

Fogel, Robert

From: Ellis, Benjamin <bellis@EMSL.com>
Sent: Wednesday, January 8, 2020 11:49 AM
To: Latsha, Gary
Cc: Cahill, Ed; Ray, Robyn
Subject: [External] RE: Standard Operating Procedures (SOP's) for the Asbestos Differential Counting Method

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Gary,

Below we have provided background information on what constitutes asbestiform structures and the decision making process used by EMSL during analysis on your samples.

Regards,

Ben

Differentiating true asbestiform fibers from cleavage fragments of the same mineral is often an important distinction when attempting to determine applicability of existing regulations and danger from exposure. Unfortunately the distinction between asbestiform and non-asbestiform on a fiber by fiber basis is difficult at best and is often based on subjective morphological observations. Even the importance of the distinction between asbestiform and other fibers with similar dimensions is subjective and highly debated.

Though the data end users typically look to the laboratory to make the critical distinction between asbestiform and non-asbestiform, it should be recognized that the distinction can be subjective. It is important that the client and the laboratory have a discussion prior to analysis, about the specific criteria to be applied.

EMSL endeavors to provide as much information as possible about what fibers were and were not included as part of the asbestiform count and why so that the end user has an accurate picture of what the analyst encountered during the analysis. The level of effort and the degree of documentation to be employed should be part of the initial conversation between the laboratory and the client.

Since the asbestiform and non-asbestiform manifestations of a particular mineral can have identical chemistry and crystallography at the microscopic level, the primary distinctions are made by morphology (size and shape) of the elongate mineral particles (EMPs) in question. Because of this, it is extremely important to recognize that the preparation steps that the laboratory employs can have a profound impact on the size and shape of the fibers observed during analysis.

Preparation steps for the analysis of manufactured products are specific to the material in question, and are chosen to identify components, minimize or reduce interferences and aid in the detection and identification of the mineral fibers present. All of the preparation steps are chosen to minimize the comminution of EMPs as much as possible while recognizing that a proper light or transmission electron microscopy preparation and analysis requires a fairly small particle size.

The specific criteria outlined in the analytical methods significantly affect the final results that are reported. These criteria typically do not address distinguishing asbestiform from non-asbestiform EMPs. Laboratories are left with ambiguous and subjective definitions for fibers that change with the method being employed.

The asbestiform habit is best defined at the macro scale on hand samples and not the micro scale on individual fibers. None of the current asbestos methods can unambiguously classify a countable fiber as asbestiform vs. cleavage fragment in all cases. Furthermore, it cannot be unambiguously stated that non-asbestiform fibers can be dismissed as non-contributors to asbestos related diseases.

Of particular concern in this differentiation challenge is the presence of cleavage fragments. Cleavage fragments are particles that can result from the comminution (natural or manufactured) of a non-asbestos amphibole or other mineral. Cleavage fragments have the potential to be elongate, and if they have the same chemistry as the asbestiform variety of a specific mineral, they will be counted as a fiber during analysis.

Below are some common definitions.

Asbestiform

The unusual crystallization habit of a mineral when the crystals are thin, hair-like fibers. With a light microscope, this habit is recognized in a bulk hand sample by the following characteristics:

- Mean aspect ratio ranging from 20:1 to 100:1 or higher for fibers longer than 5 μm . Aspect ratio should be determined for fibers, not bundles.
- Very thin fibrils, usually less than 0.5 μm in width.
- Two or more of the following:
 - parallel fibers occurring in bundles
 - fiber bundles displaying splayed ends
 - matted masses of individual fibers
 - fibers showing curvature

Asbestos

A commercial industrial term rather than a mineralogical term referring to well-developed and hair-like long-fibered varieties of certain minerals that satisfy a particular industrial need.

Cleavage fragments

Mineral particles resulting from the fragmentation of non-asbestiform amphibole. Some may have dimensions of a countable fiber, by whatever counting method employed. (I.e. AHERA length = $>0.5 \mu\text{m}$, aspect ratio of 5:1; NIOSH 7402 length = $>5 \mu\text{m}$, width 0.25 - 3.0 μm)

Elongate mineral particle (EMP)

A mineral particle with an aspect ratio (length: diameter) greater than 3:1, irrespective of whether its origin is asbestiform or non-asbestiform.

Mineral

A naturally occurring inorganic substance having a defined chemical composition and crystal structure.

Analysis by Transmission Electron Microscopy (TEM)

The high magnifications (typically 20,000X and above) employed in TEM analysis allow the analyst to see fibers that are well beyond the limit of resolution of light microscopy.

