***Chapter 6***

***Bulk Sampling and Analysis***

The asbestos NESHAP regulates building materials containing greater than one percent asbestos. For this reason, the taking of bulk samples is an essential component of a NESHAP inspection. A bulk sample is a portion of a building material collected by an inspector and then analyzed to determine its asbestos content. In the absence of bulk samples, an inspector may find it difficult, if not impossible, to determine the compliance status of a facility with respect to the NESHAP regulation.

The process of bulk sampling and analysis were developed pursuant to the Asbestos Hazard Emergency Response Act (AHERA) – 40 CFR Part 763 Subpart E. The asbestos NESHAP compliance program adopted, by reference, the Polarized Light Microscopy method of analysis when it included the AHERA citation in the definitions of Category I and Category II non-friable asbestos. The AHERA program represents the only federally-promulgated rule that describes procedures and practices for collecting and analyzing bulk samples for asbestos content. It is the only method recognized for complying with the asbestos NESHAP regulation.

***Sample Collection and Analysis***

Collect samples whenever feasible, especially where violations are suspected and enforcement action is anticipated. Follow written standard operating procedures and use only accredited laboratories for bulk sample analysis**1**. Ask the laboratory to archive samples for you. Improper sampling techniques or non-accredited laboratories may jeopardize an agency's ability to successfully enforce the asbestos NESHAP.

Inspectors must be able to testify that the samples:

* Accurately represent conditions at the site;
* Were maintained using proper chain of custody (COC); and
* Were acquired and analyzed using proper methodology.

Appropriate analyses of bulk samples reveal the types and percentages of asbestos they contain. If the amount of asbestos in bulk samples does not exceed one percent, the materials are not RACM and therefore are not subject to the requirements of the asbestos NESHAP.

**1** The AHERA program requires samples to be analyzed by a laboratory accredited under the National Voluntary Laboratory Accreditation Program (NVLAP). For the asbestos NESHAP program it is not required but highly recommended that collected bulk samples be analyzed by a NVLAP laboratory.

***Protective Equipment***

EPA's *Health and Safety Guidelines for EPA Asbestos Inspectors* recommends that the following personal protective equipment be used by EPA inspectors when collecting bulk samples**2**. While the regulations are not specifically noted in the guidelines, the recommendations are useful for inspectors who are evaluating compliance with the *Asbestos-In-Schools Rule*, the *Worker Protection Rule* and the asbestos NESHAP.

***Protective Clothing***

If samples cannot be taken without a significant chance of releasing fibers, inspectors should wear the following protective clothing when collecting bulk samples:

* Disposable, full-body coveralls (hood and foot covers attached);
* Eye protection (if a full-face respirator is not used);
* Disposable shoe coverings over safety shoes (if site conditions necessitate);
* Hard hat (if applicable); and
* Disposable gloves.

Inspectors should use safety shoes, hearing protection and other safety equipment as needed.

***Respiratory Protection***

EPA inspectors collecting bulk samples should wear full-face, air-purifying respirators with HEPA filter cartridges. This includes NIOSH-approved, tight-fitting powered air purifying respirators (PAPRs) equipped with HEPA filters.

OSHA regulation 1926.1101(h)(3)(iv)(A) states that an employer must provide employees, at a minimum, a tight-fitting PAPR whenever the employees are in a regulated area performing Class I asbestos work for which a negative exposure assessment (NEA) and where exposure assessment is not available, and where the exposure assessment indicates that the exposure level will not exceed 1 f/cc as an 8-hour time-weighted average. The OSHA regulation applies only to an inspector performing Class I work, which does not include bulk sample collection. It is prudent to wear a tight-fitting PAPR though this specific regulation does not apply to EPA asbestos inspectors.

**2** If there is any doubt, refer to the Occupational Safety and Health Administration’s asbestos regulation for the construction industry (29CFR 1926.1101) and the Respiratory Protection Standard (29CFR 1910.134) for information on appropriate personal protection equipment when encountering asbestos-containing or suspect asbestos-containing materials.

***Sampling Equipment/Materials***

The following items are recommended for collecting bulk samples:

* *Amended water.* Water to which a surfactant (wetting agent) has been added to improve its ability to penetrate ACM. Amended water is available commercially but inspectors may also make their own amended water by adding one or two drops of dishwashing liquid to a liter of water.
* *Bathroom caulking, water-activated repair cloth or prepared encapsulant (hand-pump sprayer only)*. To temporarily repair a sampled area in a noncontaminated environment.
* *Documentation materials.*
	+ Field logbook.
	+ Plastic clipboard.
	+ Inspection checklist.
	+ Watch.
	+ Sample labels.
	+ Chain-of-custody forms.
	+ Waterproof pens.
	+ Overhead transparency sheets.

