DEPARTMENT OF LABOR

Mine Safety and Health Administration

30 CFR Parts 56, 57, and 71

RIN 1219–AB24

Asbestos Exposure Limit

AGENCY: Mine Safety and Health Administration, Labor.

ACTION: Final rule.

SUMMARY: The Mine Safety and Health Administration (MSHA) is revising its existing health standards for asbestos exposure at metal and nonmetal mines, surface coal mines, and surface areas of underground coal mines. This final rule reduces the permissible exposure limits for airborne asbestos fibers and makes clarifying changes to the existing standards. Exposure to asbestos has been associated with lung cancer, mesothelioma, and other cancers, as well as asbestosis and other nonmalignant respiratory diseases. This final rule will help improve health protection for miners who work in an environment where asbestos is present and lower the risk that miners will suffer material impairment of health or functional capacity over their working lifetime.

DATES: This final rule is effective April 29, 2008.

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I. Summary

The final rule lowers MSHA's permissible exposure limits (PELs) for asbestos; incorporates the Occupational Safety and Health Administration (OSHA) Reference Method (29 CFR 1910.1001, Appendix A) for MSHA's analysis of mine air samples for asbestos; and makes several clarifying changes to MSHA's existing rule. MSHA is issuing this health standard limiting miners' exposure to asbestos under section 101(a)(6)(A) of the Federal Mine Safety and Health Act of 1977 (Mine Act). MSHA based this final rule on its experience, an assessment of the health risks of asbestos, OSHA's rulemaking history and enforcement experience with its asbestos standard and public comments and testimony on MSHA's asbestos proposed rule.

To protect the health of miners, this final rule lowers MSHA's 8-hour, time-weighted average (TWA), full-shift PEL from 2 fibers per cubic centimeter of air (f/cc) to 0.1 f/cc. The existing excursion limit for metal and nonmetal mines is 10 fibers per milliliter (f/mL) for 15 minutes and the existing excursion limit for coal mines is 10 f/cc for a total of 1 hour in each 8-hour day. This final rule lowers these existing excursion limits to 1 f/cc for 30 minutes. Together, these lower PELs significantly reduce the risk of material impairment for exposed miners. These final PELs are the same as proposed and the same as OSHA's asbestos exposure limits. Although OSHA stated in the preamble to its 1994 final rule (59 FR 40967) that there is a remaining significant risk of material impairment of health or functional capacity at the 0.1 f/cc limit, OSHA concluded that this concentration is ''the practical lower limit of feasibility for measuring asbestos levels reliably.'' MSHA agrees with this conclusion.

To clarify the criteria for the analytical method that MSHA will use to analyze mine air samples for asbestos under this final rule, the rule includes a reference to Appendix A of OSHA's asbestos standard (29 CFR 1910.1001). Appendix A specifies basic elements of a phase contrast microscopy (PCM) method for analyzing airborne asbestos samples, which includes the same basic analytical elements as those specified in MSHA's existing standards.

Because the risk assessment used as the basis for MSHA's asbestos PELs relies on PCM-based methodology, MSHA will continue to use PCM as the primary methodology for analyzing air samples to determine compliance with the PELs. PCM provides a relatively quick and cost-effective analysis of asbestos samples. In addition, MSHA will continue to follow-up with its policy of using a transmission electron microscopy (TEM) analysis when PCM results indicate a potential overexposure.

MSHA, however, encourages the development of analytical methods specifically for asbestos in mine air samples. MSHA will consider using a method statistically equivalent to Appendix A, if it meets the OSHA Reference Method (ORM) equivalency criteria in OSHA's asbestos standard [29 CFR 1910.1001(d)(6)(iii)] and is recognized by a laboratory accreditation organization. For example, ASTM D7200–06, ''Standard Practice for Sampling and Counting Airborne Fibers, Including Asbestos Fibers, in Mines and Quarries, by Phase Contrast Microscopy and Transmission Electron Microscopy,'' contains the same procedure as NIOSH 7400 to identify fibers. ASTM D7200–06 then has an additional procedure to discriminate potential asbestos fibers, which NIOSH 7400 does not. NIOSH is supporting an ASTM inter-laboratory study to determine whether this additional procedure can be performed accurately and consistently. This procedure was developed in part as a result of this rulemaking and has not been validated.

II. Background to the Final Rule

A. Scope of Final Rule

This final rule applies to all metal and nonmetal mines, surface coal mines, and surface areas of underground coal mines. It is substantively unchanged from the proposed rule and contains the same PELs and analytical method as in OSHA's asbestos standard. Some commenters supported additional changes to MSHA's definition of asbestos and its analytical method. Others recommended that MSHA propose additional requirements from the OSHA asbestos standard to prevent take-home contamination. Such changes were not contemplated in the proposed rule and, therefore, are beyond the scope of this final rule.

B. Mineralogy and Analytical Methods for Asbestos

Asbestos is a generic term used to describe the fibrous habits of specific naturally occurring, hydrated silicate minerals. Several federal agencies [1] have regulations that address six asbestos minerals: chrysotile, crocidolite, cummingtonite-grunerite asbestos (amosite), actinolite asbestos, anthophyllite asbestos, and tremolite asbestos. Other agencies address asbestos more generally.[2]

The terminology used to refer to how minerals form and how they are named is complex. Much of the existing health risk data for asbestos uses the commercial mineral terminology.[3] In the asbestiform habit, mineral crystals grow forming long, thread-like fibers. The U.S. Bureau of Mines defined *asbestiform minerals* to be ''a certain type of mineral fibrosity in which the fibers and fibrils possess high tensile strength and flexibility.'' [4] When light pressure is applied to an asbestiform fiber, it bends much like a wire, rather than breaks. In the nonasbestiform habit, mineral crystals do not grow in long thin fibers; they grow in a more massive habit. When pressure is applied, the nonasbestiform crystals fracture into prismatic particles, which are called cleavage fragments because they result from the particle's breaking or cleavage. Cleavage fragments may be formed when nonfibrous minerals are crushed, as may occur in mining and milling operations. Distinguishing between asbestiform fibers and cleavage fragments in certain size ranges can be difficult or impossible for some minerals.[5]

C. Summary of Asbestos Health Hazards

Studies first identified health problems associated with occupational exposure to asbestos in the early 20th century among workers involved in the manufacturing or use of asbestos-containing products.[6] These studies identified the inhalation of asbestos as the cause of asbestosis, a slowly progressive disease that produces lung scarring and loss of lung elasticity. Studies also found that asbestos caused lung and several other types of cancer.[7] For example, mesotheliomas, rare cancers of the lining of the chest or abdominal cavities, are almost exclusively attributable to asbestos exposure. Once diagnosed, they are rapidly fatal. The damage following many years of workplace exposure to asbestos is generally cumulative and irreversible. Most asbestos-related diseases have long latency periods, typically not producing symptoms for 20 to 30 years following initial exposure. Studies also indicate adverse health effects in workers who have had relatively brief exposures to asbestos.[8]

Several studies have examined respiratory health and respiratory symptoms of asbestos-exposed workers.[9] Asbestos-induced pleurisy is the most common asbestos-related condition to occur during the 20-year period immediately following a worker's first exposure to asbestos.[10] Pleural plaques may develop within 10–20 years after an initial asbestos exposure [11] and slowly progress in size and amount of calcification, independent of any further exposure. Diffuse pleural thickening and pleural plaques are biologic markers reflecting previous asbestos exposure.[12] In addition, presence in lung tissue of asbestos fibers with a coating of iron and protein, called asbestos bodies, is one of the criteria that serve to support a pathologic diagnosis of asbestosis.[13] These nonmalignant respiratory conditions can be used to identify at-risk miners prior to their developing a more serious asbestos disease.

Because the hazardous effects from exposure to asbestos are well known, MSHA's discussion in this section will focus on the results of studies and literature reviews published since the publication of OSHA's risk assessment, and those involving miners. One such review by Tweedale (2002) stated,

> Asbestos has become the leading cause of occupational related cancer death, and the second most fatal manufactured carcinogen (after tobacco). In the public's mind, asbestos has been a hazard since the 1960s and 1970s. However, the knowledge that the material was a mortal health hazard dates back at least a century, and its carcinogenic properties have been appreciated for more than 50 years.

Greenberg (2003) also published a recent review of the biological effects of asbestos and provided a historical perspective similar to that of Tweedale.

The three most commonly described adverse health effects associated with asbestos exposure are lung cancer, mesotheliomas, and pulmonary fibrosis (i.e., asbestosis). OSHA, in its 1986 asbestos rule, reviewed each of these diseases and provided details on the studies demonstrating the relationship between asbestos exposure and the clinical evidence of disease.[14] In 2001, the Agency for Toxic Substances and Disease Registry (ATSDR) published an updated *Toxicological Profile for Asbestos* that also included an extensive discussion of these three diseases. A search of peer-reviewed scientific literature yielded many new articles [15] that continue to demonstrate and support findings of asbestos-induced lung cancer, mesotheliomas, and asbestosis, consistent with the conclusions of OSHA and ATSDR. Thus, in the scientific community, there is compelling evidence of the adverse health effects of asbestos exposure.

D. Factors Affecting the Occurrence and Severity of Disease

The toxicity of asbestos, and the subsequent occurrence of disease, is related to its concentration in the air and the duration of exposure. Other variables, such as the fiber's characteristics or the effectiveness of a person's lung clearance mechanisms, lung fiber burden, residence-time-weighted cumulative exposures, and susceptible populations are also relevant factors affecting disease severity.[16]

1. Fiber Concentration

Early airborne asbestos dust measurements had counted particles

[1] In addition to MSHA's and OSHA's existing worker protection standards, other federal statutory and regulatory requirements that apply only to the six commercial varieties of asbestos include the Asbestos Hazard Emergency Response Act (AHERA) [15 U.S.C. 2642(3)] and the Clean Air Act's National Emission Standards for Hazardous Air Pollutants (NESHAP) [40 CFR 61.141].

[2] Asbestos is listed as a hazardous air pollutant under the Clean Air Act [42 U.S.C. 7412(b)(1)]; as a hazardous substance under the Comprehensive Environmental Response, Compensation and Liability Act [40 CFR 302.4]; and in EPA's Integrated Risk Information System (IRIS), a collection of health assessment information regarding the toxicity of asbestos, *http://www.epa.gov/IRIS/susbst/0371.htm.*

[3] Asbestos mineralogy was discussed more fully in the proposed rule (70 FR 43952–43953).

[4] U.S. Bureau of Mines (Campbell *et al.*), 1977.

[5] Meeker *et al.*, 2003.

[6] GETF Report, p. 38, 2003; OSHA (40 FR 47654), 1975.

[7] Doll, 1955; Reeves *et al.*, 1974; Becker *et al.*, 2001; Browne and Gee, 2000; Sali and Boffetta, 2000; IARC, 1987.

[8] Sullivan, 2007.

[9] Wang *et al.*, 2001; Delpierre *et al.*, 2002; Eagen *et al.*, 2002; Selden *et al.*, 2001.

[10] Rudd, 2002.

[11] Bolton *et al.*, 2002; OSHA, 1986.

[12] ATSDR, 2001; Manning *et al.*, 2002.

[13] ATSDR, 2001; Peacock *et al.*, 2000; Craighead *et al,* 1982.

[14] Berry and Newhouse, 1983; Dement *et al.*, 1982; Finkelstein, 1983; Henderson and Enterline, 1979; Peto, 1980; Peto *et al.*, 1982; Seidman *et al.*, 1979; Seidman, 1984; Selikoff *et al.*, 1979; Weill *et al.*, 1979.

[15] Baron, 2001; Bolton *et al.*, 2002; Manning *et al.*, 2002; Nicholson, 2001; Osinubi *et al.*, 2000; Roach *et al.*, 2002.

[16] ICRP, 1966; EPA, 1986; West, 2000 and 2003; Manning *et al.*, 2002.

and reported the results as millions of particles per cubic foot of air (mppcf). Most recent studies express the concentration of asbestos as the number of fibers per cubic centimeter (f/cc). Some studies have also reported asbestos concentrations in the number of fibers per milliliter (f/mL), which is an equivalent concentration to f/cc. MSHA's existing PELs for asbestos are expressed in f/mL for metal and nonmetal mines and as f/cc for coal mines. To improve consistency and avoid confusion, MSHA expresses the concentration of asbestos fibers as f/cc in this final rule, for both coal and metal and nonmetal mines.

