VI. ANALYTICAL

Asbestos is analyzed by microscopic examination. There are established techniques for analyzing a bulk material for percent composition and also for analyzing the fiber concentrations of air samples.

Bulk materials are initially examined under a low power stereo microscope to determine the percent composition and homogenity. Specific materials observed which are suspected of being asbestos are further analyzed under higher magnification (100X) using a polarized light microscope with a dispersion staining objective. Participation is recommended in the EPA-sponsored Bulk Asbestos Quality Assurance Program by Research Triangle Institute (see page 36 for address). A written standard operating procedure should be followed when extracting bulk samples, to minimize the disturbance of suspect asbestos-containing materials.

Air concentrations of asbestos fibers are determined by drawing air through a filter and subsequently analyzing that filter for fibers with certain characteristics. There are a number of techniques available for both the collection of the samples and the analysis of the filters.

Caution should be exercised in interpreting the results of air sampling. There are severe limitations in the conclusions which can be drawn from air sampling data. Sufficient air sampling is expensive, logistically difficult, and can miss episodic events. Air sampling, in spite of these limitations, serves an important role in an asbestos abatement effort.

The three primary methods of analyzing airborne asbestos are phase contrast microscopy (PCM), scanning electron microscopy (SEM), and transmission electron microscopy (TEM). All of these methods have advantages and disadvantages: the selection of the most appropriate analytical method will depend on the purpose for which the data is intended. The following chart summarizes the major characteristics and relative benefits and deficits of the three methods:

Method	Phase Contrast Microscopy (PCM)	Scanning Electron Microscopy (SEM)	Transmission Electron Microscopy (TEM)
Standard reference	NIOSH P&CAM 239 or NIOSH 7400	No standard method	EPA 1977 with Yamate revision 1984
Quality control	NIOSH PAT Program No NBS reference	No program UICC Standards(1)	NBS reference
Specificity	Not specific for asbestos	More specific than PCM but not definitive	Definitive for asbestos
Cost sample	\$25-\$50	\$100-\$300	\$200-\$600
Turnaround time	1 hour to 1 week	1 day to 2 weeks	1 week to 4 weeks
Sensitivity (Thinnest fiber visible)	0.25 micron	0.15 micron	0.0025 micron
Equipment cost	\$5,000	\$50,000	\$150,000

(1) UICC: Union Internationalle Contre le Cancer - uses reference known for *Bulk* samples.

The lowest measurable concentration of fibers in the air is the "limit of detection". Below that limit, the reported concentration is not statistically reliable. A number of factors influence the detecton limit. Generally, the longer the sampling duration, the higher the sampling flow rate, the higher the microscope resolution, and the more microscope fields which are counted, the lower will be the corresponding detection limit. A low detection limit is very important when evaluating risks to the general public.

The EPA Guidelines from PCM analysis of fibers in air samples recommend a lower limit of detection of 0.01 fibers/cc of air.

Air sampling is conducted under three abatement conditions:

- Pre-Abatement sampling may be used to document conditions prior to abatement, when conducting an occupancy risk assessment, or as routine element in an operations and maintenance program.
- During-Abatement sampling is used to document conditions both inside and outside containment during an abatement project. This sampling serves as a complement to a strictly enforced Means and Methods program.
- Post-Abatement sampling serves to close out an abatement project by verifying, at a specific detection limit, that the project specifications have been met. Pre-occupancy sampling also may be desired as a definitive evaluation of fiber concentration in the air.

Two broad categories of sampling techniques are used. Static sampling is conducted without intentionally disturbing the asbestos-containing material or the surrounding air. Dynamic sampling is conducted by deliberately disturbing the surrounding air so as to stir up any settled dust and create an environment which maximizes the asbestos fiber concentrations. Obviously, the

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results obtained with static techniques are going to be different from those obtained with dynamic techniques. Static sample results *are always lower* than dynamic sample results: however, either technique is representative only of the conditions under which the sampling is conducted.

The choice between using static or dynamic sampling is not arbitrary: there are appropriate conditions for both. The following table summarizes the conditions under which the two techniques may be used:

Abatement Condition	Situtation	Sampling Technique
Pre-Abatement	• Normal occupancy under normal use	• Static
	• Maximum potential fiber concentration	• Dynamic
During-Abatement	• Fiber concentrations inside and outside containment	• Static
Post-Abatement	• Project closeout	• Dynamic
	• Pre-Occupancy	• Dynamic

In order to compare results, similar sampling conditions must be used. For example, pre-abatement static samples cannot be compared with post-abatement dynamic samples.

All air samples are analyzed by examination under a microscope. PCM and TEM analyses follow established procedures for counting the fibers. The laboratories and analysts must be required to follow these procedures and have established a formal quality control program to assure the results.

The American Industrial Hygiene Association (AIHA) administers a voluntary laboratory accreditation program. The NIOSH PAT (Proficiency Analytical Testing, Program) now administered through AIHA checks the analytical accuracy of the participants during four "round robin" submittals per year.

Any accredited laboratory must *successfully* participate in NIOSH PAT *and* it must have undergone a rigorous examination of staff, facilities, and quality control. There is no similar formal program for TEM-related work.

Samples that have been analyzed by an accredited laboratory are the most defensible in terms of unquestioned analytical accuracy. Samples which are field analyzed, that is where the microscope and analyst are not in the laboratory, cannot be claimed to be analyzed by an accredited laboratory. Field analyzed samples may be claimed to have been analyzed by an individual who participated in NIOSH PAT, if that is the case.

The comparison between methods allows the following recommendations to be made:

- TEM is the ultimate definitive analysis for airborne asbestos when used to its fullest capability. PCM is nonspecific, but is a flexible, fast and inexpensive method limited to large fibers. SEM has no acceptable standard protocol or quality assurance checks at this time.
- PCM is an adequate analytical methodology when used to complement a strictly enforced "Means and Methods" project. PCM is not adequate when definitive analysis is required.
- There are times and circumstances when definitive analysis is needed. At these times, TEM should be used.
- If PCM is used on airborne filters, analysis of at least 10 percent of all samples by accredited laboratories is important because of the defensibility of the results. The lab should be specifically rated proficient in PAT asbestos analysis. If TEM is used, the analysis should be performed by laboratories that prove good compliance with the NBS reference materials available, as well as use of the Yamate revision of the U.S. EPA analytical method.
- Due to the fast turnaround time often needed for post-abatement samples, PCM may be the only method available that will fit the required time frames. If definitive results are required, the filters can be subsequently set out for TEM analysis after the PCM analysis has been completed, or samples can be obtained specifically for TEM analysis.

It is recommended that the sampling strategies for pre- and post-abatement be modeled after those specified in Appendix M of the EPA booklet *Guidance for Controlling Asbestos Containing Materials in Buildings*, 1985 edition.