Inspectors can use permanent markers to write directly on plastic transparencies which can be cleaned in the shower without loss of the inspection notes. Paper should not be brought into a contaminated work area since it cannot be decontaminated.

* *Drop cloths.* Plastic drop cloths are used to protect area beneath sampling point from contamination.
* *Duct tape*. To temporarily repair a sampled area.
* *Glove bags*. For sampling sealed waste bags when a containment area is not present.
* *Labeled waste disposal bags*. For the disposal of contaminated materials.
* *Plastic bags*. To store equipment, supplies, packaged samples and waste materials.
* *Plastic drop cloth*. To protect area beneath sampling point from contamination.
* *Repair materials.* Bathroom caulking, water-activated repair cloth and prepared encapsulants (applied only with hand-pump sprayers) are used to temporarily repair sampled areas in a noncontaminated environment.
* *Sample containers.* Use any dry, sealable and clean container, such as a 35-mm film canister or plastic vial. Always wash canisters before use and never reuse containers that have contained asbestos. Otherwise, the inspector may be cross-examined about cross-contamination from previous samples. This could compromise the enforcement case. Although many inspectors use resealable plastic bags as sample containers, OSHA §1926.1101, Appendix K, *Polarized Light Microscopy of Asbestos (Non-Mandatory*), states:

“Do not use envelopes, plastic, or paper bags of any kind to collect samples. The use of plastic bags presents a contamination hazard to laboratory personnel and to other samples. When these containers are opened, a bellows effect blows fibers out of the container onto everything, including the person opening the container.”

OSHA recommends the use of 20 ml scintillation or similar vials.

Larger containers, such as quart- or gallon-sized zip-top bags may be needed, however, for samples of roofing, flooring, asbestos cements, etc., that are difficult to break down into small sizes.

Be sure to clean the sealed sample containers to prevent contamination of subsequent samples or individuals who might encounter the containers after they leave the project site.

* *Spray bottle.* For wetting a surface (using amended water) prior to sampling to prevent generation of dust and for decontamination purposes. Asbestos compliance inspectors may use commercially available surfactants or create their own amended water by adding one (or no more than a few) drops of dishwashing liquid to a liter of water.
* *Tamperproof tape/labels*. To seal sample containers and evidence envelopes.
* *Tools*. Forceps, a locking-blade penknife, coring device, screwdrivers, needle-nose pliers, laboratory spatula are examples.
* *Wet wipes*. To clean tools between samples and to decontaminate equipment and sample containers.

The above items are considered essential and should be included in every sampling kit. Other items, such as specialty corers, hammer and chisel and various cutting tools may also be needed. A comprehensive inspection equipment checklist is provided as an appendix to this manual.

***Procedural Guidelines for Asbestos Sampling***

The asbestos NESHAP regulation does not address collection of bulk samples. Information regarding sample collection can be found, however, in several EPA and American Society for Testing and Materials (ASTM) publications:

* *Guidance for Controlling Asbestos-Containing Materials in Buildings* (EPA 560/5-85-024, June 1985) ("Purple book")
* *Asbestos in Buildings: Simplified Sampling Scheme for Friable Surfacing Material* (EPA 560/5-85-030a, October 1985) ("Pink book")
* *Health and Safety Guidelines for EPA Asbestos Inspectors* (EPA, March 1991)
* *Test Method for the Determination of Asbestos in Bulk Building Materials* (EPA/600/R-93/116)
* *Asbestos Sampling Bulletin* (EPA, 9/30/94)
* *Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading* (ASTM D 5755-09).
* *Standard Test Method for Wipe Sampling of Surfaces, Indirect Preparation, and Analysis for Asbestos Structure Number Surface Loading by Transmission Electron Microscopy* (ASTM D 6480-10).
* *Standard Practice for Comprehensive Building Asbestos Surveys* (ASTM E2356-10).

The Pink and Purple books provide guidance for sampling in areas which are neither contaminated nor disturbed, e.g., AHERA school inspections, pre-abatement or pre-demolition inspections, etc. The health and safety document referenced above and portions of this manual describe protective equipment and procedural guidelines for collecting bulk samples. The *Test Method* document referenced above details preferred sample sizes for various asbestos-containing materials. The *Asbestos Sampling Bulletin* referenced above provides detailed information regarding the collection and analysis of bulk samples of multi-layered materials.