In the late 1960s, scientists correlated PCM-based fiber counting methods with the earlier types of dust measurements, which provided a means to estimate earlier workers' asbestos exposures and enabled researchers to develop a dose-response relationship with the occurrence of disease. The British Occupational Hygiene Society reported [17] that a worker exposed to 100 fiber-years per cubic centimeter (e.g., 50 years at 2 f/cc, 25 years at 4 f/cc, 10 years at 10 f/cc) would have a 1 percent risk of developing early signs of asbestosis. The correlation of exposure levels with the disease experience of populations of exposed workers provided a basis for setting an occupational exposure limit for asbestos measured by the concentration of the fibers in air.

OSHA (51 FR 22617) applied a conversion factor of 1.4 to convert mppcf, which includes all particles of respirable size, to f/cc, which includes only those particles greater than 5 µm in length with at least a 3:1 aspect ratio. More recently, Hodgson and Darnton (2000) recommended the use of a factor of 3. In reviewing the scientific literature, MSHA did not critically evaluate the impact of these and other conversion factors. MSHA notes this difference here for completeness. MSHA is relying on OSHA's risk assessment and, thus, is using OSHA's conversion factor.

2. Duration of Exposure

The duration of exposure (T) is reported in both epidemiological and toxicological studies, and is generally much shorter in animal studies (*e.g.*, months versus years). In epidemiological studies involving toxic substances that do not have acute health effects, such as asbestos, duration of exposure is typically expressed in years.

3. Cumulative Exposure

When developing dose-response relationships for asbestos-induced health effects, researchers typically use the product of exposure concentration (C in f/cc) and exposure duration (T in years), expressed as fiber-years,[18] to indicate the level of exposure or dose. When summed over all periods of exposure, this measure is called cumulative exposure. Because of the difficulties in obtaining good quantitative exposure assessments, cumulative exposure expressed in fiber-years is often selected as the common metric for the levels of exposures reported in epidemiological studies.

Finkelstein[19] noted that this product of exposure concentration times duration of exposure ($C \times T$) assumes an equal weighting of each variable (C, T). Finkelstein stated further that exposure at a low concentration for a long period of time may be numerically equivalent to exposure at a high concentration for short periods of time; but, they may not be biologically equivalent. What this means is that, in some studies, either concentration or duration of exposure may be more important in predicting disease. For example, in the case of mesothelioma risk following asbestos exposure, Finkelstein [20] concluded that ''* * * duration of exposure may dominate the exposure term * * *''.

4. Fiber Characteristics

Baron (2001) reviewed techniques for the measurement of fibers and stated, ''* * * fiber dose, fiber dimension, and fiber durability are the three primary factors in determining fiber toxicity * * *''. Manning *et al.* (2002) also noted the important roles of bio-persistence (*i.e.*, durability), physical properties, and chemical properties in defining the ''toxicity, pathogenicity, and carcinogenicity'' of asbestos. Roach *et al.* (2002) stated that—

> Physical properties, such as length, diameter, length-to-width (aspect ratio), and texture, and chemical properties are believed to be determinants of fiber distribution [in the body] and disease severity.

Many other investigators [21] also have concluded that the dimensions of asbestos fibers are biologically important.

The NIOSH 7400 analytical method used by MSHA's contract laboratories specifies that analysts count those fibers that are greater than 5 micrometers (microns, µm) in length with a length to diameter aspect ratio of at least 3:1. Several recent publications [22] support this aspect ratio, although larger aspect ratios such as 5:1 or 20:1 have been proposed.[23] There is some evidence that longer, thinner asbestos fibers (*e.g.*, greater than 20 µm long and less than 1 µm in diameter) are more potent carcinogens than shorter fibers. Suzuki and Yuen (2002), however, concluded that ''Short, thin asbestos fibers should be included in the list of fiber types contributing to the induction of human malignant mesotheliomas * * * ''. More recently, Dodson *et al.* (2003) concluded that all lengths of asbestos fibers induce pathological responses and that researchers should exercise caution when excluding a population of inhaled asbestos fibers based on their length.

Researchers have found neither a reliable method for predicting the contribution of fiber length to the development of disease, nor evidence establishing the exact relationship between them. There is suggestive evidence that the dimensions of asbestos fibers may vary with different diseases. A continuum may exist in which shorter, wider fibers produce one disease, such as asbestosis, and longer, thinner fibers produce another, such as mesotheliomas.[24]

Some commenters suggested that MSHA consider additional fiber characteristics, such as durability, in evaluating risk. Some emphasized that not all fibers with the same dimensions will lead to the same disease endpoint. The science is inconclusive on the relationship between the various fiber characteristics and the disease endpoints.[25]

E. MSHA Asbestos Standards

The early PELs for asbestos in mining dropped dramatically as more information on the health effects of asbestos exposure became evident 20 to 30 years (latency period) following its widespread use during the 1940s.

Year	8-hour TWA, Asbestos PEL
1967	5 mppcf (30 f/mL)
1969	2 mppcf (12 f/mL)
1974	5 f/mL for metal and nonmetal mines
1976	2 f/cc for surface areas of coal mines (41 FR 10223)
1978	2 f/mL for metal and nonmetal mines (43 FR 54064)

[17] Lane *et al.*, 1968; OSHA (40 FR 47654), 1975; NIOSH, 1980.

[18] ATSDR, 2001; Fischer *et al.*, 2002; Liddell, 2001; Pohlabeln *et al.*, 2002.

[19] Finkelstein, 1995; ATSDR, p. 42, 2001.

[20] Finkelstein, 1995

[21] ATSDR, 2001; ATSDR, 2003; Osinubi *et al.*, 2000; Peacock *et al.*, 2000; Langer *et al.*, 1979.

[22] ATSDR, 2001; Osinubi *et al.*, 2000.

[23] Wylie *et al.*, 1985.

[24] ATSDR, pp. 39–41, 2001; ATSDR, 2003; Mossman, pp. 47–50, 2003; Kuempel *et al.*, 2006.

[25] Hodgson and Darnton, 2000; Browne, 2001; Liddell, 2001; ATSDR, 2001.

On March 29, 2002 (67 FR 15134), MSHA published an advance notice of proposed rulemaking to obtain public comment on how best to protect miners from exposure to asbestos. MSHA published the proposed rule on July 29, 2005 (70 FR 43950) and held two public hearings in October 2005.

F. OSHA's Asbestos Standards

Like MSHA's, OSHA's 8-hour TWA PEL for occupational exposure to asbestos dropped dramatically over the past several decades.

Year	8-hour TWA Asbestos PEL
1971	12 f/cc
1971	5 f/cc
1972	2 f/cc
1983	0.5 f/cc [26]
1986	0.2 f/cc [27]
1994	0.1 f/cc

In addition, on September 14, 1988, OSHA promulgated an asbestos excursion limit of 1 f/cc over a sampling period of 30 minutes (53 FR 35610).

OSHA's 1986 standards had applied to occupational exposure to both asbestiform and nonasbestiform actinolite, tremolite, and anthophylite. On June 8, 1992, OSHA removed the nonasbestiform types of these minerals from the scope of its asbestos standards (57 FR 24310).

III. Asbestos Exposures in Mines

A. Where Asbestos Is Found at Mines

Asbestos exposure of miners can come from either naturally occurring asbestos in the ore or host rock or from asbestos contained in manufactured products.

1. Metal and Nonmetal Mines

The National Institute for Occupational Safety and Health (NIOSH) and other research organizations and scientists have noted the occurrence of cancers and asbestosis among miners involved in the mining and milling of commodities that contain asbestos.[28] (See Table IV–3.) Although asbestos is no longer mined as a commodity in the United States, veins, pockets, or intrusions of asbestos-containing minerals have been found in other ores in specific geographic regions, primarily in metamorphic or igneous rock.[29] It is possible to find asbestos in sedimentary rock. The U.S. Geological Survey (USGS) has reported weathering or abrasion of asbestos-bearing rock and soil, or air transportation, to carry asbestos to sedimentary deposits.[30] MSHA's experience is that miners may encounter asbestos during the mining of a number of mineral commodities,[31] such as talc, limestone and dolomite, vermiculite, wollastonite, banded ironstone and taconite, lizardite, and antigorite. Even if asbestos contamination is found in a specific mineral commodity, not all mines of that commodity will encounter asbestos and those that do may encounter it rarely. (See Table III–1.)

Mining activities, such as blasting, cutting, crushing, grinding, or simply disturbing the ore or surrounding earth may cause asbestos fibers to become airborne.[32] Milling may transform bulk ore containing asbestos into respirable fibers. Asbestos tends to deposit on workplace surfaces and accumulate during the milling process, which is often in enclosed buildings. The use of equipment and machinery or other activities in these locations may re-suspend the asbestos-containing dust from these surfaces into the air. For this reason, MSHA generally finds higher asbestos concentrations in mills than among mobile equipment operators or in ambient environments, such as pits.

Some mine operators are making an effort to avoid deposits that are likely to contain asbestos minerals. They use knowledge of the geology of the area, core or bulk sample analysis, and workplace examinations (of the pit) to avoid encountering asbestos deposits, thus preventing asbestos contamination of their process stream and final product.[33]

2. Coal Mines

MSHA is aware of only one coal formation in the United States that contains naturally occurring asbestos; however, there is no coal mining in this formation.[34] The more likely exposure to asbestos in coal mining occurs at surface operations from introduced asbestos-containing materials (ACM).

3. Asbestos-Containing Materials (ACM)

Asbestos is a component in some commercial products and may be found as a contaminant in others. The USGS estimates that, during 2006, manufacturers in the United States used about 2,340 metric tons (5.2 million pounds) of asbestos, primarily in roofing products and coatings and compounds. In addition to domestic manufacturing, the United States continues to import products that contain asbestos, primarily cement products, such as flat cement panels, sheets, and tiles.[35]

Although manufacturers have removed the asbestos from many new products,[36] asbestos may still be found at mines. Asbestos-containing building materials (ACBM), such as Transite® board and reinforced cements, could present a hazard during maintenance, construction, remodeling, rehabilitation, or demolition projects. Asbestos in manufactured products, such as electrical insulation, joint and packing compounds, automotive clutch and brake linings,[37] and fireproof protective clothing and welding blankets, could present a hazard during activities at the mine site that may cause a release of fibers.[38] MSHA expects mine operators to determine whether ACM or ACBM are present on mine property by reading the labels or Material Safety Data Sheets (MSDS) required by the OSHA Hazard Communication Standard (29 CFR 1910.1200). The presence of asbestos at a mine indicates that there is a potential for exposure.

B. Sampling Data and Exposure Calculations

To evaluate asbestos exposures in mines, MSHA collects personal exposure samples. MSHA samples a miner's entire work shift using a personal air-sampling pump and a filter-cassette assembly. This assembly is composed of a 50-mm static-reducing, electrically conductive, extension cowl and a 0.8 μm pore size, 25-mm diameter, mixed cellulose ester (MCE) filter. Following standard sampling procedures, MSHA also submits blank filters for analysis.

MSHA collects a sample over the entire time the miner works; 10- to 12-hour shifts are common. The time-weighted average (TWA) PELs in MSHA's standards, however, are based on an 8-hour workday. Regardless of the actual shift length, MSHA calculates a full-shift concentration as if the fibers had been collected over an 8-hour shift. For work schedules less than or greater than 8 hours, this technique allows MSHA to compare a miner's exposure

[26] U.S. Court of Appeals for the 5th Circuit invalidated this rule on March 7, 1984, in *Asbestos Information Association/North America* v. *OSHA* (727 F.2d 415, 1984).

[27] OSHA added specific provisions in the construction standard to cover unique hazards relating to asbestos abatement and demolition jobs.

[28] NIOSH WoRLD, 2003.

[29] MSHA (Bank), 1980; Ross, 1978.

[30] USGS, 1995.

[31] Roggli *et al.*, 2002; Selden *et al.*, 2001; Amandus *et al.*, Part I, 1987; Amandus *et al.*, Part III, 1987; Amandus and Wheeler, Part II, 1987; Meeker *et al.*, 2003.

[32] MSHA (Bank), 1980; Amandus *et al.*, Part I, 1987.

[33] GETF Report, pp. 17–18, 2003; Nolan *et al.*, 1999.

[34] Brownfield *et al.*, 1995.

[35] USGS (Virta), 2007.

[36] GETF Report, pp. 12 and 15, 2003.

[37] Lemen, 2003; Paustenbach *et al.*, 2003.

[38] EPA, 1986; EPA, 1993; EPA, October 2003.

directly to the 8-hour TWA PEL. MSHA calls this calculated equivalent, 8-hour TWA a ''shift-weighted average'' (SWA).

