Chapter 10
Air Sampling and Analysis

This chapter is designed to provide inspectors general information concerning the equipment, methods and procedures involved in air monitoring and air sample analysis. Although there are no requirements under the asbestos NESHAP for conducting air monitoring at demolition/renovation or asbestos removal sites, such requirements have been issued by OSHA to monitor worker exposure and determine appropriate respiratory protection and by EPA under TSCA to verify the adequacy of abatement activities at public and private schools, grades K-12. These rules create the likelihood that asbestos NESHAP inspectors will encounter monitoring equipment and air monitoring data during inspections.

The EPA has published a number of guidance documents that recommend when, where, and how asbestos air monitoring should be conducted. Many of these documents have not been updated and therefore do not reflect current air monitoring practices.

When transmission electron microscopy (TEM) procedures are used to determine final air clearance levels in school buildings, the procedures detailed in the *Asbestos Containing Materials (ACM) in Schools,* found in 40 CFR, Subpart E, are used. Personal air monitoring is typically performed in accordance with the procedures detailed in the OSHA asbestos standard for the construction industry (*29 CFR 1926.1101(f) and Appendix A*). Phase contrast microscopy (PCM) analysis of air samples is conducted per NIOSH Method 7400 or Appendix A of the OSHA asbestos standard. Additional information pertaining to air monitoring can be found in the "List of Available References," an appendix to this manual.

Types of Air Monitoring

Asbestos air monitoring is conducted for a number of reasons and in a variety of scenarios. The most often encountered situations are:

- ***Ambient or background monitoring*** – measures indoor or outdoor pre-abatement fiber concentrations.

- ***Personal air monitoring*** – required by OSHA to protect those not using personal protective equipment (PPE) and to prove that PPE in use is sufficient for the fiber levels present during asbestos disturbing activities. Inspectors should examine available personal air monitoring data to aid in the selection of respiratory protection. The data, however, may not represent current conditions.

- ***Monitoring during active removal operations*** – measures asbestos fiber concentrations in the work area, helps determine the efficacy of engineering controls and work practices and determines worker exposure during the monitoring time interval.

- ***Clearance monitoring*** - determines whether airborne levels of asbestos in the containment area are below an acceptable level after the abatement project is completed; is done before critical barriers are taken down and the contractor is released from the job.

Sampling Types

Several types of air sampling may be performed at inspection sites.

Personal Sampling

An air-monitoring device is worn by the worker during his/her normal work schedule. The sampling is used to determine the "breathing zone" fiber levels to which the worker would be exposed if he or she were not wearing a respirator. In the absence of a negative exposure assessment (NEA), OSHA requires representative personal air sampling to be performed daily on OSHA Class I & II projects. Owners/operators may collect abatement workers' personal air samples; but this activity is often subcontracted to a qualified firm.

Area Sampling

A stationary air-monitoring device is placed in an area representative of the overall area under investigation. This technique is used for fiber level assessments for background sampling and for monitoring during and after abatement actions. It has been used to monitor the ambient air for asbestos fibers after catastrophic events.

Samples taken outside of an operating asbestos removal project may be referred to as "environmental air samples," "ambient air monitoring," "leakage testing," etc. Many states and project contracts require such sampling during asbestos removal projects. It is most common, and often required, that an appropriate third-party firm provide this service.

Final Clearance Air Sampling

Large volume air samples are obtained in the asbestos abatement work area and analyzed to determine if airborne asbestos levels are low enough for re-occupancy by the public. Where the ACM in Schools Rule applies under the authority of the *Asbestos Hazard Emergency Response Act (AHERA)*, specific procedures must be followed for obtaining and analyzing these air samples. The AHERA-based regulations requires the collection of certain air volumes, use of particular equipment, and TEM analysis.

AHERA also requires aggressive air sampling. Before the sampling begins, an individual typically uses a leaf blower to agitate all surfaces in the work area to create a worse case scenario. After this agitation, the samples are collected. During the sampling period, fans should be used to keep any fibers in the area airborne for possible collection.

When AHERA does not apply, owners/operators may use PCM for final air clearance sample analysis.