Two of the three ASTM documents describe settled dust sampling techniques. The last ASTM document (E2356-10) describes three types of asbestos surveys: Baseline Surveys, Project Design Surveys and Pre-Construction Surveys. **The stated purpose of the Pre-Construction Survey is to satisfy “…the EPA NESHAP requirements for renovation or demolition to “thoroughly inspect the affected facility…”.”**

***Pre-sampling Procedures (Non-contaminated Areas)***

EPA's *Health and Safety* document provides the following procedural guidelines for inspectors, e.g., Asbestos-in-Schools inspectors taking bulk samples in non-contaminated areas, i.e., areas where the asbestos-containing materials have not been disturbed.

* Discuss with building officials how the samples will be obtained and the rationale for selecting the sampling locations and the number of samples. Also discuss the advisability of notifying employees and/or their representatives prior to the inspection.
* Determine the equipment needed during the inspection to adequately access the area, e.g., ladders and/or scaffolding.
* Determine the best time to obtain the samples in each area selected, i.e., times when few people are in the vicinity of the work being conducted.
* Limit access to the area while samples are being collected. Post area(s) with appropriate signs or construct barricades, if necessary. Under no circumstances should samples be taken when school children or other unprotected individuals are present.
* Determine the minimum number of people needed in the affected area during sample collection and limit access to that number. These individuals may need to use personal protective equipment, depending on the asbestos inspector's assessment of the potential for asbestos fiber release.
* Determine how the area will be decontaminated should there be an accident, e.g., a piece of asbestos comes loose and drops to the floor. Be prepared to isolate the area and to damp wipe/mop the area and/or have access to a HEPA vacuum.
* Based on the best information available, determine the personal protective equipment required in the event of an accident, the conditions under which it will be worn and by whom.

***Sampling Procedures***

Asbestos inspectors may need to collect bulk samples of suspect RACM in pre-abatement, active and post-abatement areas and from other sites such as roll-off waste containers, trailers, abandoned buildings, waste disposal sites and demolished sites.

Bulk samples may be taken of stripped, removed, or in-place materials. Although the environments in which these samples are collected may not be conducive to formal random sampling approaches, by using proper judgment the inspector can ensure that samples are representative. Because the main goal of collecting bulk samples is to determine and document whether materials associated with a suspect violation contain greater than one percent asbestos, a subjective approach is warranted and appropriate.

***General Sampling Expectations***

In general, the following procedures should be followed when taking bulk samples.

* Identify homogeneous (similar in color and texture) thermal system insulation, surfacing and miscellaneous materials.
* Determine the friability of suspect materials.
* Select sample sites that will minimize disturbance of the asbestos material, e.g., the upper surface of horizontal thermal system insulation to reduce the possibility of contamination from material falling out of the sampling hole.
* If necessary, place a covering such as plastic sheeting on the floor under the sample collection area.
* Spray the area to be sampled with amended water to minimize release of fibers.
* Collect a complete core or cross section of suspect materials. In the case of a multi-layered system, if a bulk sample remains intact through all layers and the sample will remain intact until it reaches the analytical laboratory, containerize the sample as is. However, if such a bulk sample crumbles or breaks down at the time of sample collection, take separate samples from discrete layers at the site and carefully identify them and their position in the multi-layered system before sending them for analysis. Additional information regarding multi-layered systems is provided later in this chapter.
* Collect sufficient sample quantities per the analytical laboratory’s recommendations. In general, for items such as floor tiles, roofing felts and paper insulation, obtain three to four square inches of the material. For other materials such as ceiling tiles, loose-fill insulation and pipe insulation, gather approximately one cubic inch. For samples of thin coating materials such as paints, mastics, spray plasters and tapes, attempt to collect at least 2 square inches. An insufficient volume of sampled materials could be rejected by the laboratory.
* Collect a minimum of three representative samples from each homogeneous area of suspect material associated with a possible violation.

AHERA (40 CFR Part 763) requires that a specific minimum number of samples be obtained based on the classification of the material. OSHA [§1926.1101 (k)(5)] specifically relies upon the AHERA model. Also, many local and state agencies rely upon the AHERA model for NESHAP compliance or are more stringent. See Minimum Samples below for additional information.