MSHA's existing sampling procedures specify using several, typically three, filter-cassette assemblies in a consecutive series to collect a full-shift sample. For results from both PCM and TEM analyses, MSHA calculates the SWA exposure levels for each miner sampled from the individual filters according to the following formulas.

$$SWA = (TWA_1t_1 + TWA_2t_2 + * * * + TWA_nt_n)/480 \text{ minutes}$$

Where:

TWA_n is the time-weighted average concentration for filter ''n'' calculated by dividing the number of fibers (f) collected on the filter by the volume of air (cc) drawn through the filter.

t_n is the duration sampled in minutes for filter ''n''.

Some commenters criticized MSHA's sampling and analytical procedures. A few commenters believed that MSHA should develop specific test procedures for the sampling and analysis of bulk samples for the mining environment, as well as specific air sampling procedures. Some commenters suggested that respirable dust sampling using a cyclone might be a means to remove interfering dust from the sample. NIOSH recommended that thoracic samplers be evaluated in a mining environment. Cyclones and thoracic samplers are not included in MSHA's existing sampling and analytical protocols for asbestos and are not included in existing approved methods. Exposures determined using these devices have not been correlated with the risk assessment that forms the basis of the PELs in the final rule.

Some commenters supported MSHA's existing asbestos monitoring protocols with emphasis on full-shift monitoring for comparison to the PEL. Other commenters stated that MSHA's existing field sampling and analysis methods are adequate for most mines and quarries, particularly when no significant amount of asbestos is found.

Some commenters stated that MSHA should improve its inspection reports by including inspection field notes; sampling location, purpose, and procedure; as well as descriptions of the accuracy, meaning, and limitations of the analytical results. MSHA routinely provides the sampling and analytical results and, when requested, will provide the additional information.

C. Summary of MSHA's Asbestos Air Sampling and Analysis Results

To assess personal exposures and present the Agency's sampling data for January 1, 2000 through May 31, 2007, MSHA calculated an SWA exposure for each miner from the TWA results of individual filters. MSHA has compiled these data into a PowerPoint® slide, and has posted it, together with additional explanatory information, on MSHA's Asbestos Single Source Page at *http://www.msha.gov/asbestos/asbestos.htm*.

MSHA conducted asbestos sampling at 207 mines (206 non-asbestos metal and nonmetal mines and one coal mine) during the period January 1, 2000 through May 31, 2007. Some were sampled multiple times over the seven and one quarter years. MSHA found 29 mines with at least one miner exposed to an equivalent 8-hour TWA (SWA) fiber concentration exceeding 0.1 f/cc. Out of a total of 917 SWA personal full-shift fiber exposure sample results, 113 (12 percent) exceeded 0.1 f/cc using the existing PCM-based analytical screening method.

Further analysis of the 113 samples with TEM confirmed asbestos fiber exposures exceeding 0.1 f/cc in 23 of them. Using the existing TEM-based analytical method, 3 percent of the total number of SWA samples taken exceeded 0.1 asbestos f/cc. Five mines (two taconite, one wollastonite, one sand and gravel, and one olivine), out of the 29 mines potentially impacted by lowering the PEL, had at least one miner with an SWA asbestos fiber exposure exceeding 0.1 f/cc. Although MSHA has no evidence of asbestos exposure above the new PEL in coal mines, the Agency anticipates that some coal mines will encounter asbestos from asbestos containing materials (ACM) brought onto mine property. These operators may have to take corrective action. Table III–1 below summarizes MSHA's asbestos sampling results for the period January 2000 through May 2007.

TABLE III–1.—PERSONAL EXPOSURE SAMPLES AT MINES [1] BY COMMODITY

[1/2000–5/2007]

Commodity	Number of mines sampled	Number (%) of mines with SWA samples >0.1 f/cc by PCM	Number of SWA samples	Number (%) of SWA samples >0.1 f/cc by PCM [2]	Number (%) of SWA samples >0.1 f/cc by TEM
Rock & quarry products [3]	127	11 (9%)	326	20 (6%)	2 (1%)
Vermiculite	4	3 (75%)	149	13 (9%)	0
Wollastonite	1	1 (100%)	18	18 (100%)	9 (50%)
Iron (taconite)	15	5 (33%)	254	43 (17%)	11 (4%)
Talc	12	1 (8%)	38	2 (5%)	0
Alumina [4]	1	0	1	0	0
Feldspar	7	0	[5] 6	0	0
Boron	2	1 (50%)	12	7 (58%)	0
Olivine	2	2 (100%)	9	3 (33%)	1 (11%)
Other [6]	36	[7] 5 (14%)	104	7 (6%)	0
TOTAL	207	[8] 29 (14%)	917	113 (12%)	23 (3%)

[1] Excludes data from an asbestos mine and mill closed in 2003.
[2] MSHA uses TEM to identify asbestos on samples with results exceeding 0.1 f/cc.
[3] Including stone, and sand and gravel mines.
[4] 15-minute sample.
[5] Incomplete SWA at one mine.
[6] Coal, potash, gypsum, cement, perlite, clay, lime, mica, metal ore NOS, shale, pumice, trona, salt, gold, and copper.
[7] Coal, potash, gypsum, cement, and perlite. (Coal and potash exposures were due to fiber release episodes from commercially introduced asbestos).
[8] TEM confirmed airborne asbestos exposures exceeding 0.1 f/cc at five (2%) mines.

The USGS has published a series of maps showing historic asbestos prospects and natural asbestos occurrences in the United States. The USGS published a map covering the eastern states in 2005; the central states in 2006; and the Rocky Mountain states in 2007. These maps served as a guide for the investigation of possible naturally occurring asbestos within the vicinity of mining operations. MSHA found that stone mines and quarries are the predominate types of mining operations in the vicinity of naturally occurring asbestos locations identified on the maps. MSHA conducted fiber sampling at these mines to screen for potential asbestos exposures. The results of the sampling indicated a small degree of asbestos at some of these mining operations, but no widespread asbestos contamination. Although not included on the USGS maps, MSHA also surveyed two mines in El Dorado County, California. Sampling at one of the mines resulted in two personal asbestos exposures greater than 0.1 f/cc, confirmed by TEM analysis, and 2 to 5 percent naturally occurring asbestos in an associated bulk sample. Air sampling at the other mine had low PCM fiber results.

D. Asbestos Take-Home Contamination

The final rule, like the proposal, does not address take-home contamination. In making this decision, MSHA considered its enforcement experience; comments and testimony on the proposal; as well as OSHA, NIOSH, and EPA publications and experience.[39] MSHA based its determination to address asbestos take-home contamination, without promulgating new regulatory provisions, on the following factors:

- There are no asbestos mines or mills currently operating in this country and different ore bodies of the same commodity, such as vermiculite mining, are not consistent in the presence, amount, or dispersion of asbestiform minerals. Based on MSHA's recent enforcement sampling, asbestos exposures in mining are low. (See Table III–1.)
- The measures taken to prevent take-home contamination are varied. Operators may choose the most effective method for eliminating this hazard based on the unique conditions in the mine, including the nature of the hazard. For example, in one situation providing disposable coveralls could minimize or prevent asbestos take-home contamination. Another situation may require on-site shower facilities coupled with clothing changes to provide the same protection.
- Existing standards (e.g., personal protection §§ 56/57.15006; sanitation §§ 56/57.20008, 56/57.20014, 71.400, 71.402; housekeeping §§ 56/57.16003, 56/57.20003, 77.208; appropriate actions §§ 56/57.18002, 56/57.20011, 77.1713; hazard communication 30 CFR 46, 47, and 48), together with lower PELs, provide sufficient enforcement authority to ensure that mine operators take adequate measures when necessary to prevent asbestos take-home contamination.

Commenters urged MSHA to expand the rulemaking to include specific requirements to prevent take-home contamination. NIOSH also encouraged MSHA to adopt measures included in its 1995 Report to Congress on their *Workers' Home Contamination Study Conducted under the Workers' Family Protection Act*. Other commenters, however, supported MSHA's decision and stated that take-home contamination requirements could not be justified at this time.

IV. Application of OSHA's Risk Assessment to Mining

MSHA has determined that OSHA's 1986 asbestos risk assessment (51 FR 22644) is applicable to asbestos exposures in mining. In developing this final rule, MSHA also evaluated studies published since OSHA completed its 1986 risk assessment, and studies that specifically focused on asbestos exposures of miners. These additional studies corroborate OSHA's conclusions in its risk assessment.

A. Summary of OSHA's Risk Assessment

1. Cancer Mortality

In its 1986 risk assessment, OSHA estimated cancer mortality for workers exposed to asbestos at various cumulative exposures (i.e., combining exposure concentration and duration of exposure). MSHA has reproduced this data in Table IV–1. Table IV–1 shows that the estimated mortality from asbestos-related cancer decreases significantly by lowering exposure. This is true regardless of the type of cancer, e.g., lung, pleural or peritoneal mesotheliomas, or gastrointestinal. Although excess relative risk is linear in dose, the excess mortality rates in Table IV–1 are not.[40]

TABLE IV–1.—ESTIMATED ASBESTOS-RELATED CANCER MORTALITY PER 100,000 BY NUMBER OF YEARS EXPOSED AND EXPOSURE LEVEL

Asbestos fiber concentration (f/cc)	Cancer mortality per 100,000 exposed			
	Lung	Mesothelioma	Gastro-intestinal	Total
1-year exposure				
0.1	7.2	6.9	0.7	14.8
0.2	14.4	13.8	1.4	29.6
0.5	36.1	34.6	3.6	74.3
2.0	144	138	14.4	296.4
4.0	288	275	28.8	591.8
5.0	360	344	36.0	740.0
10.0	715	684	71.5	1,470.5
20-year exposure				
0.1	139	73	13.9	225.9
0.2	278	146	27.8	451.8
0.5	692	362	69.2	1,123.2
2.0	2,713	1,408	271.3	4,392.3
4.0	5,278	2,706	527.8	8,511.8

[39] NIOSH (Report to Congress) September 1995.

[40] Nicholson, p. 53, 1983.

TABLE IV–1.—ESTIMATED ASBESTOS-RELATED CANCER MORTALITY PER 100,000 BY NUMBER OF YEARS EXPOSED AND EXPOSURE LEVEL—Continued

Asbestos fiber concentration (f/cc)	Cancer mortality per 100,000 exposed			
	Lung	Mesothelioma	Gastro-intestinal	Total
5.0	6,509	3,317	650.9	10,476.9
10.0	12,177	6,024	1,217.7	13,996.7
45-year exposure				
0.1	231	82	23.1	336.1
0.2	460	164	46.0	670.0
0.5	1,143	407	114.3	1,664.3
2.0	4,416	1,554	441.6	6,411.6
4.0	8,441	2,924	844.1	12,209.1
5.0	10,318	3,547	1,031.8	14,896.8
10.0	18,515	6,141	1,851.5	26,507.5

Table IV–1 shows that, by lowering the PEL from 2 f/cc to 0.1 f/cc, the risk of cancer mortality drops 95 percent from an estimated 6,411 to 336 deaths (per 100,000 workers).

2. Asbestosis

Finkelstein (1982) studied a group of 201 men who worked in a factory in Ontario, Canada, that manufactured asbestos-cement pipe and rock-wool insulation. Finkelstein demonstrated that there was a relationship between cumulative asbestos exposure and confirmed asbestosis.

Berry and Lewinsohn (1979) studied a group of 379 men who worked in an asbestos textile factory in northern England. Berry and Lewinsohn (1979) defined two different cohorts: Men who were first employed before 1951, when asbestos fiber levels were estimated; and men first employed after 1950, when asbestos fiber levels were measured. They plotted cases of possible asbestosis to determine a dose response curve.

OSHA stated that ''* * * the best estimates of asbestosis incidence are derived from the Finkelstein data * * *'' (48 FR 51132). OSHA did not rely on the values for the slope as determined by Berry and Lewinsohn (1979). Based on Finkelstein's (1982) linear relationship for lifetime asbestosis incidence, OSHA calculated estimates of lifetime asbestosis incidence at five exposure levels of asbestos (i.e., 0.5, 1, 2, 5, and 10 f/cc) and published its estimate in tabular form (48 FR 51132). MSHA has reproduced OSHA's estimates in Table IV–2 below. OSHA stated (51 FR 22646) that ''Reducing the exposure to 0.2 f/cc, a concentration not included in Table IV–2, would result in a lifetime incidence of asbestosis of 0.5%.''

TABLE IV–2.—ESTIMATES OF LIFETIME ASBESTOSIS INCIDENCE [41]

Exposure level, f/cc	Percent (%) Incidence		
	Finkelstein	Berry and Lewinsohn (employed before 1951)	Berry and Lewinsohn (first employed after 1950)
0.5	1.24	0.45	0.35
1	2.49	0.89	0.69
2	4.97	1.79	1.38
5	12.43	4.46	*3.45
10	24.86	8.93	6.93
Slope	0.055	0.020	0.015
R^2	0.975	0.901	0.994

*Note: 1.38 in original table was a typographical error. The text (48 FR 51132) and the regression formula indicate that 3.45 is the correct percent.

