

Supplemental explanation of MSHA data for:  
Personal Air Sampling Results for Asbestos Fibers,  
January 2000 through December 2003.

The data set represents MSHA's airborne asbestos monitoring experience for the years 2000 through 2003. Each Excel workbook contains spreadsheets for the personal samples collected during that calendar year.

The following information is provided:

- Pump flow rate (Lpm),
- Sampling duration for each individual filter cassette (minutes),
- TWA concentration for each individual filter cassette (f/cc),
- TWA concentration for the sample (f/cc),
- Calculated SWA, for the series of filter cassettes that make up the sample (f/cc),
- Identifying information, such as the miner's occupation and the sampling date.

A blank cell in the spreadsheet indicates that the laboratory did not analyze the filter for some reason. The filter may have been overloaded or damaged for example. A zero indicates that the laboratory analyzed the filter, but the result was less than the detectable limit. Each workbook contains the sampling results for a single year. Each spreadsheet in the workbook presents the sampling results for a mine.

The field sampling procedure involves drawing a calibrated airflow across a 25 mm 0.8 micron pore size filter mounted inside of a 50 mm long static reducing plastic cowed cassette. Mixtures of airborne dust and fibers are drawn into the filter/cassette sampling apparatus and retained on the filter. MSHA's policy for determining airborne mineral fiber concentrations involves laboratory screening by phase contrast microscopy (PCM) in accordance with OSHA ID 160 or NIOSH Method 7400.

Care is taken to prevent excessive particulate from accumulating on any filter that could obscure visual identification of fibers by the analyst. When sampling in the field and the inspector observes dust beginning to accumulate on a filter surface inside a cassette, the entire filter/cassette assembly is replaced with a new filter/cassette and sampling is continued uninterrupted. This process, referred to as consecutive sampling, is repeated as necessary throughout the shift for each miner's personal sample. Thus, each "sample" is one full shift filter/cassette or a composite made up of a number of consecutive filter/cassettes taken in series throughout the individual's entire work shift.

To determine a miner's actual full-shift personal exposure to mineral fibers, an overall time weighted average ( $TWA_{sum}$ ) exposure can be calculated from the

separate fiber TWA concentration results corresponding to each consecutive series filter/cassette.

For MSHA compliance purposes, the calculation is based on eight hours regardless of the actual full-shift sampling time and is called the Shift Weighted Average or "SWA". The units are fibers/cubic centimeter (f/cc). This allows us to compare the measured personal exposure to the allowable permissible exposure limits that are based on an eight hour exposure. For a consecutive sample taken over the length of the shift, and the results are reported as the TWA for each individual filter/cassette, the calculation of the eight hour equivalent SWA (shift weighted average) is determined by the following formula:

$$SWA = (TWA_1t_1 + TWA_2t_2 + . . . + TWA_nt_n) / 480 \text{ min.}$$

where:

TWA = contaminant concentration in f/cc measured over actual sampling time

t = time period of sample in minutes

and,

$t_1 + t_2 + . . . t_n$  = the total time of the full work shift in minutes.

furthermore:

$$TWA_{(sum)} = (TWA_1t_1 + TWA_2t_2 + \dots + TWA_nt_n) / (t_1 + t_2 + \dots + t_n)$$

When the total sampling time of a miner's work shift is less than eight hours (480 minutes), the remaining unsampled time up to eight hours, is counted as zero exposure ( $TWA_{nt_n} = 0$ ) in the SWA calculation. Therefore:

- When the total sample time is less than 480 minutes, the SWA is less than the  $TWA_{(sum)}$ . And,
- When the total sample time is greater than 480 minutes, the SWA is greater than the  $TWA_{(sum)}$ .

Hence, when the miner's actual work-shift is greater than eight hours, the mine operator may have more difficulty complying with the exposure limit than when the work shift is eight hours or less. The value of zero is used in the exposure compliance calculation ( $TWA_{nt_n} = 0$ ) when the laboratory reports a result for a particular filter analysis that is less than the method's detection limit. This zero value substitution is consistent with MSHA policy for enforcement calculations. However, zero values may not be appropriate for other types of data analysis, such as exposure assessments.

These data spreadsheets show the analytical result for each individual filter/cassette, and the composite calculated result that represents the corresponding miner's eight-hour SWA personal exposure to airborne fibers, both unidentified and asbestos.

Fibers are defined by the shape and size of the particles—

- greater than 5 microns in length and
- with an aspect ratio (length to width) of at least 3:1 in accordance with the applicable phase contrast microscopy (PCM) based OSHA

ID160 or equivalent NIOSH 7400 method that was used by our contract lab.