* Place samples in airtight containers.
* Clean sampling equipment and wash hands or change gloves between samples to avoid cross-contamination.
* Use repair materials to seal the spot where the sample was taken, if necessary.
* Seal containers so that tampering will be evident and to prevent accidental opening.
* Write a unique identification number and your initials on each sample container.
* Record sample information in field notes. If dry material is encountered and a wetting violation is suspected, record this information in the field logbook and note in both the logbook and on the chain-of-custody form that the material was wetted during sample collection.
* Photograph the sampling location(s). When necessary, place a familiar item of known size in the picture as a size reference.
* Make a drawing of the inspection site, noting where samples and photographs were taken. Indicate angles of photographs and provide written descriptions of materials sampled.
* When sampling is completed, decontaminate the sampling equipment and outsides of sample containers.
* Follow appropriate personal decontamination procedures.
* Dispose of asbestos-contaminated waste properly.

***Minimum Samples***

AHERA (§763.86) requires the following minimum number of samples:

***Surfacing Material.***

Sample surfacing material in a statistically random manner.

* ≤ 1,000 ft2 – 3 samples;
* >1,000 but ≤5000 ft2 – 5 samples; and
* > 5,000 ft2 – 7 samples.

***Thermal System Insulation.***

* At least 3 samples per homogeneous material;
* At least 1 sample for each TSI “patch” < 6 linear or square feet; and
* In a manner sufficient to determine whether the material is ACM or not ACM for cement or plaster used on fittings, e.g., tees, elbows, valves.

Segregate homogeneous materials and sample them by type; e.g. long runs of TSI versus elbow mud. Collect samples in a randomly distributed manner, i.e., spread them out.

AHERA does not require the collection of bulk samples of any homogeneous material determined by the inspector to be fiberglass, foam glass, rubber or other non-ACBM. These materials, however, may be cemented, sealed, joined with ACM or applied over ACM. Also, in the early years of fiberglass use, hand-applied ACM may have been used as insulation on long runs of piping and pipe fittings such as elbows, T-connections and valve assemblies.

***Miscellaneous Material.***

Collect bulk samples from each area of friable miscellaneous material that is not assumed to be ACM “in a manner sufficient to determine …”

AHERA never specifically determined a minimum number of samples to be collected for miscellaneous materials. Because the word “samples” is plural, many accredited training providers in industry teach that a minimum of two samples must be collected for each miscellaneous material not assumed to be ACM. What is more determinative is the phrase, “In a manner sufficient to determine…” This would imply that the inspector take the number of samples necessary to assure that the suspect material is adequately sampled. This can be a very important aspect of sampling with low percentage materials like gypsum wallboard joint compound and others similar materials. Under-sampling these materials could yield a variety of results and create a deficient determination of whether regulated materials and violations exist.

***Multi-layered System Sampling***

Asbestos NESHAP inspectors may need to determine the applicability of the NESHAP to multi-layered systems they encounter. Such systems include plaster wall or ceiling systems, resilient flooring systems (flooring, mastic and underlayment), plaster/stucco systems and wallboard systems with add-on layers.

Since EPA had received many questions about the applicability of the NESHAP to multi-layered systems, it published the *Asbestos NESHAP Clarification Regarding Analysis of Multi-layered Systems* (59 FR 542, January 5, 1994). In this document EPA discussed the following:

***Plaster/Stucco***

If the plaster and stucco wall or ceiling systems are layered and the layers can be distinguished, then the layers must be analyzed separately.

***Add-on Materials***

All materials such as sprayed-on materials, paint, ceiling and wall texture "added" to wallboard or other base materials must be analyzed and reported separately if possible.

***Wallboard***

In its *Asbestos Sampling Bulletin* (September 30, 1994) EPA stated that it does not consider a sheet of "plasterboard," commonly called sheetrock, wallboard and gypsum board, by itself a multi-layered material under either AHERA or NESHAP regulations.

When joint compound or tape is applied to wallboard, it becomes an integral part of the wallboard and in effect becomes one material forming a wall system. Therefore, where a demolition or renovation impacts such a wall system, a composite analysis of the wall system (percent of asbestos in the joint compound, tape and wallboard) should be conducted.

Since analytical requirements differ for wallboard systems versus add-on materials, inspectors need to take samples in a manner that will help distinguish the two. EPA recommends the following sampling procedures be followed:

***Joint Compound***

Sample where joints are expected (take a minimum of three samples):

* inside or outside corners;
* at wallboard joint intervals; and
* around nail heads.

***Add-on Materials***

Take a minimum of three samples where joints are not expected, e.g., between corners and wallboard joint intervals.

Since a laboratory cannot distinguish joint compound at joints from the same materials used as a skim coat, the inspector must clearly describe the sample composition so that the analytical laboratory knows whether to report the results as individual layers or as a “composite” result for non-layered material.