Similar to the cancer risk, Table IV–2 shows a significant reduction in the incidence of asbestosis by lowering asbestos exposures. MSHA calculated the incidence of asbestosis following 45 years of exposure to asbestos at a concentration of 0.1 f/cc, which OSHA had not included in Table IV–1, to be 0.25 percent or 250 cases per 100,000 workers. Thus, by lowering the 8-hour TWA PEL from 2 f/cc to 0.1 f/cc, MSHA will reduce the lifetime asbestosis risk by 95 percent from an estimated 4,970 cases to 250 cases (per 100,000 workers).

B. Risk Assessment for the Mining Industry

OSHA stated in the preamble to its 1986 asbestos rule that it excluded mining studies in its risk assessment because it believed that risks in the asbestos mining-milling operations are lower than other industrial operations due to differences in fiber size (51 FR 22637). MSHA reviewed the studies OSHA used to develop its risk assessment.[42] In addition, MSHA obtained and reviewed the latest available scientific studies on the health

[41] Finkelstein, 1982; Berry and Lewinsohn, 1979.

[42] Berry and Newhouse, 1983; Dement *et al.*, 1982; Finkelstein, 1983; Henderson and Enterline, 1979; Peto, 1980; Peto *et al.*, 1982; Seidman *et al.*, 1979; Seidman, 1984; Selikoff *et al.*, 1979; Weill *et al.*, 1979.

effects of asbestos exposure. MSHA recognizes that there are uncertainties in any risk assessment. MSHA concluded, however, that these studies provide further support of the significant risk of adverse health effects following exposure to asbestos.

MSHA reviewed the mining studies described in OSHA's asbestos risk assessment, as well as other studies that involved the exposure of miners to asbestos. Most of these studies were conducted in Canada, although some have been conducted in Australia, India, Italy, South Africa, and the United States. Table IV–3 lists some of these mining studies, in chronological order, and gives the salient features of each study. These studies are in MSHA's rulemaking docket.

TABLE IV.–3—SELECTED STUDIES INVOLVING MINERS EXPOSED TO ASBESTOS

Author(s), year of publication	Study group, type of asbestos	Major finding(s) or conclusion(s)
Rossiter *et al.*, 1972	Canadian miners and millers, Chrysotile	Radiographic changes (opacities) related to age and exposure.
Becklake, 1979	Canadian miners and millers, Chrysotile	Weak relationship between exposure and disease.
Gibbs and du Toit, 1979	Canadian and South African miners, Chrysotile.	Need for workplace epidemiologic surveillance and environmental programs.
Irwig *et al.*, 1979	South African miners, Amosite and Crocidolite	Parenchymal radiographic abnormalities preventable by reduced exposure.
McDonald and Liddell, 1979	Canadian miners and millers, Chrysotile	Lower risk of mesotheliomas and lung cancer from chrysotile than crocidolite.
Nicholson *et al.*, 1979	Canadian miners and millers, Chrysotile	Miners and millers: at lower risk of mesotheliomas, at risk of asbestosis (as factory workers and insulators), at risk of lung cancer (as factory workers).
Rubino *et al.*, Ann NY Ac Sci 1979.	Italian miners, Chrysotile	Role of individual susceptibility in appearance and progression of asbestosis.
Rubino *et al.*, Br J Ind Med 1979.	Italian miners, Chrysotile	Elevated risk of lung cancer.
Solomon *et al.*, 1979	South African miners, Amosite and Crocidolite	Sign of exposure to asbestos: thickened interlobar fissures.
McDonald *et al.*, 1980	Canadian miners and millers, Chrysotile	No statistically significant increases in SMRs.
McDonald *et al.*, 1986	U.S. miners, Tremolite.	A. Increased risk of mortality from respiratory cancer.
McDonald *et al.*, 1986	U.S. miners, Tremolite	B. Increased prevalence of small opacities by retirement age.
Cookson *et al.*, 1986	Australian miners and millers, Crocidolite	No threshold dose for development of radiographic abnormality.
Amandus *et al.*, 1987	U.S. miners and millers, Tremolite-Actinolite	Part I: Exposures below 1 f/cc after 1977, up to 100–200 × higher in 1960's and 1970's.
Amandus and Wheeler, 1987	U.S. miners and millers, Tremolite-Actinolite	Part II: Increased mortality from nonmalignant respiratory disease and lung cancer.
Amandus *et al.*, 1987	U.S. miners and millers, Tremolite-Actinolite	Part III: Increased prevalence of radiographic abnormalities associated with past exposure.
Armstrong *et al.*, 1988	Australian miners and millers, Crocidolite	Increased mortality from mesotheliomas and lung cancer.
Enarson *et al.*, 1988	Canadian miners, Chrysotile	Increased cough, breathlessness, abnormal lung volume and capacity.
McDonald *et al.*, 1988	U.S. miners and millers, Tremolite	Low exposure and no statistically significant SMRs.
McDonald *et al.*, 1993	Canadian miners and millers, Chrysotile	Increased SMRs for lung cancer and mesotheliomas as cohort aged.
Dave *et al.*, 1996	Indian miners and millers, Chrysotile	Higher exposures in surface than underground mines; higher exposures in mills than mines; restrictive lung impairment and radiologic parenchymal changes more common in millers.
McDonald *et al.*, 1997	Canadian miners and millers, Chrysotile	Risk of mesotheliomas related to geography and mineralogy of region; mesotheliomas caused by amphiboles.
Nayebzadeh *et al.*, 2001	Canadian miners and millers, Chrysotile	Respiratory disease related to regional differences in fiber concentration and not dimension.
Ramanathan and Subramanian, 2001.	Indian miners and millers, Chrysotile and tremolite.	Increased risk of cancer, restrictive lung disease, radiologic changes, and breathing difficulties; more common in milling.
Bagatin *et al.*, 2005	Brazilian miners and millers, Chrysotile	Decreased risk of non-malignant abnormalities with improvements in workplace conditions.
Nayebzadeh *et al.*, 2006	Canadian miners and millers, Chrysotile, Tremolite, Amosite.	Possible use of lung fiber concentration, especially short tremolite fibers, to predict fibrosis grade.
Sullivan, 2007	U.S. miners, millers, and processors, Tremolite.	Increased mortality from asbestosis, cancer of the pleura, and lung cancer that were dose-related.

MSHA found that many of the observations presented in these mining studies (e.g., age of first exposure, latency, radiologic changes) are consistent with those from the studies OSHA relied on in its risk assessment, as well as studies of other asbestos-exposed factory and insulation workers. MSHA concludes that exposure to asbestos, a known human carcinogen, results in similar disease endpoints regardless of the occupation that has been studied. Because there is evidence of asbestos-related disease among miners, MSHA is applying the OSHA risk assessment to the mining industry.

Some commenters stated that there is a differential health risk related to fiber type and that OSHA's risk assessment is not adequate or appropriate for the mining industry. The OSHA risk assessment addresses adverse health effects from exposure to six asbestos minerals. MSHA applies TEM analysis to its PCM results to determine exposure to these same six asbestos minerals. Exposure of miners to these asbestos minerals, at the same concentrations and length of exposures as workers in other industries, can be expected to result in the same disease endpoints as quantified in OSHA's risk assessment. (See section II.C and II.D of this preamble and chapter III of the REA.)

Some commenters also expressed concern regarding the health risks of fibrous minerals that are not currently regulated under MSHA's existing standards and suggested that MSHA conduct a new risk assessment to include them. MSHA considered these comments and determined that a new risk assessment is not necessary for this final rule, since fibrous minerals that are not currently regulated under MSHA's existing standards are beyond the scope of this rulemaking.

Some commenters stressed the lack of asbestos-related disease among miners in studies conducted at gold, taconite, and talc operations where there was asbestos contamination in the ore. In developing this final rule, MSHA considered a number of environmental and epidemiological studies conducted at mining operations. These studies demonstrated adverse health effects among miners consistent with exposure to asbestos in other workers. Researchers have found excessive incidence of asbestos-related disease in miners at a vermiculite mining operation.[43] Studies of talc miners have shown excess lung cancer and non-malignant respiratory disease.[44] Researchers are now studying excessive mesotheliomas among iron miners in northeastern Minnesota to determine the source of the asbestos exposure.

Section VI of this preamble contains a summary of MSHA's findings from applying OSHA's quantitative assessment of risk to the mining industry. MSHA's *Regulatory Economic Analysis* (REA) contains a more in-depth discussion of the Agency's methodology and conclusions. MSHA placed the REA in the rulemaking docket and posted it on the Asbestos Single Source Page at *http://www.msha.gov/asbestos/asbestos.htm*. MSHA also placed OSHA's risk assessment in its rulemaking docket.

C. Characterization of the Risk to Miners

After reviewing the evidence of adverse health effects associated with exposure to asbestos, MSHA evaluated that evidence to ascertain whether exposure levels currently existing in mines warrant regulatory action. The criteria for this evaluation are established by the Federal Mine Safety and Health Act of 1977 (Mine Act) and related court decisions.[45]

Section 101(a) of the Mine Act requires MSHA "* * * to develop, promulgate, and revise * * * improved mandatory health or safety standards for the protection of life and prevention of injuries in coal or other mines." Further, section 101(a)(6)(A) provides that—

> The Secretary, in promulgating mandatory standards dealing with toxic materials or harmful physical agents under this subsection, shall set standards which most adequately assure on the basis of the best available evidence that no miner will suffer material impairment of health or functional capacity even if such miner has regular exposure to the hazards dealt with by such standard for the period of his working life.

Section 101(a)(6)(A) also requires that MSHA base its health and safety standards on "* * * the latest available scientific data in the field, the feasibility of the standards, and experience gained under this and other health and safety laws." As discussed in section VI.B, a 0.1 f/cc TWA PEL for asbestos is technologically and economically feasible.

Based on court interpretations of similar language under the Occupational Safety and Health Act, MSHA has addressed the following three questions:

(1) Do the health effects associated with asbestos exposure constitute a "material impairment" to miner health or functional capacity? Miners exposed to asbestos are at risk of developing lung cancer, mesotheliomas, and other cancers, as well as asbestosis and other nonmalignant respiratory diseases.[46] These health effects constitute a "material impairment of health or functional capacity."

(2) Are exposed miners at significant risk of incurring any of these material impairments? Based on OSHA's risk assessment, MSHA has determined that a significant health risk exists for miners exposed to asbestos at MSHA's existing 8-hour TWA PEL of 2 f/cc. Over a 45-year working life, exposure at this level can be expected to result in a 6.4 percent incidence of cancer (lung cancer, mesotheliomas, and gastrointestinal cancer) and a 5.0 percent incidence of asbestosis.

(3) Will this final rule substantially reduce such risks? By lowering the 8-hour TWA PEL to 0.1 f/cc, MSHA will reduce the risk of asbestos-related cancers from 6.4 percent to 0.34 percent and the risk of asbestosis from 5.0 percent to 0.25 percent. MSHA considers this reduction to be substantial.

V. Section-by-Section Analysis of Final Rule

The final rule is substantively the same as the proposed rule. To make the standard easier to read, however, MSHA has divided the requirements in the final standards into three paragraphs: *Definitions, Permissible Exposure Limits (PELs), and Measurement of Airborne Fiber Concentration*. For §§ 56/57.5001(b), the metal and nonmetal asbestos standards, MSHA designated the paragraphs (b)(1), (b)(2), and (b)(3). For § 71.702, the coal asbestos standard, MSHA designated the paragraphs (a), (b), and (c).

A. §§ 56/57.5001(b)(1) and 71.702(a): Definitions

The final rule, like the proposal, makes no substantive changes to the definition of asbestos in MSHA's existing standards. MSHA's existing definition of asbestos is consistent with the regulatory provisions of several Federal agencies including EPA, OSHA, and CPSC, among others. Asbestos is not a definitive mineral, but rather a generic name for a group of minerals with specific characteristics. MSHA's existing standards state that, "when crushed or processed, [asbestos] separates into flexible fibers made up of fibrils" [§§ 56/57.5001(b)]; and "does not include nonfibrous or nonasbestiform minerals" (§ 71.702). Although there are many asbestiform minerals,[47] the term asbestos in MSHA's existing standards and this final rule is limited to the following six:[48]

- Chrysotile (serpentine asbestos, white asbestos).
- Cummingtonite-grunerite asbestos (amosite, brown asbestos).
- Crocidolite (riebeckite asbestos, blue asbestos).
- Anthophylite asbestos (asbestiform anthophyllite).
- Tremolite asbestos (asbestiform tremolite).
- Actinolite asbestos (asbestiform actinolite).