In the absence of state or contract document requirements, final clearance sampling is required only for AHERA-related projects. Building owners often insist on this sampling for any facility that will be re-occupied by the public. Various states, such as New York and South Carolina, have their own specific final air clearance procedures.

Below are a number of final clearance requirements:

- The sampling agency has numerous responsibilities including sampling logs, pump calibration, and technical knowledge of proper sampling techniques.

- Filter cassettes must be commercially available cassettes designed for single-use and preloaded typically with a 0.45 µm pore size mixed cellulose ester (MCE) sampling filter and a 5.0 µm backing filter.

- The abatement work area must undergo a stringent visual inspection to assure that all material has been removed and cleaning has been performed properly. This is most commonly accomplished by the sampling technician and the owner/operator's supervisor.

- Use aggressive air sampling to dislodge any remaining dust. This is commonly accomplished with a 1 horsepower leaf blower. This activity should occur before the sampling pumps are turned on.

- Air sampling pumps are to operate at a rate of no more than 10 L/min.

- The recommended air sampling volume range for a 25 mm sampling cassette is 1,200 to 1,800 liters.

- A minimum of 13 samples are to be collected from each testing site, consisting of the following:

    - Five samples inside the abatement work area;
    - Five samples outside the abatement work area, positioned at locations representative of the air entering the abatement work area. These samples will typically be collected at the entrance to the decontamination chamber and at critical barriers;
    - Two field blanks opened for 30 seconds and then closed. One should be opened inside the abatement work area and the other outside of the abatement work area; and
    - One sealed blank.

- The work is completed if the average of the five samples collected in the abatement work area is 70 structures/mm^2 or less.

- There is an option to perform a Z-test, a statistical evaluation of the difference between sample and population means. If all samples are analyzed and the Z-test result is < 1.65, the area passes. The Z-test option is rarely employed.

- For abatement work areas that exceed the small-scale short-duration (SS-SD) criteria but are less than 160 square feet (ft^2)/260 linear feet (LF), PCM techniques can be employed. Five samples are required within the abatement work area but no outside samples are required. The work is considered complete if all samples are ≤0.01 f/cc with no averaging allowed. Sampling and analysis procedures must follow the requirements in NIOSH Method 7400.

Sampling Equipment

Air sampling equipment consists of pumps and their associated filters and cassettes.

Sampling Pumps

These devices are available from a variety of manufacturers and are usually described as low-volume (personal) and high-volume pumps.

Low-Volume

Low volume pumps are generally light-weight, battery-powered, personal monitoring devices with a flow rate range of 1 to 5 liters per minute (L/min). More sophisticated versions are flow compensating and can be programmed to turn on, shut off, record flow rates, store data and interface with a data logger or personal computer. These devices are used for personal monitoring and occasionally for area air sampling where asbestos disturbance is occurring.

For OSHA required personal sampling, set the maximum flow rate of the device at 2.5 L/min as mandated by 29 CFR 1926.1101, Appendix A.

High-Volume

High volume devices are capable of achieving flow rates up to 25 L/min. Larger, heavier and noisier than the low-volume types, these machines collect large volumes of air in relatively short periods of time. High volume pumps are used to collect area samples before, during and after abatement actions. They should not be used where asbestos is being disturbed since they are difficult to clean once contaminated.

Filters and Cassettes

Airborne asbestos fibers are most often collected on 25-mm filters housed in 2 or 3-piece plastic cassette bodies.

The most common filter media are:

- ***Mixed cellulose ester (MCE) membrane*** – Filters with a pore size of 0.8-1.2 µm must be used when collecting samples to be analyzed by Phase Contrast Microscopy (PCM). These filters are sold nominally as 0.8 µm filters. When Transmission Electron Microscopy

(TEM) is the analytical method, the filter assembly (as required by AHERA) consists of 2 filters - a 0.45 µm sampling filter and a 5.0 µm backing filter, and a support pad.

- ***Polycarbonate filter***- Though rarely used today, these smooth-surfaced filters with a pore size of 0.4 µm may be used when collecting AHERA-related air samples for TEM analysis.

Continuous Monitors

Continuous monitors provide real time data concerning nonspecific fiber concentrations but are not commonly used and are not approved by any state or federal asbestos regulatory program. They must be run a minimum of 1,000 minutes in order to provide useful monitoring data.

