DEPARTMENT OF LABOR

Mine Safety and Health Administration

30 CFR Parts 56, 57, 60, 70, 71, 72, 75, and 90

[Docket No. MSHA–2023–0001]

RIN 1219–AB36

Lowering Miners' Exposure to Respirable Crystalline Silica and Improving Respiratory Protection

AGENCY: Mine Safety and Health Administration (MSHA), Department of Labor.

ACTION: Final rule.

SUMMARY: The Mine Safety and Health Administration (MSHA) is amending its existing standards to better protect miners against occupational exposure to respirable crystalline silica, a significant health hazard, and to improve respiratory protection for miners from exposure to airborne contaminants. MSHA's final rule also includes other requirements to protect miner health, such as exposure sampling, corrective actions to be taken when a miner's exposure exceeds the permissible exposure limit, and medical surveillance for metal and nonmetal mines.

DATES:

Effective date: The final rule is effective June 17, 2024, except for amendments 21, 22, 25, 26, 27, 30, 31, 34, 35, 36, 38, 39, 42, 43, 46, 47, 50, 51, 54, 55, 59, 60, 63, 64, 68, 69, 73, 74, 77, 78, 81, 82, 83, 86, 87, 90, 91, 94, 95, 98, 99, 102, 103, 106, 107, 110, and 111, which are effective April 14, 2025, and amendments 4, 5, 8, 9, 13, 14, 17, and 18, which are effective April 8, 2026.

Incorporation by reference date: The incorporation by reference of certain materials listed in the rule is approved by the Director of the Federal Register beginning June 17, 2024, except for the material in amendment 60, which is approved beginning April 14, 2025, and the material in amendments 9 and 18, which is approved beginning April 8, 2026. The incorporation by reference of certain other material listed in the rule was approved by the Director of the Federal Register as of July 10, 1995.

Compliance dates: Compliance with this final rule is required April 14, 2025 for coal mine operators and April 8, 2026 for metal and nonmetal mine operators.

FOR FURTHER INFORMATION CONTACT: S. Aromie Noe, Director, Office of Standards, Regulations, and Variances, MSHA, at: *silicaquestions@dol.gov* (email); 202–693–9440 (voice); or 202–693–9441 (facsimile). These are not toll-free numbers.

SUPPLEMENTARY INFORMATION:

The preamble to the final standard follows this outline:

Acronyms and Abbreviations

COPD chronic obstructive pulmonary disease
ESRD end-stage renal disease
FEV forced expiratory volume
FRA final risk analysis
FRIA final regulatory impact analysis
FVC forced vital capacity
L/min liters per minute
mg milligram
mg/m^3 milligrams per cubic meter
mL milliliter
μg/m^3 micrograms per cubic meter
MNM metal and nonmetal
MRE Mining Research Establishment
NMRD nonmalignant respiratory disease
PEL permissible exposure limit
PMF progressive massive fibrosis
PRA preliminary risk analysis
RCMD respirable coal mine dust
REL recommended exposure limit
SiO_2 silica
TB tuberculosis
TLV® Threshold Limit Value
TWA time-weighted average

I. Executive Summary

A. Purpose of the Regulatory Action

The purpose of this final rule is to reduce occupational disease in miners and to improve respiratory protection against airborne contaminants. The rule sets the permissible exposure limit (PEL) of respirable crystalline silica at 50 micrograms per cubic meter of air (μg/m^3) for a full-shift exposure, calculated as an 8-hour time weighted average (TWA) for all mines. This rule also establishes an action level for respirable crystalline silica of 25 μg/m^3 for a full-shift exposure, calculated as an 8-hour TWA for all mines. In addition to the PEL and action level, the rule includes provisions for methods of compliance, exposure monitoring, corrective actions, respiratory protection, medical surveillance for metal and nonmetal (MNM) mines, and recordkeeping.

The statutory authority for this rule is provided by the Mine Act under sections 101(a), 103(h), and 508. 30 U.S.C. 811(a), 813(h), and 957. A full discussion of Mine Act legal requirements can be found in *Section II. Pertinent Legal Authority.* MSHA implements and administers the provisions of the Mine Act to prevent death, illness, and injury from mining and promote safe and healthful workplaces for miners.