Like the proposal, the final rule makes several clarifying changes to the existing regulatory language. They have no impact on the minerals that MSHA regulates as asbestos. This more precise

[43] Sullivan, 2007.

[44] NIOSH (HETA/MHETA), 1990; NIOSH (Technical Report), 1980.

[45] *Industrial Union Department, AFL–CIO* v. *American Petroleum Institute*, 448 U.S. 607, 100 S.Ct. 2844 (1980) ("Benzene case")

[46] American Thoracic Society, 2004; Delpierre *et al.*, 2002.

[47] Leake *et al.*, 1997; Meeker *et al.*, 2003.

[48] ATSDR, p.136, 2001; NIOSH Pocket Guide, 2003.

language will facilitate mine operators' understanding of the scope of the standard. This final asbestos rule—

- Clarifies that *cummingtonite-grunerite asbestos* is the mineralogical term for *amosite*, a trade name for asbestos from a specific geographical region;
- Clarifies that MSHA's definition of *fiber* for analytical purposes includes the same dimensional criteria as in the existing standards, which are consistent with OSHA's asbestos standard; and
- Clarifies the asbestos standard by inserting uniform structure and language.

Some commenters suggested that MSHA should expand its definition of asbestos to include other asbestiform minerals, so long as MSHA's analytical method excluded the counting of cleavage fragments. Another commenter asked that MSHA not include nonasbestiform fibrous minerals and mineral cleavage fragments when MSHA performs microscopic analyses of samples. Others supported the inclusion and regulation of asbestiform amphiboles that have shown or are likely to show asbestos-like health effects.

Many commenters did not want MSHA to make changes to the fibers regulated as asbestos in the existing standards. Specifically, they did not want MSHA to address other asbestiform amphiboles found in mineral deposits because there is no evidence that these fibers pose the same health problems that asbestos does. Some said that it would be unreasonable and expensive to try to meet exposure limits for all these other asbestiform minerals. Other commenters stated that, whatever they are called, asbestiform minerals cause illness.

As stated throughout this rulemaking, the final rule makes no substantive changes to the definition of asbestos in MSHA's existing standards. Such changes were not contemplated in the proposed rule and, therefore, are beyond the scope of this final rule.

B. Sections 56/57.5001(b)(2) and 71.702(b): Permissible Exposure Limits (PELs)

1. Sections 56/57.5001(b)(2)(i) and 71.702(b)(1): 8-Hour, Time-Weighted Average (TWA), Full-Shift Permissible Exposure Limit

The final rule adopts OSHA's 8-hour TWA PEL of 0.1 f/cc. No commenters objected to this aspect of the proposal.

Asbestos occurs naturally in many types of ore bodies and may be released from mine sites into the environment; but, MSHA's sampling results indicate that there is not widespread overexposure to asbestos in the mining industry at this time. MSHA's sampling data for 2000 through May 2007 show that 3 percent of MSHA's full-shift asbestos samples exceed OSHA's TWA PEL of 0.1 f/cc using a TEM-based analysis.

Commenters expressed concern about potential asbestos exposure of those living close to a mining operation. Although MSHA's reduction of its asbestos PELs may reduce environmental levels, other Federal, State, and local agencies have jurisdiction over environmental exposures.

2. Sections 56/57.5001(b)(2)(ii) and 71.702(b)(2): Excursion Limit

The final rule, like the proposal, adopts OSHA's excursion PEL of 1 f/cc as measured over 30 minutes. Some commenters were concerned that an excursion limit is not enforceable and, therefore, should be removed from the rule. Although MSHA may not always be present to take air samples to evaluate a miner's exposure during brief episodes of asbestos exposure, existing §§ 56/57.5002 and 71.701 require mine operators to conduct sampling to determine the need for, and effectiveness of, control measures when miners may be exposed to asbestos.

An excursion limit sets levels, not based on toxicological data, for peak episodes of exposure. As previously discussed, asbestos poses a long-term health risk to exposed workers. Although the final rule will substantially reduce the risk of asbestos-related deaths from a lifetime exposure, it does not completely eliminate this risk. The excursion limit will help reduce the long-term risk by addressing brief, episodic exposures. This type of episodic exposure can be foreseen and proactively controlled by the use of personal protective equipment (respirators and protective clothing) and by implementing engineering or work practice controls (glove boxes, tents, wet methods).

The final rule includes an excursion limit for asbestos to help maintain the average airborne concentration below the full-shift exposure limit. For example, for miners exposed to one 30-minute excursion per day at 1 f/cc, the 8-hour TWA airborne asbestos concentration would be 0.06 f/cc, which is less than the 0.1 f/cc 8-hour TWA PEL. For miners exposed to two 30-minute excursions per day at 1 f/cc, the 8-hour TWA airborne asbestos concentration would be 0.13 f/cc, which exceeds the 0.1 f/cc 8-hour TWA PEL.

One commenter urged MSHA to retain 15 minutes, rather than switch to 30 minutes, as the sampling period for enforcement of the excursion limit. As shown in Table V–1 below, the excursion limit of 1 f/cc for 30 minutes is the lowest concentration that MSHA can measure reliably for determining compliance with the excursion limit. MSHA recognizes that in some situations, such as low background dust levels, lower exposures could be measured by using a higher flow rate; but, the risk of overloading the filter with debris increases when using higher flow rates. MSHA can be confident that it is measuring the actual airborne concentrations of asbestos, within a standard sampling and analytical error (±25 percent), when the Agency uses the minimum loading suggested by the OSHA Reference Method (29 CFR 1910.1001, Appendix A).

As discussed in OSHA's 1986 asbestos final rule (51 FR 22686), the key factor in sampling precision is fiber loading. To determine whether the analytical method described in Appendix A of its asbestos standard could be used to analyze short-term samples, OSHA calculated the lowest reliable limit of quantification using the following formula:

$$C = [(f/[(n)(A_f)])(A_c)]/[(V)(1{,}000)]$$

Where:

C = fiber concentration (in f/cc of air);
f = the total fiber count;
n = the number of microscope fields examined;
A_f = the field area (0.00785 mm^2) for a properly calibrated Walton-Beckett graticule;
A_c = the effective area of the filter (in mm^2); and
V = the sample volume (liters).

Table V–1 was generated from the above equation. The table shows that 1 f/cc measured over 30 minutes can be reliably measured when pumps are used at the higher flow rates of 1.6 Lpm or more, using 25-mm filters. The table also shows that MSHA cannot reliably measure 1 f/cc with 15-minute air samples, even when they are collected at the higher pump flow rates.

TABLE V–1.—RELATIONSHIP OF SAMPLING METHOD TO MEASUREMENT OF ASBESTOS

Sampling time and flow rate	Lowest level reliably measured using 25-mm filters
15 min at 2.5 Lpm	1.05 f/cc.
15 min at 2.0 Lpm	1.31 f/cc.
15 min at 1.6 Lpm	1.63 f/cc.
15 min at 1.0 Lpm	2.61 f/cc.
15 min at 0.5 Lpm	5.23 f/cc.
30 min at 2.5 Lpm	0.51 f/cc.
30 min at 2.0 Lpm	0.65 f/cc.
30 min at 1.6 Lpm	0.82 f/cc.
30 min at 1.0 Lpm	1.31 f/cc.
30 min at 0.5 Lpm	2.61 f/cc.

After evaluating the comments, MSHA retains the proposed asbestos excursion limit of 1 f/cc over a period of 30 minutes in the final rule.

C. Sections 56/57.5001(b)(3) and 71.702(c): Measurement of Airborne Fiber Concentrations

The final rule, like the proposed rule, requires an initial determination of fiber concentration using a PCM-based analytical method statistically equivalent to the OSHA Reference Method in OSHA's asbestos standard (29 CFR 1910.1001, Appendix A).

With respect to analytical methods, the final rule is substantively the same as MSHA's existing standards. PCM-based analytical methods were used in the development of past exposure assessments and risk estimates, and are relatively quick and cost-effective. OSHA used a PCM-based methodology as the defining basis of its asbestos risk assessment. PCM-based analytical methods remain the most practical way to evaluate asbestos exposures in mining. MSHA recognizes, however, that all analytical methods, including those used to identify and quantify the six asbestos minerals regulated by MSHA have limitations. Analysts have quantified the limits of detection, precision, and accuracy of these methods, termed ''analytical error;'' and MSHA includes this analytical error in evaluating asbestos exposures and enforcing the PELs. As discussed below, comments varied on MSHA's proposed sampling and analytical techniques. Most commenters supported a combination of PCM-based and TEM-based techniques for evaluating mine air samples.

1. Background of Analytical Method for Asbestos

Historically, asbestos samples have been analyzed by mass (weighing), counting (microscopy), or a qualitative property (spectroscopy). When recommending an exposure standard for chrysotile asbestos, the British Occupational Hygiene Society said [49] that the microscopic counting of particles greater than 5 µm in length would show a relationship with the prevalence of asbestosis similar to those studies based on the mass of respirable asbestos. Many studies have suggested that counting only fibers longer than 5 µm minimizes variations between microscopy techniques [50] and improves the precision of the results.[51] The scientific community accepted this length together with a minimum 3:1 length to diameter aspect ratio, as the counting criteria for asbestos fibers that provides an index of asbestos exposure, even though some believed that shorter fibers should be included due to their possible health effects.[52] Acceptance of PCM-based methodology has served as the basis of asbestos risk assessments.

In recommending an asbestos standard in 1972 and 1976, NIOSH suggested using the same size criteria that the British adopted. They also recommended reevaluating these criteria when more definitive information on the biologic response and precise epidemiologic data are developed. NIOSH applied a conversion factor to exposure data not obtained using a PCM-based analytical method, to estimate what the exposure data would have been using a PCM-based method. This conversion allowed NIOSH to use non-PCM-based exposure data, together with PCM-based exposure data, in determining a recommended permissible exposure level.

2. MSHA's Analytical Methods for Enforcement of Its Asbestos PELs

Prior to 2001, OSHA analyzed MSHA's asbestos samples using OSHA ID–160, a PCM-based analytical method. Since 2001, MSHA has contracted with American Industrial Hygiene Association (AIHA) accredited laboratories to analyze its asbestos samples using NIOSH's PCM-based analytical method, and to follow up with an analysis using NIOSH's TEM-based method when the PCM results indicate an exposure exceeding 0.1 f/cc. These commercial laboratories report analytical results as the fiber concentration (f/cc) for each filter analyzed.

Several factors complicate the evaluation of personal exposure levels in mining environments. For example, non-asbestos fibers and dust particles collected on the filter can obscure the asbestos fibers or overload the filter. Depending on the amount of visible dust in the air, MSHA's sampling procedures allow the setting of pump flow rates and consecutive sampling to minimize or eliminate mixed dust overload.

Commenters criticized MSHA's use of PCM-based methods to evaluate asbestos exposures. Several recommended that MSHA adopt a new ASTM method (ASTM D 7200–06), which references the characteristics of asbestiform fibers in EPA's bulk sample method.[53] Many recommended that MSHA not conduct air sampling unless prior bulk sampling had identified asbestos fibers. Some commenters recommended that the final rule include a TEM-based analytical method for the initial determination of compliance.

Bulk sampling presents limitations. The presence of asbestos in a bulk sample does not mean that it poses a hazard. The asbestos must become airborne and be respirable, or contaminate food or water, to pose a health hazard to miners. Analysis of bulk samples is usually performed using polarized light microscopy (PLM). A particle must be at least 0.5 µm in diameter to refract light and many asbestos fibers are too thin to refract light. Asbestos may be a small percentage of the parent material or not uniformly dispersed in the sample and,

[49] Lane *et al.*, 1968.

[50] ACGIH–AIHA, 1975.

[51] Wylie, 2000.

[52] ACGIH–AIHA, 1975; NIOSH, 1972.

[53] ASTM, 2006; EPA, 1993.

therefore, may not be seen in the small portion of sample that is examined under the microscope. Another problem with identifying asbestos using PLM is that both the asbestiform and nonasbestiform varieties of a mineral show the same refractive index. Although a trained individual may be able to identify bulk asbestos by its appearance and physical properties, the identification can be difficult when the asbestos is dispersed in a dust sample or is present in low concentration in a rock.

Due to a lack of consensus in the regulatory and scientific communities, revisions to MSHA's use of PCM-based analytical methods were not included within the scope of this rulemaking. If PCM-based analysis reveals a potential overexposure, MSHA will perform a TEM-based analysis to confirm asbestos exposure levels. Further, MSHA will consider the use of alternative analytical methods for the measurement of airborne asbestos that meet the analytical equivalency criteria for OSHA's Reference Method once they are recognized by a laboratory accreditation organization. For example, NIOSH is supporting an ASTM inter-laboratory study to validate whether ASTM D7200–06, ''Standard Practice for Sampling and Counting Airborne Fibers, Including Asbestos Fibers, in Mines and Quarries, by Phase Contrast Microscopy and Transmission Electron Microscopy'' can meet the OSHA equivalency criteria and be accredited.

a. Discussion of Microscope Properties.