Continuous monitors are designed to mimic the NIOSH methodology and count all airborne fibers greater than 5 µm in length and with a minimum 3:1 aspect ratio that pass through the sensor during a pre-selected time period. At the completion of the sampling period, the device electronically computes the asbestos concentration in fibers/cc.

Analytical Techniques

Air samples may be analyzed by either the PCM or TEM methodology. Each has certain advantages and disadvantages depending on the circumstances in which it is used and the investigator's data requirements. To ensure the admissibility of analytical results, make sure that the laboratory uses an accredited method of analysis. Table 10-1 illustrates a general comparison of these different methods.

Phase Contrast Microscopy (PCM)

- Adopted by the Occupational Safety and Health Administration (OSHA) as a standard protocol for measuring airborne asbestos in the industrial work place (OSHA Reference Method).

- Nonspecific for asbestos fibers (counts all fibers > 5µm long with a minimum aspect ratio of 3:1).
- Limit of resolution is approximately 0.25 µm in diameter. Some asbestos fiber diameters may be less than this resolution, making them undetectable under the PCM method.

- Less expensive and widely available analytical technique.

- Because of its many limitations, EPA's AHERA allows this method of air sample analysis for asbestos removal projects exceeding the SS-SD criteria (similar to OSHA Class III) but involving ≤ 160 ft^2 or 260 LF of ACM.

Transmission Electron Microscopy (TEM)

- TEM is very sensitive and specific and is EPA's preferred method of air sample analysis for final clearance air samples. AHERA requires TEM analysis for all school asbestos removal projects greater than 160 ft^2 or 260 LF.

- Due to magnification capabilities ranging from 15,000X -20,000X, TEM is capable of detecting extremely thin asbestos fibers (typically 0.025 to 0.0025 µm in diameter).

- TEMs that meet AHERA-required laboratory accreditation requirements must be outfitted with energy dispersive x-ray analysis (EDXA or EDS) and selective area electron diffraction (SAED) capabilities to provide definitive information concerning the chemical composition and crystalline structure of the observed fibers.

- TEM analysis is more expensive than PCM analysis and cannot be performed on site.

- TEM analysis exists as a standard protocol. See 40 CFR Part 763, Appendix A to Subpart E - *Interim Transmission Electron Microscopy Analytical Method and Field Sampling Protocol for the Clearance Testing of an Abatement Site.*

Table 10-1 Comparison of Methods for Measuring Airborne Fibers (PCM) and Asbestos (TEM)		
Category	**PCM**	**TEM**
Standard Method	NIOSH Method 7400[1]	EPA AHERA Method[2]
Quality Assurance	Proficiency Analytical Testing (PAT)	NVLAP Accreditation
Cost	$10-20	$60-150
Time Requirements	1 hour preparation and analysis, less than 6 hours turnaround, in many cases	4-24 hour preparation and analysis, 2-7 days turnaround for final reports in many cases
Sensitivity	0.25µm maximum	0.025 – 0.0025 µm; fiber size
Specificity	Not specific for asbestos	Definitive for asbestos (TEM with EDXA & SAED)
Collection Filters, typical	0.8 µm MCE	0.45 µm MCE

[1]Revision #2: 3/1/87. OSHA Reference Method (ORM, 1986) is a modification of NIOSH 7400.
[2]U.S. EPA, Asbestos-Containing Materials in Schools, 40 CFR 763, Subpart E, Appendix A, 1987.

Quality Assurance

Final clearance air and bulk samples acquired at AHERA sites must be analyzed at laboratories that are accredited through the National Institute for Standard and Technology (NIST) National Voluntary Accreditation Program (NVLAP). This program follows internationally recognized accreditation guidelines. All accredited facilities are physically assessed initially as well as periodically. They must perform adequately with proficiency test samples and meet other quality criteria.

Laboratories which perform PCM analysis of air samples at AHERA sites must be enrolled in the American Industrial Hygiene Association (AIHA) Proficiency Analytical Testing (PAT) program. Although a requirement within AHERA; such laboratory participation is only strongly recommended in the NIOSH Method 7400 and OSHA regulations.