Respirable crystalline silica is classified by the International Agency for Research on Cancer (IARC) as a human carcinogen. Occupational exposure to respirable crystalline silica results in adverse health effects and increases risk of death. The adverse health effects include silicosis (*i.e.,* acute silicosis, accelerated silicosis, chronic silicosis, and progressive massive fibrosis), nonmalignant respiratory diseases (*e.g.,* emphysema and chronic bronchitis), lung cancer, and kidney disease. Each of these effects is chronic, irreversible, and potentially disabling or fatal. Occupational exposure to respirable crystalline silica at mines occurs most commonly from respirable dust generated during mining activities, such as cutting, sanding, drilling, crushing, grinding, sawing, scraping, jackhammering, excavating, and hauling of materials that contain silica.

Existing standards pertaining to respirable crystalline silica for both MNM and coal mines have been in place since the early 1970s. For MNM mines, the existing standards, established by the Department of Interior, Bureau of Mines, in 1974, helped protect miners from the most dangerous levels of exposure to respirable crystalline silica. The existing MNM PELs for the three polymorphs of respirable crystalline silica are: 0.1 mg/m^3 or 100 micrograms per cubic meter of air (μg/m^3) for quartz; 0.05 mg/m^3 or 50 μg/m^3 for cristobalite; and 0.05 mg/m^3 or 50 μg/m^3 for tridymite. Existing standards for coal mines, first established by the Federal Coal Mine Health and Safety Act of 1969 as interim standards in 1970, control miners' exposures to respirable crystalline silica indirectly by reducing the respirable coal mine dust standard when quartz is present. The exposure limit for respirable crystalline silica during a coal miner's shift is 100 μg/m^3, reported as an equivalent concentration as measured by the Mining Research Establishment (MRE) instrument.

However, since the promulgation of these existing standards, the National Institute for Occupational Safety and Health (NIOSH) has recommended a lower respirable crystalline silica exposure level of 50 μg/m³ for all workers, including miners. In 2016, the Occupational Safety and Health Administration (OSHA) established a PEL of 50 and an action level of 25 μg/m³ as an 8-hour TWA in the general and construction industries and maritime sector that it regulates. In the mining industry, however, the higher PELs have remained in place for miners in both the MNM sector and the coal sector.

To better protect miners' health, therefore, with this final rule MSHA is lowering its existing exposure limits for quartz or respirable crystalline silica to 50 μg/m³ and setting an action level of 25 μg/m³ for all miners. As discussed in *Section V. Health Effects Summary* and *Section VI. Final Risk Analysis Summary,* lowering the PEL will substantially reduce health risks to miners. This final rule also provides a uniform, streamlined regulatory framework to ensure consistent protection across mining sectors and make compliance more straightforward. As discussed in *Section VII. Feasibility* and *Section IX. Summary of Final Regulatory Impact Analysis and Regulatory Alternatives,* compliance with the final rule is technologically and economically feasible, and the final rule has quantified benefits in terms of avoided deaths and illnesses that greatly outweigh the costs, as well as other important unquantified benefits.

B. Summary of Major Provisions

MSHA amends its existing standards on respirable crystalline silica or quartz, after considering all the testimonies and written comments the Agency received from a variety of stakeholders, including miners, mine operators, labor unions, industry trade associations, government officials, and public health professionals, in response to its notice of proposed rulemaking. Below is a summary of major provisions in the final rule. *Section VIII. Summary and Explanation of the Final Rule* discusses each provision in the final rule.

This final rule:

1. *Establishes a uniform permissible exposure limit (PEL) and action level for all mines.* The rule sets a PEL for respirable crystalline silica at 50 micrograms per cubic meter of air (μg/m³) over a full shift, calculated as an 8-hour TWA and an action level at 25 μg/m³ over a full shift, calculated as an 8-hour TWA for all mines.

2. *Requires exposure monitoring for respirable crystalline silica.* Mine operators are required to conduct sampling to assess miners' exposures to respirable crystalline silica. Mine operators are also required to evaluate the impact of mining production, processes, equipment, engineering controls, and geological condition changes on respirable crystalline silica exposures.

3. *Updates the standard for respirable crystalline silica sampling.* ISO 7708:1995(E), *Air quality—Particle size fraction definitions for health-related sampling,* First Edition, 1995–04–01 (ISO 7708:1995), is incorporated by reference. The final rule requires mine operators to conduct sampling for respirable crystalline silica using respirable particle size-selective samplers that conform to ISO 7708:1995, which is the international consensus standard that defines sampling conventions for particle size fractions used in assessing possible health effects of airborne particles in the workplace and ambient environment.