One issue commenters mentioned concerning PCM-based analytical methods is the limited resolution and magnification of light microscopes compared to electron microscopes. The resolution of the microscope is the smallest separation between two objects that will allow them to be distinctly visible. The higher the resolving power of a microscope, the smaller the distance can be between two particles and have them still appear as two distinct particles. Resolution is about 0.2 μm using PCM compared with 0.0002 μm using TEM. This means that an analyst who sees a single fiber using PCM may see a number of thinner fibers using TEM. Individual fibrils of chrysotile are about 0.05 μm in diameter while amphibole fibrils are about 0.1 μm in diameter. Using TEM, the analyst is able to see thinner fibers and, therefore, should be able to see more fibers than when using PCM.

Magnification is the ratio of the size that the object appears under the microscope to its actual size. A PCM-based analysis of air samples for asbestos typically uses a magnification of 400 to 450 times (×) the object's actual size. In contrast, a TEM-based analysis typically uses a magnification of 10,000×. As a result, an analyst using PCM sees a larger amount of the sample than one using TEM, although in less detail.

b. Variability in Counting Asbestos Fibers Using PCM.

Commenters generally supported MSHA's use of a PCM-based analytical method for the initial analysis of fiber samples for determining compliance. One of the commenters' major concerns focused on the variability of fiber counting procedures. MSHA understands that the PCM-based analytical methods yield considerable variability in counting fibers because it is dependent on a number of related variables, such as the optical performance of the microscope, the optical properties of the prepared sample, and the proportion of fine particles.[54]

OSHA recognized the variability of using a PCM-based analytical method in its rulemaking. The requirements listed at 29 CFR 1910.1001 Appendix A minimize the effect of the known variability by describing the essential steps of a generic sampling and analytical procedure. OSHA also established criteria to limit variability. Subsequently, other papers have addressed variability issues related to PCM counting techniques.[55]

Commenters suggested a number of techniques to reduce the variability in counting fibers on mine air samples. Some asked that MSHA consider respirable or thoracic sampling to minimize interference from large particles that can obscure asbestos fibers on the filter. Some supported a counting technique based on the typical characteristics of asbestos in air. Others recommended using a higher aspect ratio to increase the probability that the structures counted are fibers. Another commenter stated that several approaches have been tried to remove non-asbestos minerals from samples, such as low temperature ashing or dissolution, but these approaches are not useful for mining samples. Many commenters suggested the development of differential counting techniques that consider the fiber morphology and the distributions or populations of distinct fiber groups with characteristic dimensions to analyze mine air samples for fibers. Other commenters stated that particle characteristics could not be used reliably to differentiate fibers from cleavage fragments when examining relatively small numbers of fibers. Several commenters suggested the development of a new analytical method for asbestos in mine air samples.

Much of the variability in counting asbestos is attributed to the visual acuity of the analyst in observing and sizing fibers and in interpreting the counting rules.[56] Overall, commenters recognized that it takes far less time to develop expertise in counting fibers using PCM than in developing expertise using TEM. NIOSH has developed a 40-hour training course for analysts as an adequate prerequisite to conducting total fiber counts using PCM. To differentially count asbestos fibers, an analyst must have advanced knowledge of mineralogy and expertise in the microscopic techniques used. This knowledge and expertise can be gained only by years of experience counting fiber samples collected in a variety of environments.

The availability of analyst training courses, and the formation of accreditation bodies requiring laboratory quality assurance programs, helps minimize the variations in measurements between and within laboratories.[57] Accreditation bodies require laboratories to use standardized analytical methods. AIHA has the Asbestos Analyst Registry that specifies criteria for competence, education, and performance for analysts. In addition to these programs, MSHA's incorporation of OSHA's Appendix A helps minimize the subjectivity and increase consistency of measuring airborne asbestos concentrations by specifying core elements of an acceptable PCM-based analytical method.

3. MSHA's Incorporation of Appendix A of OSHA's Asbestos Standard

MSHA's existing standards include basic elements of PCM-based analytical methods. These same basic elements for asbestos exposure monitoring are included in the OSHA Reference Method in Appendix A of OSHA's asbestos standard. The evaluation or inclusion of methods that do not include these basic elements or that deviate from the criteria for counting fibers in MSHA's existing standards was not contemplated in the proposed rule and, therefore, is beyond the scope of this final rule.

OSHA's Appendix A, the OSHA Reference Method (ORM), specifies the elements of an acceptable analytical method for asbestos and the quality

[54] Rooker *et al.*, 1982.

[55] Pang, 2000; Harper and Bartolucci, 2003.

[56] Rooker *et al.*, 1982.

[57] Schlect and Shulman, 1995.

control procedures that laboratories performing the analysis must implement. To encourage innovation and technological advancement, the final rule allows for MSHA's acceptance of other analytical methods that are at least as effective in identifying potential asbestos overexposures as the OSHA Reference Method (29 CFR 1910.1001, Appendix A). MSHA considers the counting criteria for a fiber in the OSHA Reference Method to be statistically equivalent to that in MSHA's definition of a fiber.

For the purpose of this final rule, MSHA considers a method to be statistically equivalent to the ORM and at least as effective as MSHA's existing method if it meets the following criteria from 29 CFR 1910.1001(d)(6)(iii):

(A) Replicate exposure data used to establish equivalency are collected in side-by-side field and laboratory comparisons; and

(B) The comparison indicates that 90% of the samples collected in the range 0.5 to 2.0 times the permissible limit have an accuracy range of plus or minus 25 percent of the ORM results at a 95% confidence level as demonstrated by a statistically valid protocol; and

(C) The equivalent method is documented and the results of the comparison testing are maintained.

Although MSHA can calculate concentrations below 0.1 f/cc, neither NIOSH 7400 nor OSHA ID 160 sampling and analytical methods obtain statistically reliable, repeatable measurements within ± 25 percent of the mean with 95 percent confidence for concentrations lower than 0.1 f/cc. The preamble to OSHA's 1994 asbestos rule (59 FR 40967) states that 0.1 f/cc is ''the practical lower limit of feasibility for measuring asbestos levels reliably.''

Appendix A lists NIOSH 7400 and OSHA ID–160 as analytical methods that meet these equivalency criteria. MSHA will consider other analytical methods that afford an equivalent measurement alternative as they become available.

4. Epidemiological Studies and Health Risk Data Based on PCM Analytical Methods

A number of commenters pointed out that a PCM-based methodology counts more than asbestos. These commenters suggested that the lower risk seen in epidemiological studies relating PCM-based exposure estimates to adverse health outcomes in miners was due to the other material inherent in air samples taken in a mining environment. They speculated that non-asbestos dust particles had been counted and included in the estimated concentrations, which would have overestimated asbestos exposures. MSHA acknowledges the possible overestimation of asbestos-related disease in applying OSHA's risk assessment to mining exposures based solely on PCM analytical results. For this reason, by policy, MSHA uses a subsequent TEM analysis to identify asbestos minerals and minimize this overestimation when determining asbestos exposures. MSHA has not found sufficient information to make a ''differential risk'' determination for the mining industry within OSHA's quantitative risk assessment, which MSHA uses as the basis for this final rule.

5. Discussion of Cleavage Fragments and Non-Asbestos Minerals

During this rulemaking, MSHA has received many comments regarding cleavage fragments. MSHA has not addressed cleavage fragments in this final rule. To do so would require a change in both the analytical method and the definition of asbestos, neither of which were contemplated in the proposed rule and are, therefore, beyond the scope of this final rule. The final rule retains MSHA's PCM-based analytical method. To minimize the impact of cleavage fragments on sampling results, however, MSHA will continue its policy of conducting a subsequent TEM-based analysis on samples with PCM results that exceed the PEL.

Many commenters expressed concern that standard phase contrast counting techniques are not specific in determining exposure to only the six Federal asbestos minerals and may misidentify cleavage fragments as asbestos fibers. PCM-based analytical methods do not distinguish between asbestos and any other fiber meeting the size and aspect ratio criteria. A number of commenters highlighted the seeming contradiction between MSHA's stated intent to exclude cleavage fragments from the standard and the Agency's selection of a PCM-based analytical method that may identify elongated amphibole cleavage fragments as asbestos fibers.

Commenters suggested several ways to eliminate cleavage fragments. For example, some suggested that MSHA use a revised PCM-based method with differential counting criteria that referenced OSHA's 29 CFR 1910.1001 Appendices B and C.[58] Others suggested a proposed ASTM method, which was adopted in June 2006 (ASTM D 7200–06). Several recommended a fiber population analysis that examined samples for the characteristics of commercial asbestos listed in Appendix A of EPA's *Method for the Determination of Asbestos in Bulk Building Materials* (EPA, 1993).

MSHA acknowledges that PCM-based analytical methods for the quantitative analysis of asbestos samples have some limitations, especially if samples are collected in a mixed dust environment. PCM-based analysis, however, addresses the key problem of needing to make a relatively fast, cost-effective evaluation of miners' work environments so as to improve their health protection. Using a PCM-based analytical method maintains the usefulness of the analytical results relative to the historic health data.[59] When an exposure exceeds the full-shift or excursion PEL, MSHA uses a TEM-based method to confirm the presence of asbestos.

D. § 71.701(c) and (d): Sampling; General Requirements (Controlling Asbestos Exposures in Coal Mines)

This final rule retains the proposed revision to add a reference to § 71.702 in paragraphs (c) and (d) of § 71.701 to clarify MSHA's intent that coal mine operators control miners' exposures to asbestos. MSHA received no substantive comments on this proposed change.

VI. Regulatory Analyses

A. Executive Order (E.O.) 12866

Executive Order (E.O.) 12866 (58 FR 51735) as amended by E.O. 13258 (Amending Executive Order 12866 on Regulatory Planning and Review (67 FR 9385)) requires regulatory agencies to assess both the costs and benefits of regulations. To comply with Executive Order 12866, MSHA has prepared a Regulatory Economic Analysis (REA) for this final rule. The REA contains supporting data and explanation for the summary materials presented in section VI of this preamble, including the covered mining industry, costs and benefits, feasibility, and small business impact. The REA is located on MSHA's Web site at *http://www.msha.gov/regsinfo.htm*. A copy of the REA can be obtained from MSHA's Office of Standards, Regulations, and Variances.

Executive Order 12866 classifies a rule as a significant regulatory action

[58] Appendix B (non-mandatory) is a detailed procedure for asbestos sampling and analysis. OSHA removed Appendix C (mandatory), which specified qualitative and quantitative fit testing procedures, when they promulgated their respiratory protection standard (29 CFR 1910.134). Given the context of the comment, MSHA thinks the commenter may have been referring to Appendix J, OSHA's PLM analytical method.

[59] Wylie *et al.*, 1985.

requiring review by the Office of Management and Budget if it has an annual effect on the economy of $100 million or more; creates a serious inconsistency or interferes with an action of another agency; materially alters the budgetary impact of entitlements or the rights of entitlement recipients; or raises novel legal or policy issues. MSHA has determined that the final rule would not have an annual effect of $100 million or more on the economy and, therefore, it is not an economically ''significant regulatory action'' pursuant to section 3(f) of E.O. 12866. MSHA, however, has concluded that the proposed rule is otherwise significant under Executive Order 12866 because it raises novel legal or policy issues.

1. Discussion of Benefits

This final rule will reduce diseases arising from exposure to asbestos, and the associated costs to employers, miners' families, and society at large. Exposure to asbestos can cause lung cancer; mesothelioma; gastrointestinal cancer; cancers of the larynx, pharynx, and kidneys; asbestosis; and other respiratory diseases. Reduced miners' exposures will reduce adverse health effects both in terms of the incidence of disease affecting quality of life, and deaths from both cancer and non-cancer disease. These asbestos-related diseases cause a material impairment of human health or functional capacity.

This benefit analysis quantifies the reduction in expected deaths to miners resulting from reduced exposure to airborne asbestos. The benefit is a result of reducing the 8-hour time-weighted average (TWA) permissible exposure limit (PEL) from 2 fibers per cubic centimeter (f/cc) to 0.1 f/cc. MSHA acknowledges that this change will not eliminate the risk of asbestos-related material impairment of health. (See Table IV–1.)

a. Summary of Benefits.

