significant damage, and remaining undamaged ACBM with low potential for damage) and other classification systems (good/fair/poor, accessible, etc.), hazard ranking, response action priorities, and recommendations (abatement, O&M) for controlling the asbestos hazard.

6.6.2 Quantitative assessments are based on numerical ratings for Current Condition and Potential for Disturbance. Tabulation of assessment ratings and preparation of Abatement versus O&M decision charts are used to develop recommendations for response actions.

6.7 *Preparing a Report*—The Baseline Survey report is developed from the information collected during the field work, the laboratory results and the assessment. Using forms compatible with the survey report requirements, including electronic formats and file structures, for data collection and manipulation facilitates this process.

6.7.1 Copies of field data sheets filled in during the inspection, copies of laboratory results and copies of inspector and laboratory credentials should be included as appendices to the hardcopy version of the survey report, or scanned for inclusion in an electronic copy. Unless the building owner has specified the use of color in the survey documentation, homogeneous areas and functional spaces should be identified in black and white on the survey drawings to facilitate copying survey reports without a loss of information in the reproduction process.

6.7.2 Appendix X3 contains a set of forms that can be used as templates for collecting and manipulating the survey information, as well as compiling it in the form of the survey report. In addition to the forms in this appendix, drawings must be prepared (or