4. *Requires immediate reporting and corrective action to remedy overexposures.* Whenever an overexposure is identified, mine operators must immediately report to MSHA and take corrective action to lower the concentration of respirable crystalline silica to at or below the PEL, resample to determine the efficacy of the corrective action taken, and make a record of all sampling and corrective actions that were taken.

5. *Specifies methods of controlling respirable crystalline silica.* All mines are required to install, use, and maintain feasible engineering controls as the primary means of controlling respirable crystalline silica; administrative controls may be used, when necessary, as a supplementary control.

6. *Requires temporary use of respirators at metal and nonmetal mines when miners must work in concentrations above the PEL.* When MNM miners must work in concentrations of respirable crystalline silica above the PEL while engineering controls are being developed and implemented or it is necessary by nature of the work involved, the mine operator shall use respiratory protection as a temporary measure.

7. *Updates the respiratory protection standard.* ASTM F3387–19, *Standard Practice for Respiratory Protection,* approved August 1, 2019 (ASTM F3387–19), is incorporated by reference. When approved respirators are used, the mine operator must have a written respiratory protection program to protect miners from airborne contaminants, including respirable crystalline silica, in accordance with ASTM requirements.

8. *Requires medical surveillance at MNM mines.* Metal and nonmetal mine operators are required to provide to all miners, including those who are new to the mining industry, periodic medical examinations performed by a physician or other licensed health care professional (PLHCP) or specialist, at no cost to the miner. Like coal miners, MNM miners will be able to monitor their health and detect early signs of respiratory illness.

The requirements in the new part 60 will take effect on June 17, 2024. For coal mine operators, compliance with part 60 is required by 12 months after the publication date; for MNM operators, compliance is required by 24 months after the publication date. The delayed compliance is to strike a balance between meeting the urgent need to protect miners from this health hazard and giving mining operators adequate preparation time to allow them to comply effectively with the new requirements.

In addition, conforming amendments to parts 56, 57, 70, 71, 72, 75, and 90 will take effect on June 17, 2024. Compliance with conforming amendments to parts 56 and 57 is required by 24 months after the publication date; and compliance with conforming amendments to parts 70, 71, 72, 75, and 90 is required by 12 months after the publication date.

C. Summary of Final Regulatory Impact Analysis

MSHA's economic analysis estimates that the final rule would cost approximately an average of $89 million per year in 2022 dollars at an undiscounted rate, $90 million at a 3 percent discount rate, and $92 million at a 7 percent discount rate. Based on the results of the Final Regulatory Impact Analysis (FRIA), MSHA estimates that this final rule's monetized benefits would exceed its costs, with or without discount rates. Monetized benefits are estimated from avoidance of 531 deaths related to NMRD, silicosis, ESRD, and lung cancer and 1,836 cases of silicosis associated with silica exposure over the first 60-year period after the promulgation of the final rule. The estimated annualized net benefit is approximately $294 million at an undiscounted rate, $157 million at a 3 percent discount rate, and $40 million at a 7 percent discount rate.

A rule is significant under Executive Order 12866 Section 3(f)(1), as amended by E.O. 14094, if it is likely to result in ''an annual effect on the economy of $200 million or more.'' The Office of Management and Budget has determined that the final rule is significant under E.O. 12866 Section 3(f)(1).

In summary, this final rule will strengthen MSHA's existing regulatory framework and improve health protections for the nation's miners. It establishes a uniform PEL that aligns respirable crystalline silica exposure limits for MNM and coal miners with workers in other industries. Moreover, the final rule updates the existing respiratory protection standard to require mine operators to provide miners with NIOSH-approved respiratory equipment that has been fitted, selected, maintained, and used in accordance with recent consensus standards. It also requires all MNM operators to provide medical surveillance in the form of a medical examination regime similar to the one that already covers coal miners. Cumulatively, the final rule will lower miners' risks of developing chronic, irreversible, disabling, and potentially fatal health conditions, consistent with MSHA's mission and statutory mandate to prevent occupational diseases and protect U.S. miners from suffering material health impairments.