By lowering the PEL to 0.1 f/cc, MSHA estimates the prevention of one occupationally related cancer death caused by asbestos exposure over the 55-year period beginning 10 years after implementation of the final rule. MSHA estimates that there will be benefits resulting from lowering the excursion limit, but is unable to quantify these benefits. This analysis underestimates the total benefits of the rule by quantifying only the cancer deaths prevented. The benefits do not include the reduced incidence of asbestosis-related disabilities.

b. Calculation of Premature Deaths Prevented.

MSHA limits the quantified benefits to an estimation of the number of cancer cases prevented. MSHA expresses the results as ''deaths prevented'' because the cancers associated with asbestos exposure almost always result in premature death.

The benefits resulting from a reduction in the PEL depend on several factors including—

- Existing and projected exposure levels,
- Risk associated with each exposure level,
- Number of workers exposed at each exposure level, and
- Age of the miner at first exposure.

MSHA estimated the number of miners currently exposed and their levels of exposure from data on personal exposure sampling during regular and special inspections between January 2000 and May 2007. These data are available on MSHA's Web site at *http://www.msha.gov.* Section III of this preamble contains the characterization and assessment of exposures in mining.

Laboratory results indicate that exposure concentrations are unevenly distributed across mines and among miners within mines. MSHA uses four fiber concentration levels to estimate the risk to miners. The break points for these exposure levels are the existing and final exposure limits as follows: Less than 0.1 f/cc, 0.1 to less than 1 f/cc, 1 f/cc to less than 2 f/cc, and 2 f/cc or greater. Approximately 86 percent of MSHA's PCM-based fiber sampling results are below 0.1 f/cc. Approximately 97 percent of MSHA's TEM-based asbestos sampling results are below 0.1 f/cc. Based on MSHA's sampling data, concentrations ranged between 0.0 and 38.1 f/cc over these years. The highest concentration level in Table IV–1 is 10 f/cc. MSHA's calculations, therefore, use an upper exposure limit of 10 f/cc. Samples with exposure concentrations above 10 f/cc are included in this benefits analysis as 10 f/cc. MSHA's estimated benefits derive totally from the mines MSHA has sampled.

MSHA applied OSHA's linear, no-threshold, dose-response risk assessment model to MSHA's existing PEL and final PEL to estimate the expected number of asbestos-related deaths. The expected reduction of deaths resulting from lowering the PEL will be the difference between the expected deaths at 2 f/cc and 0.1 f/cc.[60] MSHA then applied these rates to the estimated number of miners exposed at the corresponding concentration based on MSHA sampling data. The result is an estimate of miners' deaths resulting from cancer due to occupational exposure to asbestos under existing exposure conditions.

c. Benefits of the 0.1 f/cc PEL.

Deaths from lung cancer, mesotheliomas, gastrointestinal cancer, and asbestosis are the result of past exposures to much higher air concentrations of asbestos than those found in mines today. The risks of these diseases still exist, however, and these risks are significant for miners exposed to lower air concentrations of asbestos. Most diseases resulting from a more recent asbestos exposure may not become evident for another 20 to 30 years. When the results of TEM analysis are incorporated into the exposure data, MSHA estimated a reduction of one cancer death (per 314 miners exposed above 0.1 f/cc, or 5 per 1,000 exposed) over a 55-year period starting 10 years after implementation of the lower 8-hour TWA PEL. This represents a 12 percent reduction in the miners' asbestos-related deaths that would be expected if existing exposures were to continue. The rate at which the incidence of the cancers decreases depends on several factors including—

- Latency of onset of cancer,
- Attrition of the mining workforce,
- Changing rates of competing causes of death,
- Dynamics of other risk factors,
- Changes in life expectancy, and
- Advances in cancer treatments.

d. Benefits of the 1 f/cc Excursion Limit.

The intended effect of the excursion limit is to protect miners from the adverse health risks associated with brief fiber releases. MSHA believes that miners will be exposed to brief fiber releases even when airborne concentrations of asbestos do not exceed the PEL. For example, mechanics may be inadvertently exposed to airborne asbestos while working on older equipment that may have asbestos-containing parts. Miners may encounter brief fiber releases while drilling, dozing, blasting, or roof bolting in areas of naturally occurring asbestos. These short-term exposures can easily be above 1 f/cc; however, when averaged over an 8-hour shift, they fall within the 0.1 f/cc PEL. However, because MSHA does not have sufficient data regarding the relationship between the frequency of brief fiber releases and adverse health risks, this analysis demonstrates the theoretical benefits from limiting short-term exposures to the excursion limit.

This section estimates the benefits of the excursion limit of 1 f/cc for one 30-

[60] Nicholson, 1983; JRB Associates, 1983; OSHA (51 FR 22612), 1986; OSHA (53 FR 35609), 1988; OSHA (59 FR 40964), 1994.

minute period per day. Two 30-minute exposures per day at 1 f/cc will exceed the 8-hour TWA, full shift exposure limit (i.e., 1 f/cc for 48 minutes = 0.1 f/cc for 480 minutes).

MSHA estimates the benefit of an excursion limit from the difference in concentration between the PEL and the excursion limit averaged over the full shift [(1 f/cc)/(16 30-minute periods) = 0.063 f/cc]. The lifetime risk associated with an exposure to 0.1 f/cc is 0.00336, if first exposed at age 25 and exposure continues every work day at that level for 45 years. The risk associated with exposure to 0.063 f/cc using the same age and duration of exposure is 0.00212. The difference in lifetime risk is 0.00124, which equates to one additional premature death prevented for every 1,000 miners exposed to asbestos above the 1 f/cc excursion limit.

2. Discussion of Costs

The final rule will result in total costs of approximately $201,000 per year for all mines. The cost will be approximately $156,000 for metal and nonmetal mines and approximately $45,000 for coal mines. These costs represent less than 0.001 percent of the yearly revenues of $64.4 billion for the metal and nonmetal mining industry and $27.0 billion for the coal mining industry.

Table VI–1 presents MSHA's estimate of the total yearly compliance costs by compliance strategy and mine size. The total costs reported are projected costs, in 2006 dollars, based on MSHA's knowledge, experience, and available information.

TABLE VI–1.—SUMMARY OF YEARLY COMPLIANCE COSTS

Metal and nonmetal mine size	Compliance strategy				Total for metal and nonmetal mines
	Selective mining	Wet methods	Ventilation	Removal of ACM	
1–19	$2,417	$2,820	$1,619	$1,750	$8,606
20–500	11,242	19,673	28,048	21,000	79,962
501+	3,747	6,558	41,278	15,750	67,333
Total	17,406	29,050	70,945	38,500	155,901
Coal mine size	**Compliance strategy**				**Total for coal mines**
	Selective mining	Wet methods	Ventilation	Removal of ACM	
1–19				$875	$875
20–500				12,250	12,250
501+				31,500	31,500
Total				44,625	44,625

B. Feasibility

MSHA has determined that the requirements of this final rule are both technologically and economically feasible.

In the discussion of PELs in section V.B of this preamble, MSHA stated that there is a residual risk of adverse health effects for miners exposed at the PEL. MSHA considered proposing a lower PEL as a regulatory alternative to further reduce the risk of adverse health effects from a working lifetime of exposure. When OSHA reduced the PEL from 0.2 to 0.1 f/cc in 1994, OSHA concluded that this concentration is "the practical lower limit of feasibility for measuring asbestos levels reliably." (59 FR 40967) About 85 percent of the sampled mines are already in compliance with the 0.1 f/cc PEL.

This final rule is not a technology-forcing standard. All equipment required by the final rule and a variety of dust control strategies and control methods are already available in the marketplace and have been used successfully by the U.S. mining community to control asbestos exposures. MSHA has concluded that this final rule is technologically feasible.

The mining industry would incur costs of about $201,000 yearly to comply with this final rule. These compliance costs represent less than 0.001 percent of the yearly revenues of the mines covered by this rule (approximately $64.4 billion for metal and nonmetal and $27.0 billion for coal). MSHA has concluded that this final rule is economically feasible.

D. Regulatory Flexibility Analysis (RFA) and Small Business Regulatory Enforcement Fairness Act (SBREFA)

Based on MSHA's data and experience, and information submitted to the record, the Agency has determined and here certifies that this final rule will not have a significant economic impact on a substantial number of small entities. The REA for this final rule (RIN: 1219–AB24), *Asbestos Exposure Limit,* contains the factual basis for this certification as well as complete details about data, equations, and methods used to calculate the costs and benefits. MSHA has placed the REA in the rulemaking docket and posted it on MSHA's Web site at *http://www.msha.gov.*

E. Other Regulatory Considerations

1. The National Environmental Policy Act of 1969 (NEPA)

MSHA has reviewed the final rule in accordance with the requirements of NEPA of 1969 (42 U.S.C. 4321 *et seq.*), the regulations of the Council on Environmental Quality (40 CFR part 1500), and the Department of Labor's NEPA procedures (29 CFR part 11) and has assessed the environmental impacts. The Agency found that the final rule will have no significant impact on air, water, or soil quality; plant or animal life; the use of land; or other aspects of the human environment.

2. Paperwork Reduction Act of 1995

The final rule contains no information collection or recordkeeping requirements. Thus, there are no additional paperwork burden hours and related costs associated with the final rule. Accordingly, the Paperwork Reduction Act requires no further agency action or analysis.

3. The Unfunded Mandates Reform Act of 1995

MSHA has reviewed the final rule under the Unfunded Mandates Reform

Act of 1995 (2 U.S.C. 1501 *et seq.*). MSHA has determined that the final rule does not include any Federal mandate that may result in increased expenditures by State, local, or tribal governments; nor does it increase private sector expenditures by more than $100 million in any one year or significantly or uniquely affect small governments. Accordingly, the Unfunded Mandates Reform Act of 1995 (2 U.S.C. 1501 *et seq.*) requires no further agency action or analysis.

4. Treasury and General Government Appropriations Act of 1999 (Section 654: Assessment of Impact of Federal Regulations and Policies on Families)

Section 654 of the Treasury and General Government Appropriations Act of 1999 (5 U.S.C. 601 note) requires agencies to assess the impact of Agency action on family well-being. MSHA has determined that the final rule will have no affect on family stability or safety, marital commitment, parental rights and authority, or income or poverty of families and children. Accordingly, MSHA certifies that the final rule will not impact family well-being.

5. Executive Order 12630: Government Actions and Interference with Constitutionally Protected Property Rights

The final rule does not implement a policy with takings implications. Accordingly, E.O. 12630 requires no further Agency action or analysis.

6. Executive Order 12988: Civil Justice Reform

The final rule was written to provide a clear legal standard for affected conduct and was carefully reviewed to eliminate drafting errors and ambiguities, so as to minimize litigation and undue burden on the Federal court system. Accordingly, the final rule meets the applicable standards provided in section 3 of E.O. 12988, Civil Justice Reform.

7. Executive Order 13045: Protection of Children from Environmental Health Risks and Safety Risks

The final rule has no adverse impact on children. Accordingly, under E.O. 13045, no further Agency action or analysis is required.

8. Executive Order 13132: Federalism

The final rule does not have ‘‘federalism implications,’’ because it does not ‘‘have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government.’’ Accordingly, Executive Order 13132, Federalism, requires no further agency action or analysis.

9. Executive Order 13175: Consultation and Coordination with Indian Tribal Governments

The final rule does not have ‘‘tribal implications,’’ because it does not ‘‘have substantial direct effects on one or more Indian tribes, on the relationship between the Federal government and Indian tribes, or on the distribution of power and responsibilities between the Federal government and Indian tribes.’’ Accordingly, under E.O. 13175, no further Agency action or analysis is required.

10. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use

Executive Order 13211 requires agencies to publish a statement of energy effects when a rule has a significant energy action that adversely affects energy supply, distribution or use. MSHA has reviewed the final rule for its energy effects because the final rule applies to the coal mining sector. MSHA has concluded that the final rule is not a significant energy action because it will not have significant adverse effect on the supply, distribution, or use of energy. Further, because the final rule will result in yearly costs of approximately $45,000 to the coal mining industry, relative to annual revenues of $27.0 billion in 2006, it is not a significant energy action because it is not likely to have a significant adverse effect on the supply, distribution, or use of energy. Accordingly, under this analysis, no further Agency action or analysis is required.

11. Executive Order 13272: Proper Consideration of Small Entities in Agency Rulemaking

MSHA has thoroughly reviewed the final rule to assess and take appropriate account of its potential impact on small businesses, small governmental jurisdictions, and small organizations. As discussed in section VI.D of this preamble, MSHA has determined and certified that the final rule would not have a significant economic impact on a substantial number of small entities. Accordingly, Executive Order 13272, Proper Consideration of Small Entities in Agency Rulemaking, requires no further agency action or analysis.