At the laboratory, all samples with an outer layer having >1% asbestos will be noted. When this situation applies, the following must be considered:

* If only joint sampling areas show layers with >1% asbestos, then the material is joint compound and analytical results of the layers are composited. If the composite result is <1%, no management is necessary. If the composite result is >1%, the material is RACM as defined by the NESHAP and management is necessary.
* If samples from both joint and non-joint areas show layers with >1% asbestos, the material is considered a skim coat or add-on material. In this case the results must not be composited and must be reported for each layer. Material so located must be treated as separate RACM layers according to the NESHAP, and proper management is necessary.

Inspectors must keep good records of sample locations for later evaluation of results.

EPA recommended the use of an improved analytical method for the analysis of bulk samples in a *Federal Register* notice of August 1, 1994 (59 FR 38970). This notice directs laboratories to analyze individual layers or strata of a multi-layered sample and to report a single result for each layer. The 1982 interim method had allowed analytical results for the discrete layers of a multi-layered sample to be combined and reported as one result across all layers. As a result, multi-layered systems that may have contained asbestos in a single layer may have been reported by laboratories as non-asbestos-containing. NESHAP inspectors, therefore, cannot rely on previous analysis of multi-layered materials to determine applicability of the NESHAP unless results of each layer's analysis are available. Inspectors must sample multi-layered materials and provide necessary information regarding the samples to the laboratory for proper analysis.

OSHA does not allow compositing of analytical results from layered materials. Also, many local/state agencies require materials to be sampled and analyzed by layer.

The issue of multi-layered materials and compositing is one of the most debated issues in the asbestos control industry. When these materials are disturbed during renovation and demolition activity, the layers often separate into discreet materials that, upon analysis, are determined to be ACM.

***EPA’s Credible Evidence Rule***

Before discussing the several methods of asbestos analysis, it is appropriate to review EPA’s Credible Evidence Rule. While the asbestos NESHAP regulation requires bulk samples to be analyzed by the Polarized Light Microscopy Method as described in 40 CFR Part 763, EPA has the ability to use other information collection methods to determine compliance. EPA published the Credible Evidence Revisions on February 24, 1997 (62 FR 8314). The credible evidence revisions are based on EPA's long-standing authority under the Act, and on amplified authority provided by the 1990 CAA Amendments. Section 113(a) of the Act authorizes EPA to bring an administrative, civil or criminal enforcement action "on the basis of any information available to the Administrator." In this provision, which predates the 1990 CAA Amendments, Congress gave EPA clear statutory authority to use any available information - not just data from reference tests or other federally-promulgated or approved compliance methods - to prove CAA violations. In the 1990 CAA Amendments, Congress included an enforcement title (Title VII) to enhance EPA's compliance and enforcement authorities. Among other things, Congress revised Section 113(e)(1) of the CAA to overrule a federal court decision, United States v. Kaiser Steel Corp., No. CV-82-2623 IH (C.D. Cal. Jan. 17, 1984) that held that only specified reference test data could prove violations. The preexisting authority of Section 113(a) forms the principal basis for the credible evidence revisions which are supported by the language, history and intent of the 1990 CAA Amendments.

***Dust Sampling Procedures***

EPA has no official policy regarding dust sampling or analysis. However, the American Society for Testing and Materials (ASTM) Committee D22 has developed two test methods described below.

In some situations, e.g., a post-removal inspection or an improperly-run abatement site, inspectors may encounter settled dust and need to determine whether it contains asbestos. Inspectors may choose to use the ASTM microvacuum or wipe technique depending upon the sampling media/equipment available.

***Microvacuum Samples***

Asbestos NESHAP inspectors are encouraged to follow the microvacuum techniques described in the ASTM document: *Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading* (ASTM D5755-09). The following is a summary of this method:

The sample is collected by vacuuming a known surface area with a standard 25 or 37 mm air sampling cassette using a plastic tube that is attached to the inlet orifice which acts as a nozzle. The sample is transferred from inside the cassette to an aqueous suspension of known volume. Aliquots of the suspension are then filtered through a membrane. A section of the membrane is prepared and transferred to a TEM grid using the direct transfer method. The asbestiform structures are identified, sized and counted by TEM, using Selected Area Electron Diffraction (SAED) and Energy Dispersive X-ray Analysis (EDXA) at a magnification of 15,000X to 20,000X.