II. Pertinent Legal Authority

The statutory authority for this final rule is provided by the Mine Act under sections 101(a), 103(h), and 508. 30 U.S.C. 811(a), 813(h), and 957. MSHA implements the provisions of the Mine Act to prevent death, illness, and injury from mining and promote safe and healthful workplaces for miners. The Mine Act requires the Secretary of Labor (Secretary) to develop and promulgate improved mandatory health or safety standards to prevent hazardous and unhealthy conditions and protect the health and safety of the nation's miners. 30 U.S.C. 811(a).

Congress passed the Mine Act to address these dangers, finding ''an urgent need to provide more effective means and measures for improving the working conditions and practices in the Nation's coal or other mines in order to prevent death and serious physical harm, and in order to prevent occupational diseases originating in such mines.'' 30 U.S.C. 801(c). Congress concluded that ''the existence of unsafe and unhealthful conditions and practices in the Nation's coal or other mines is a serious impediment to the future growth of the coal or other mining industry and cannot be tolerated.'' 30 U.S.C. 801(d). Accordingly, ''the Mine Act evinces a clear bias in favor of miner health and safety.'' *Nat'l Mining Ass'n* v. *Sec'y, U.S. Dep't of Lab.,* 812 F.3d 843, 866 (11th Cir. 2016).

Section 101(a) of the Mine Act gives the Secretary the authority to develop, promulgate, and revise mandatory health standards to address toxic materials or harmful physical agents. Under Section 101(a), a standard must protect lives and prevent injuries in mines and be ''improved'' over any standard that it replaces or revises.

The Secretary must set standards to assure, based on the best available evidence, that no miner will suffer material impairment of health or functional capacity from exposure to toxic materials or harmful physical agents over their working lives. 30 U.S.C. 811(a)(6)(A). In developing standards that attain the ''highest degree of health and safety protection for the miner,'' the Mine Act requires that the Secretary consider the latest available scientific data in the field, the feasibility of the standards, and experience gained under the Mine Act and other health and safety laws. *Id.* As a result, courts have found it ''appropriate to 'give an extreme degree of deference' '' to MSHA '' 'when it is evaluating scientific data within its technical expertise.' '' *Nat'l Mining Ass'n,* 812 F.3d at 866 (quoting *Kennecott Greens Creek Mining Co.* v. *MSHA,* 476 F.3d 946, 954 (D.C. Cir. 2007)). Consequently, MSHA's ''duty to use the best evidence and to consider feasibility . . . cannot be wielded as counterweight to MSHA's overarching role to protect the life and health of workers in the mining industry.'' *Nat'l Mining Ass'n,* 812 F.3d at 866. Thus, ''when MSHA itself weighs the evidence before it, it does so in light of its congressional mandate'' in favor of protecting miners' health. *Id.* Moreover, ''the Mine Act does not contain the 'significant risk' threshold requirement'' from the OSH Act. *Nat'l Mining Ass'n* v. *United Steel Workers,* 985 F.3d 1309, 1319 (11th Cir. 2021); *see also Nat'l Min. Ass'n* v. *Mine Safety & Health Admin.,* 116 F.3d 520, 527–28 (D.C. Cir. 1997) (contrasting the Mine Act at 30 U.S.C. 811(a) with the OSH Act at 29 U.S.C. 652 and noting that ''[a]rguably, *this* language does not mandate the same risk-finding requirement as OSHA'' and holding that ''[a]t most, . . . [MSHA] was required to identify a significant risk associated with having no oxygen standard at all'').

Section 103(h) of the Mine Act gives the Secretary the authority to promulgate standards involving recordkeeping and reporting. 30 U.S.C. 813(h). Additionally, section 103(h) requires that every mine operator establish and maintain records, make reports, and provide this information as required by the Secretary. *Id.* Section 508 of the Mine Act gives the Secretary the authority to issue regulations to carry out any provision of the Mine Act. 30 U.S.C. 957.

MSHA's final rule to lower the exposure limits for respirable crystalline silica adopts an integrated monitoring approach across all mining sectors and updates the existing respiratory protection requirements. The final rule fulfills Congress' direction to protect miners from material impairments of health or functional capacity caused by exposure to respirable crystalline silica and other airborne contaminants.