VII. Copy of the OSHA Reference Method (ORM)

MSHA's existing asbestos standards require that the analyst determine fiber concentrations using a phase contrast microscopy analytical method with 400–450X magnification. The ORM contains these requirements. The definition of fiber in MSHA's final rule includes the same characteristics as in the existing standards, i.e., longer than 5 µm with a length to width ratio of at least 3:1. Although the ORM requires counting fibers 5 µm or longer, there is no practical difference between these criteria considering the accuracy and precision of the analytical methods. NIOSH Method 7400 is equivalent to the ORM even though it requires counting fibers longer than 5 µm. The ORM also requires that analysts ‘‘* * * must have taken the NIOSH course for sampling and evaluating airborne asbestos dust or an equivalent course.’’

29 CFR 1910.1001 Appendix A: OSHA Reference Method—Mandatory

This mandatory appendix specifies the procedure for analyzing air samples for asbestos and specifies quality control procedures that must be implemented by laboratories performing the analysis. The sampling and analytical methods described below represent the elements of the available monitoring methods (such as Appendix B of their regulation, the most current version of the OSHA method ID–160, or the most current version of the NIOSH Method 7400). All employers who are required to conduct air monitoring under paragraph (d) of the [OSHA] standard are required to utilize analytical laboratories that use this procedure, or an equivalent method, for collecting and analyzing samples.

Sampling and Analytical Procedure.

1. The sampling medium for air samples shall be mixed cellulose ester filter membranes. These shall be designated by the manufacturer as suitable for asbestos counting. See below for rejection of blanks.

2. The preferred collection device shall be the 25-mm diameter cassette with an open-faced 50-mm electrically conductive extension cowl. The 37-mm cassette may be used if necessary but only if written justification for the need to use the 37-mm filter cassette accompanies the sample results in the employee's exposure monitoring record. Do not reuse or reload cassettes for asbestos sample collection.

3. An air flow rate between 0.5 liter/min and 2.5 liters/min shall be selected for the 25-mm cassette. If the 37-mm cassette is used, an air flow rate between 1 liter/min and 2.5 liters/min shall be selected.

4. Where possible, a sufficient air volume for each air sample shall be collected to yield between 100 and 1,300 fibers per square millimeter on the membrane filter. If a filter darkens in appearance or if loose dust is seen on the filter, a second sample shall be started.

5. Ship the samples in a rigid container with sufficient packing material to prevent

dislodging the collected fibers. Packing material that has a high electrostatic charge on its surface (e.g., expanded polystyrene) cannot be used because such material can cause loss of fibers to the sides of the cassette.

6. Calibrate each personal sampling pump before and after use with a representative filter cassette installed between the pump and the calibration devices.

7. Personal samples shall be taken in the ''breathing zone'' of the employee (i.e., attached to or near the collar or lapel near the worker's face).

8. Fiber counts shall be made by positive phase contrast using a microscope with an 8 to 10 × eyepiece and a 40 to 45 × objective for a total magnification of approximately 400 × and a numerical aperture of 0.65 to 0.75. The microscope shall also be fitted with a green or blue filter.

9. The microscope shall be fitted with a Walton-Beckett eyepiece graticule calibrated for a field diameter of 100 micrometers (±2 micrometers).

10. The phase-shift detection limit of the microscope shall be about 3 degrees measured using the HSE phase shift test slide as outlined below.

a. Place the test slide on the microscope stage and center it under the phase objective.

b. Bring the blocks of grooved lines into focus.

Note: The slide consists of seven sets of grooved lines (ca. 20 grooves to each block) in descending order of visibility from sets 1 to 7, 7 being the least visible. The requirements for asbestos counting are that the microscope optics must resolve the grooved lines in set 3 completely, although they may appear somewhat faint, and that the grooved lines in sets 6 and 7 must be invisible. Sets 4 and 5 must be at least partially visible but may vary slightly in visibility between microscopes. A microscope that fails to meet these requirements has either too low or too high a resolution to be used for asbestos counting.

c. If the image deteriorates, clean and adjust the microscope optics. If the problem persists, consult the microscope manufacturer.

11. Each set of samples taken will include 10 percent blanks or a minimum of 2 field blanks. These blanks must come from the same lot as the filters used for sample collection. The field blank results shall be averaged and subtracted from the analytical results before reporting. A set consists of any sample or group of samples for which an evaluation for this standard must be made. Any samples represented by a field blank having a fiber count in excess of the detection limit of the method being used shall be rejected.

12. The samples shall be mounted by the acetone/triacetin method or a method with an equivalent index of refraction and similar clarity.

13. Observe the following counting rules.

a. Count only fibers equal to or longer than 5 micrometers. Measure the length of curved fibers along the curve.

b. In the absence of other information, count all particles as asbestos that have a length-to-width ratio (aspect ratio) of 3:1 or greater.

c. Fibers lying entirely within the boundary of the Walton-Beckett graticule field shall receive a count of 1. Fibers crossing the boundary once, having one end within the circle, shall receive the count of one half (½). Do not count any fiber that crosses the graticule boundary more than once. Reject and do not count any other fibers even though they may be visible outside the graticule area.

d. Count bundles of fibers as one fiber unless individual fibers can be identified by observing both ends of an individual fiber.

e. Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields; stop counting at 100 fields regardless of fiber count.

14. Blind recounts shall be conducted at the rate of 10 percent.

Quality Control Procedures.

1. *Intralaboratory program.* Each laboratory and/or each company with more than one microscopist counting slides shall establish a statistically designed quality assurance program involving blind recounts and comparisons between microscopists to monitor the variability of counting by each microscopist and between microscopists. In a company with more than one laboratory, the program shall include all laboratories and shall also evaluate the laboratory-to-laboratory variability.

2. *Interlaboratory program.*

a. Each laboratory analyzing asbestos samples for compliance determination shall implement an interlaboratory quality assurance program that as a minimum includes participation of at least two other independent laboratories. Each laboratory shall participate in round robin testing at least once every 6 months with at least all the other laboratories in its interlaboratory quality assurance group. Each laboratory shall submit slides typical of its own work load for use in this program. The round robin shall be designed and results analyzed using appropriate statistical methodology.

b. All laboratories should also participate in a national sample testing scheme such as the Proficiency Analytical Testing Program (PAT), or the Asbestos Registry sponsored by the American Industrial Hygiene Association (AIHA).

3. All individuals performing asbestos analysis must have taken the NIOSH course for sampling and evaluating airborne asbestos dust or an equivalent course.

4. When the use of different microscopes contributes to differences between counters and laboratories, the effect of the different microscope shall be evaluated and the microscope shall be replaced, as necessary.

5. Current results of these quality assurance programs shall be posted in each laboratory to keep the microscopists informed.

[57 FR 24330, June 8, 1992; 59 FR 40964, Aug. 10, 1994]

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List of Subjects

30 CFR Parts 56 and 57

Air quality, Asbestos, Chemicals, Hazardous substances, Metals, Mine safety and health.

30 CFR Part 71

Air quality, Asbestos, Chemicals, Coal mining, Hazardous substances, Mine safety and health.

Dated: February 22, 2008.

Richard E. Stickler,

Acting Assistant Secretary for Mine Safety and Health.

■ For the reasons set out in the preamble, and under the authority of the Federal Mine Safety and Health Act of 1977, MSHA is amending chapter I of title 30 of the Code of Federal Regulations as follows.

PART 56—SAFETY AND HEALTH STANDARDS—SURFACE METAL AND NONMETAL MINES

■ 1. The authority citation for part 56 continues to read as follows:

Authority: 30 U.S.C. 811.

■ 2. Section 56.5001 is amended by revising paragraph (b) to read as follows:

§ 56.5001 Exposure limits for airborne contaminants.

* * * * *

(b) *Asbestos standard*—(1) *Definitions.* Asbestos is a generic term for a number of hydrated silicates that, when crushed or processed, separate into flexible fibers made up of fibrils. As used in this part—

Asbestos means chrysotile, cummingtonite-grunerite asbestos (amosite), crocidolite, anthophylite asbestos, tremolite asbestos, and actinolite asbestos.

Fiber means a particle longer than 5 micrometers (μm) with a length-to-diameter ratio of at least 3-to-1.

(2) *Permissible Exposure Limits (PELs)*—(i) *Full-shift limit.* A miner's personal exposure to asbestos shall not exceed an 8-hour time-weighted average full-shift airborne concentration of 0.1 fiber per cubic centimeter of air (f/cc).

(ii) *Excursion limit.* No miner shall be exposed at any time to airborne concentrations of asbestos in excess of 1 fiber per cubic centimeter of air (f/cc) as averaged over a sampling period of 30 minutes.

(3) *Measurement of airborne fiber concentration.* Fiber concentration shall be determined by phase contrast microscopy using a method statistically equivalent to the OSHA Reference Method in OSHA's asbestos standard found in 29 CFR 1910.1001, Appendix A.

* * * * *

PART 57—SAFETY AND HEALTH STANDARDS—UNDERGROUND METAL AND NONMETAL MINES

■ 3. The authority citation for part 57 continues to read as follows:

Authority: 30 U.S.C. 811.

■ 4. Section 57.5001 is amended by revising paragraph (b) to read as follows:

§ 57.5001 Exposure limits for airborne contaminants.

* * * * *

(b) *Asbestos standard*—(1) *Definitions.* Asbestos is a generic term for a number of hydrated silicates that, when crushed or processed, separate into flexible fibers made up of fibrils. As used in this part—

Asbestos means chrysotile, cummingtonite-grunerite asbestos (amosite), crocidolite, anthophylite asbestos, tremolite asbestos, and actinolite asbestos.

Fiber means a particle longer than 5 micrometers (µm) with a length-to-diameter ratio of at least 3-to-1.

(2) *Permissible Exposure Limits (PELs)*—(i) *Full-shift limit.* A miner's personal exposure to asbestos shall not exceed an 8-hour time-weighted average full-shift airborne concentration of 0.1 fiber per cubic centimeter of air (f/cc).

(ii) *Excursion limit.* No miner shall be exposed at any time to airborne concentrations of asbestos in excess of 1 fiber per cubic centimeter of air (f/cc) as averaged over a sampling period of 30 minutes.

(3) *Measurement of airborne fiber concentration.* Fiber concentration shall be determined by phase contrast microscopy using a method statistically equivalent to the OSHA Reference Method in OSHA's asbestos standard found in 29 CFR 1910.1001, Appendix A.

* * * * *

PART 71—MANDATORY HEALTH STANDARDS—SURFACE COAL MINES AND SURFACE WORK AREAS OF UNDERGROUND COAL MINES

■ 5. The authority citation for part 71 continues to read as follows:

Authority: 30 U.S.C. 811, 951, 957.

■ 6. Section 71.701 is amended by revising paragraphs (c) and (d) to read as follows:

§ 71.701 Sampling; general requirements.

* * * * *

(c) Where concentrations of airborne contaminants in excess of the applicable threshold limit values, permissible exposure limits, or permissible excursions are known by the operator to exist in a surface installation or at a surface worksite, the operator shall immediately provide necessary control measures to assure compliance with § 71.700 or § 71.702, as applicable.

(d) Where the operator has reasonable grounds to believe that concentrations of airborne contaminants in excess of the applicable threshold limit values, permissible exposure limits, or permissible excursions exist, or are likely to exist, the operator shall promptly conduct appropriate air sampling tests to determine the concentration of any airborne contaminant which may be present and immediately provide the necessary control measures to assure compliance with § 71.700 or § 71.702, as applicable.

■ 7. Section 71.702 is revised to read as follows:

§ 71.702 Asbestos standard.

(a) *Definitions.* Asbestos is a generic term for a number of hydrated silicates that, when crushed or processed, separate into flexible fibers made up of fibrils. As used in this part—

Asbestos means chrysotile, cummingtonite-grunerite asbestos (amosite), crocidolite, anthophylite asbestos, tremolite asbestos, and actinolite asbestos.

Fiber means a particle longer than 5 micrometers (µm) with a length-to-diameter ratio of at least 3-to-1.

(b) *Permissible Exposure Limits (PELs)*— (1) *Full-shift limit.* A miner's personal exposure to asbestos shall not exceed an 8-hour time-weighted average full-shift airborne concentration of 0.1 fiber per cubic centimeter of air (f/cc).

(2) *Excursion limit.* No miner shall be exposed at any time to airborne concentrations of asbestos in excess of 1 fiber per cubic centimeter of air (f/cc) as averaged over a sampling period of 30 minutes.

(c) *Measurement of airborne fiber concentration.* Fiber concentration shall be determined by phase contrast microscopy using a method statistically equivalent to the OSHA Reference Method in OSHA's asbestos standard found in 29 CFR 1910.1001, Appendix A.

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