This high magnification however limits the amount of sub-sample that can be prepared and analyzed. It is therefore more difficult to assess the entire population of fibers present, if indeed a population has been collected onto the filter. TEM analysis involves more analysis and decisions on a fiber by fiber basis. The lab can characterize the fibers present in the sample with a particle size distribution that includes average length, width, aspect ratio etc. however on a fiber by fiber basis subjective decisions need to be made on the basis of morphology as to whether the particle is to be included in the overall count.

EMSL recognizes that as a service laboratory and not a risk assessor or health expert, we can only provide the most accurate and transparent data possible in an effort to inform our client what is present in the sample. The potency of non-asbestiform fibers or non asbestos (non-regulated) minerals, to induce cancer or cause other asbestos related disease is still debated. Therefore, after consulting with the client, we will attempt to distinguish non-countable minerals from countable ones on morphology. In a scientific approach to this technical challenge, EMSL has adopted the following criteria for differentiation of asbestos vs. non-asbestos elongate particles.

- For a countable fiber, the structure will need to meet the definition of a fiber as counted by the method in regards to length, width and aspect ratio. All visible edges of the fiber should be substantially parallel.
- There is some subjectivity to the determination, especially if the fiber is attached to a matrix. If the edges are obscured by matrix or other debris and cannot be conclusively determined, it will be regarded as method countable fiber.
- Elongate mineral fibers of amphiboles with pointed terminations (acicular), Rounded or cleft sides or ends, or do not meet aspect ratio will be counted as non-countable elongate mineral fibers (Non- Asbestiform)

In addition to morphology, confirmation by chemistry (energy-dispersive x-ray spectroscopy) and by diffraction (selected-area electron diffraction) will also be provided. Chemistry and diffraction may be used to reject a particle as asbestos regardless of morphology if the particle is clearly not a regulated mineral. Both countable and non-countable EMP's will use semi quantitative EDXA to determine the mineral species. In the course of the analysis, numerous EMPs which match the mineralogy and chemistry of asbestos may nevertheless be excluded from being asbestos due to their physical/structural form.

Background References

Useful references include primarily documents related to PLM analysis of asbestos, though the morphological descriptions of asbestiform characteristics and cleavage fragment characteristics translate somewhat to TEM analysis.

- EPA-600/M4-82-020 (Interim Method for the Determination of Asbestos in Bulk Building Materials), December 1982
- EPA-600/R-93/116 (Method for the Determination of Asbestos in Bulk Building Materials), July 1993
- OSHA Method "Polarized Light Microscopy of Asbestos", February 1995
- J. Occup. Environ. Hyg., Dec. 2008, M. Harper et al., "Differentiating Non-asbestiform Amphibole and Amphibole Asbestos by Size Characteristics"
- AIHA Journal, 1985, A. Wylie et al., "Characterizing and Discriminating Airborne Amphibole Cleavage Fragments and Amosite Fibers: Implications for the NIOSH Method"
- Asbestiform Fibers: Non-occupational Health Risks, 1984, National Academies Press
- The Habit of Asbestiform Amphiboles: Implications for the Analysis of Bulk Samples, 1999, A. Wylie, ASTM Publication STP1342
- NIOSH Roadmap



Benjamin Ellis, M.S. | *Senior Scientist – Special Projects*

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From: Ellis, Benjamin
Sent: Thursday, December 05, 2019 9:44 AM
To: 'Latsha, Gary' <galatsha@pa.gov>
Subject: RE: Standard Operating Procedures (SOP's) for the Asbestos Differential Counting Method

Gary,

I am working with QA and management to get you a releasable document to you. As the way they stand now they are confidential business documents and cannot be distributed. I will get back to you shortly.

Regards,

Ben



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From: Latsha, Gary [<mailto:galatsha@pa.gov>]
Sent: Tuesday, December 03, 2019 9:46 AM
To: Ellis, Benjamin <bellis@EMSL.com>
Subject: Standard Operating Procedures (SOP's) for the Asbestos Differential Counting Method

[EXTERNAL E-MAIL]

Good Morning Mr. Ellis; It is my understanding that EMSL would have Standard Operating Procedures (SOP's) for the asbestos differential counting method utilized by the EMSL Laboratories. Can you provide an actual SOP where the procedures used to implement the specific differential counting protocols to selectively separate particles in the application of EPA Method 600/R-93/116 to report asbestos? Thanks!

Gary

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