The PCM analytic method allows a visual screen to determine the concentration of airborne mineral fibers satisfying this definition of fibers, however, the mineral or minerals comprising the fibers cannot be definitively identified using PCM. Whenever a fiber concentration is determined by PCM analysis by the contract laboratory to be 0.1 fibers per cubic centimeter (f/cc) or greater, MSHA's policy requires further mineral-specific analysis of the filter using transmission electron microscopy (TEM) in accordance with NIOSH Method 7402. TEM analysis is used to determine whether the

mineral comprising the fiber is asbestos as defined by 30 CFR 56.5001(b). We have discontinued the practice of using the "direct" version of the method in favor of the "rationated" procedure outlined in the NIOSH 7402 method. For compliance determinations, MSHA enforces an exposure limit on asbestos fibers, but not on fibers of unknown mineralogy.

Sometimes, if one or more of the consecutive series filters making up the sample have a PCM result below the 0.1 f/cc trigger or could not be analyzed, a complete TEM based asbestos analysis was not performed and only a SWA PCM based fiber exposures can be reported. Spreadsheet cell entries of zero (0) represent a laboratory derived value less than the detectable limit of the applied analytical method. A blank cell indicates that no analysis was performed.

MSHA's current asbestos exposure standard (2.0 f/ml) is over 20 years old, and compliance with this standard will not provide adequate protection for miners exposed to asbestos fibers. Both the Occupational Safety and Health Administration (OSHA) exposure limit (PEL) and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for asbestos is 0.1 fibers per cubic centimeter on the basis of an eight-hour time weighted average exposure, which is 1/20th of the current MSHA limit. Neither the OSHA PEL nor the ACGIH TLV are enforceable at mine sites, and reference to them in this context is solely to enable you to compare sample results with the more protective standards used in other industries. MSHA's current policy is to encourage all mining operations to adopt the OSHA PEL of 0.1 f/cc for asbestos exposures as a company standard. Adoption of this exposure limit will help reduce the potential for illness and liability.

MSHA District Abbreviations:

RM - Rocky Mountain  
Central

NC – North Central  
Northeastern

SE – Southeastern

WE – Western

SC – South

NE –

A summation of the asbestos air sampling data available on the MSHA website is displayed in the following Tables 1.a., 1.b., and 1.c.

Table 1.a. – All Mines Personal Samples, Over the Proposed 0.1 fibers/cc Exposure Limit, By Analytical Method.

SWA SAMPLE RESULTS	PCM (OSHA)	PCM (NIOSH)	TEM (direct)	TEM (ratio)
# of samples analyzed	281	451	31	75
# of samples > 0.1 fibers/cc	9	62	3	19
% > 0.1 fibers/cc	3	14	10	25

Table 1.b. – All Mines Personal Samples, Over the Proposed 0.1 fiber/cc

SWA SAMPLE RESULTS	PCM	TEM
# of samples analyzed	732	106
# of samples > 0.1 fibers/cc	71	22
% > 0.1 fibers/cc	10	3

Exposure Limit.

Tables 1.a., 1.b. Notes:

- 1.) On average, each personal SWA “Sample Result” is defined by approximately three consecutive series filter/cassette analyses results (i.e., approximately 2200 filters).
- 2.) Twenty nine personal SWA samples were analyzed by both the OSHA and NIOSH PCM methods.
- 3.) Samples analyzed by direct and/or ratio TEM procedures, were first determined to be > (greater than) 0.1 f/cc by a PCM method.
- 4.) Includes data from an asbestos mine/mill, for a total of 125 mines.

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Table 1.c. presents results from January 2000 to the end of 2003 for 123 non asbestos mines that includes approximately 2000 air filters collected and analyzed for asbestos fibers in the spreadsheets.

Table 1. c. – Non Asbestos Mines Personal Samples, Over the Proposed 0.1 f/cc Exposure Limit.

SWA SAMPLE RESULTS	PCM	TEM
# of samples analyzed	661	92
# of samples > 0.1 fibers/cc	56	13
% > 0.1 fibers/cc	8	2

Table 1.c. Notes:

- 1.) We use an average of three consecutive series filter/cassette analyses results to determine each personal SWA Sample Result.
- 2.) Filters were first analyzed by PCM and if they were greater than (>) 0.1 f/cc, they were further analyzed by TEM.
- 3.) Excludes data from an asbestos mine/mill that permanently closed in June 2003,  
(i.e., 14 TEM samples analyzed, with nine > 0.1 f/cc).
- 4.) The 13 TEM samples > 0.1 f/cc are from a wollastonite mine in New York (9), and a taconite mine in Minnesota (4).