***Wipe Samples***

Asbestos NESHAP inspectors are encouraged to follow the wipe sampling techniques described in the ASTM document: *Standard Test Method for Wipe Sampling, Indirect Preparation, and Analysis for Asbestos Structure Number Surface Loading by Transmission Electron Microscopy* (D 6480-10).

ASTM recommends the use of a particle-free, sealed edge, continuous filament cloth sampling medium. This material is available from commercial scientific suppliers and is commonly known as “clean room wiper*.”* The sampling medium should be moistened with a 50:50 mixture of alcohol and water. Depending on the size of the sample area, inspectors should follow either the *Template Assisted Sampling Procedure* or the *Confined Area Sampling Procedure* found in the ASTM document. Once gathered, each sample should be sealed in a sample container, labeled with a unique identification number and delivered to a National Voluntary Laboratory Accreditation Program (NVLAP)-accredited laboratory for analysis. At the laboratory the sample will be analyzed via transmission electron microscopy (TEM) for its asbestos content.

***Tape Lift Samples***

In the tape lift method, adhesive materials such as transparent tape, self-stick office notes, or forensic tape are used to gather the dust sample. Duct tape should never be used since recovery of the dust particles for analysis is essentially impossible.

At the laboratory the sample is prepared directly for TEM or scanning electron microscopy (SEM) analysis. This method of gathering and analyzing the sample minimally disturbs the asbestos present, but other fibers and matrix material may mask the asbestos fibers.

***Passive Samples***

In passive sampling, a clean collection surface such as a shallow metal lid is deployed to collect dust over a measured period of time. The dust is rinsed out of the container and then analyzed via TEM. Since the collection time is usually several weeks, asbestos NESHAP inspectors do not often use this method. Passive samples are useful, however, in determining if dust is being deposited during the sampling period.

***Post-sampling Activities***

The following activities are necessary after the inspection and sampling have been concluded:

* Complete all documentation including checklist entries and chain-of-custody (COC) form. A sample COC form is provided in Figure 6-1. If a commercial lab is used for analysis, it may supply appropriate COC forms. Many times, regulatory agencies have their own prescribed forms.
* Secure samples before conducting another inspection.
* Minimize the number of individuals who handle the samples thereafter. The name of every individual who acquires custody of the samples must be recorded on the COC form. The samples should not be handled by multiple custodians unless necessary and unless a COC form is signed by each person who has possession of the samples.
* Chain of Custody can best be maintained by personal delivery of samples to the analytical laboratory. If this is not possible, the U.S. Postal Service or a commercial courier service may be used. Since packaging and labeling requirements may differ depending on the organization chosen, inspectors should contact these couriers before shipping samples. If being shipped, package the bulk samples in a manner that assures that asbestos will not be released during transport. Make sure the sample vials are securely taped shut and well cushioned to prevent breakage.
* Analyze samples as necessary. It is advisable to collect extra samples and analyze only enough to satisfy the evidence requirements; for instance, one sample containing greater than one percent asbestos. Additional samples may be analyzed as needed.
* Retain original samples until such time as an enforcement action is completed.

***Bulk Sample Analysis***

Bulk sample analysis is performed to determine whether the material from which samples have been collected contains greater than 1% asbestos. EPA provided guidance regarding the analysis of asbestos in bulk samples in its publication *Method for the Determination of Asbestos in Bulk Building Materials* (EPA/600/R-93/116, July 1993). This improved analytical method was designed to address certain materials:

* that are known to contain asbestos fibers, but in which the asbestos percentage is low (<10%);
* where the percentage of asbestos is obscured by a matrix binder of some kind, e.g., vinyl or asphalt floor tiles; and
* in which small, thin fibers are present, but are frequently not detected at the magnification and resolution limits of polarizing light microscopes.

The improved method expanded on the previous 1982 interim polarizing light microscope (PLM) method. As before, it begins with a careful examination of the sample using a stereomicroscope and then proceeds, as before, to the examination of sample specimens under a polarizing microscope. In most cases, these steps will be sufficient to characterize a sample as asbestos-containing (asbestos present >1%) or non-asbestos-containing (no asbestos detected, or 1% or less in the sample).

The improved method includes additional procedures required for the reliable analysis of certain bulk building materials, such as steps for the elimination of the obscuring matrix materials, as well as specifying use of the TEM techniques of X-Ray Diffraction (XRD) and Analytical Electron Microscopy (AEM).

While there are a few regulatory references to the 1982 interim method, commercial laboratories have been utilizing the 1993 method since its publication and it is considered the current standard for bulk sample analysis.

***Analytical Techniques***

Microscopic, chemical and x-ray techniques are used to determine the asbestos content of an asbestos-containing material. Polarized light microscopy works well for many, but not all, materials. Other techniques are employed for either fiber identification or asbestos quantitation when bulk materials offer specific difficulties in analysis.

***Stereomicroscopic Examination***

A preliminary visual examination, which will help determine homogeneity, texture, friability, color and the extent of fibrous components of the sample, is required for all samples. This information helps guide the selection of further, more definitive, qualitative and quantitative asbestos analysis methods.

Since vinyl floor tiles and asphaltic products contain small asbestos fibers and/or interfering components, the use of stereomicroscopic analysis may be limited.

***Polarized Light Microscopy***

PLM, a qualitative examination technique, is used to distinguish the various forms of asbestiform minerals on the basis of their unique optical crystallographic properties, and also to perform a semi-quantitative analysis of bulk samples, i.e., visual area estimation and/or point-counting.

Although PLM analysis is the primary technique used for asbestos determinations, it cannot provide all needed information because of the limited visibility of the asbestos fibers. In some samples the fibers may be reduced to a diameter so small or masked by coatings to such an extent that they cannot be reliably observed or identified. For these reasons, PLM is of limited value in analyzing floor tiles and other materials containing binders or matrices. Gravimetric and/or analytical electron microscopy procedures may be required.

When PLM is used to quantify asbestos content of a sample, the following conditions should be met:

* The slide sample should be homogeneous in order to be representative of the total sample and
* Particles in the slide preparation should have an even distribution and approach a one particle thickness to avoid particle overlap.

Quantitation of asbestos content may be accomplished via calibrated visual area estimates and/or a point counting procedure.

***Visual Area Estimation***

Per EPA’s 1993 methodology guidance, visual area estimates are made by comparing the sample to calibration materials that have similar textures and fiber abundance. A minimum of three slide mounts are examined to determine the asbestos content. Each slide is scanned in its entirety and the relative proportions of asbestos and nonasbestos are noted. EPA recommends that the ratio of asbestos to nonasbestos materials be recorded for several fields for each slide and the results be compared to data derived from the analysis of calibration materials having similar textures and asbestos content. Analytical results are reported as “area percent.” If no asbestos fibers are seen, the analyst commonly reports this result as “no asbestos observed.”

***Point Counting***

Point counting is a standard technique used in petrography for determining the relative areas occupied by separate minerals in thin sections of rock. For asbestos analysis, this technique is used to determine the relative concentrations of asbestos minerals to nonasbestos sample components. Unless a building owner/operator chooses to designate suspect materials as presumed asbestos-containing material (PACM), the point counting analytical method must be used when a method other than point counting has determined that the asbestos content of a sample is less than 10 percent.

In the point counting method, an ocular reticle with a cross-line (preferred) or point array is used to visually superimpose a point or points on the microscope field of view. A total of 400 points superimposed on either asbestos fibers or nonasbestos matrix material must be counted. Point counting provides a determination of the projected area percent asbestos.

If one or more samples from a homogeneous suspect ACM is determined to contain more than one percent asbestos, the entire material is considered to contain asbestos and is thus subject to the NESHAP.

***Gravimetry***

Gravimetry is a process in which acids, solvents and ashing (heating the sample to burn off organic materials) are used to selectively remove the binder components from a sample. Gravimetric procedures are designed to meet the following objectives:

* Isolate asbestos from the sample to allow weight determination;
* Concentrate asbestos, thereby lowering the detection limit in the total sample;
* Aid in the detection and identification of fibrous components; and
* Remove organic fibers that are optically similar to asbestos.

If the sample is friable and contains organic components, the ashing procedure should be followed. If the sample is friable and contains HCl-soluble components, the acid dissolution procedure should be followed. If the sample is friable and contains both types of components, or if the sample is nonfriable, e.g., floor tiles, the two procedures can be applied, preferably with acid dissolution following ashing.

Gravimetry is not an identification technique, but is used to aid in qualitative PLM, AEM, or XRD.

A sufficient amount of suspect ACM should be collected and the laboratory should be informed to analyze only a portion of the sample via gravimetry. The remainder must be retained as evidence.

***X-Ray Diffraction***

XRD, a technique that reveals a mineral's unique "fingerprint" on film, is typically used in conjunction with PLM or AEM. The technique is more expensive than PLM and cannot distinguish between fibrous and non-fibrous forms of asbestos. However, qualitative, semi-quantitative and quantitative results may be obtained from XRD.

***Analytical Electron Microscopy***

AEM analysis, often referred to as “TEM” analysis, is a reliable although more expensive method for the detection and positive identification of asbestos in some bulk building materials. The method is particularly useful in the analysis of floor tiles and plasters, materials that contain a large amount of interfering materials and which contain asbestos fibers that may not be resolved by PLM techniques. The AEM method can also be used to quantify asbestos concentrations.

***Other Analytical Techniques***

Scanning electron microscopy is very useful for observing surface features in complex particle matrices and for determining elemental compositions. SEM cannot, however, detect small diameter fibers (~<0.2 mm) and cannot determine crystal structure.

Field test kits should never be used to confirm the presence or absence of asbestos since their results are unreliable.

***Quality Assurance***

***Sample Identification Numbers***

A unique identification number must be assigned to each sample. This number could be a combination of a site code and the date and time the sample was taken. For example, a sample obtained at St. Joseph's Hospital on July 1, 2010 at 2:17 pm, could be assigned the following number:

**SJH-120701-1417**

Use of a consistent numbering system can help reduce a microscopist's potential bias. For example, if the numbering system chosen clearly indicates that seven samples were taken from the same room, a microscopist might not be objective when analyzing each sample.

Be sure to reference sample numbers properly in project notes, COC forms and final reports. Failure to do so can attract negative scrutiny.

***Chain-of-Custody Forms***

In order to ensure that all samples are properly identified and tracked from the point of sample collection through receipt by the analytical laboratory, EPA requires that a COC form be completed and accompany the samples when they leave the possession of the inspector. (See Figure 6-1.)

A COC form should contain the following information:

* Project name and address;
* Date of inspection/sampling;
* Sample identification numbers;
* Name/signature of sampler and date;
* Name/signature of recipient(s) and date;
* Type of analysis to be performed; and
* Other pertinent information, e.g., use of glove-bag sampling method, use of unusual sample container, dry material wetted by inspector, etc. It is very important that the glove-bag technique be noted on the COC form. When using the glove-bag technique the inspector may NOT wet the sample as would ordinarily be done. The laboratory probably will note that a particular sample was received “dry” and others were “wet.” In the absence of glove-bag notations, improper sampling techniques may be alleged.

Regulatory personnel should avoid the inclusion of lengthy notes on the COC form. The COC form should contain only information which uniquely identifies each sample. Since some laboratories require the use of their own COC forms, inspectors should contact them ahead of time to learn proper procedures.

A COC form should be completed immediately after the inspection. If mistakes are made in transferring information from field notes or sample containers to the form, a new form should be completed that is fully accurate.

Figure 6-1. Example Chain-of-Custody Form

The form should not be signed until just before the samples leave the custody of the inspector.

Every person who takes custody of the collected samples must sign the COC form. Samples should remain in the custody of one inspector until they are released to the laboratory in order to mitigate negative scrutiny on how the samples were handled post-inspection.

***Quality Control (QC) Samples***

Collection of side-by-side duplicates is recommended at the rate of one QC sample per building or one QC sample for every 20 samples taken, whichever is larger. Since analyses of QC samples can help determine both sampling and analytical precision, it is important that the laboratory conducting the analysis not know which samples are QC samples.

Inspectors can help ensure nonbiased analysis by collecting a side-by-side sample non-sequentially. The inspector should gather several samples at the facility and then go back to one of the sample locations for the side-by-side duplicate. In this way the side-by-side samples' identification numbers are not consecutive in time or number.

Side-by-side duplicates are analyzed to determine the consistency of analysis within a laboratory. Significant differences in analytical results for such samples should not be encountered. Splits of side-by side duplicates may also be sent to a second laboratory to confirm the results of the first analyses. Any significant disagreements should be investigated. It may be necessary for samples to be reanalyzed or additional samples to be collected.

***Accredited Laboratories***

To diminish the likelihood of challenges to the accuracy of laboratory results, regulatory agencies should use only laboratories which have participated in and been NVLAP-accredited by the National Institute for Standards and Technology (NIST). A list of accredited laboratories can be obtained through the TSCA Hotline (202-554-1404), NVLAP (301-975-4016) or <http://ts.nist.gov/standards/scopes/plmtm.htm>.

Be sure to contact the laboratory before conducting the inspection and discuss the following:

* Required type of analysis;
* Sampling procedures;
* Sample amounts;
* Sample containers;
* Chain of custody forms;
* Packaging of materials for shipment;
* Turnaround time for analysis; and
* Cost of analysis.

<This page is intentionally left blank.>