III. Regulatory History

On August 29, 2019, MSHA published a Request for Information (RFI) in the **Federal Register** to solicit information and data on a variety of topics concerning silica (quartz) in respirable dust (84 FR 45452). In the RFI, MSHA requested data and information on technologically and economically feasible best practices to protect MNM and coal miners' health from exposure to quartz, including a lowered permissible exposure limit (PEL), new or developing protective technologies, and/or effective technical and educational assistance (84 FR 45456).

Specifically, MSHA requested input from industry, labor, and other interested parties on the following four topics: (1) new or developing technologies and best practices that can be used to protect miners from exposure to quartz dust; (2) how engineering controls, administrative controls, and personal protective equipment can be used, either alone or concurrently, to protect miners from exposure to quartz dust; (3) additional feasible dust-control methods that could be used by mining operations to reduce miners' exposures to respirable quartz during high-silica cutting situations, such as on development sections, shaft and slope work, and cutting overcasts; and (4) any other experience, data, or information that may be useful to MSHA in evaluating miners' exposures to quartz (84 FR 45456).

The Agency received 57 comments from citizens, labor, industry, and public health stakeholders in response to the RFI. Stakeholders expressed various and differing opinions on how and to what extent MSHA should address the protection of miners' health from exposure to silica. Many of these stakeholders also commented on MSHA's proposed rulemaking, summarized below.

On June 30, 2023, MSHA made an informal copy of the proposed rule available on the Agency's website, prior to publication in the **Federal Register**, so the public and stakeholders could review it in advance of the comment period.

On July 13, 2023, MSHA published the proposed rule, *Lowering Miners' Exposure to Respirable Crystalline Silica and Improving Respiratory Protection,* in the **Federal Register** (88 FR 44852). The standalone documents ''*Health Effects of Respirable Crystalline Silica,*'' ''*Preliminary Risk Analysis,*'' and ''*Preliminary Regulatory Impact Analysis*'' were also made publicly available at that time. MSHA proposed to set the PEL of respirable crystalline silica at 50 micrograms[1] per cubic meter of air (μg/m^3) for a full-shift exposure, calculated as an 8-hour time-weighted average. MSHA's proposal included other requirements for sampling, qualitative evaluations, corrective actions, and medical surveillance for MNM mines. Finally, the proposal included requirements for respiratory protection, including the incorporation by reference of *ASTM F3387–19 Standard Practice for Respiratory Protection.*

On July 26, 2023, MSHA published a notice in the **Federal Register** scheduling three public hearings on the proposed rule (88 FR 48146). Hearings were held on: (1) August 3, 2023, in Arlington, Virginia; (2) August 10, 2023, in Beckley, West Virginia; and (3) August 21, 2023, in Denver, Colorado. Speakers and attendees could participate in-person or online. There were 14 speakers and over 150 attendees at the Arlington hearing; 24 speakers and over 200 attendees at the Beckley hearing; and 10 speakers and over 175 attendees at the Denver hearing. Speakers included active and retired miners and representatives from the mining industry, unions, the health care profession, advocacy groups, industry groups, trade associations, and law firms. Transcripts from the public hearings are available at *www.regulations.gov* and on the MSHA website.

On August 14, 2023, in response to requests from the public, MSHA published a notice in the **Federal Register** extending the comment period by changing the closing date from August 28, 2023, to September 11, 2023 (88 FR 54961).

During the comment period, MSHA received 157 written comments on the proposed rule from miners, mine operators, individuals, government officials, labor organizations, advocacy groups, industry groups, trade associations, and health organizations. Some commenters supported various aspects of the proposal. Other commenters opposed aspects of the proposal and offered recommendations for suggested changes to the proposed rule. All public comments and supporting documentation are available at *www.regulations.gov* and on the MSHA website. MSHA carefully reviewed and considered the written comments on the proposed rule and the speakers' testimonies from the hearings and addresses them in the relevant sections below.

IV. Background

A. Respirable Crystalline Silica Hazard and Mining

Silica is a common component of rock composed of silicon and oxygen (chemical formula SiO_2), existing in amorphous and crystalline states. Silica in the crystalline state is the focus of this rulemaking. Respirable crystalline silica consists of small particles of crystalline silica that can be inhaled and reach the alveolar region of the lungs, where they can accumulate and cause disease. In crystalline silica, the silicon and oxygen atoms are arranged in a three-dimensional repeating pattern. The crystallization pattern varies depending on the circumstances of crystallization, resulting in a polymorphic state, meaning several different structures with the same chemical composition. The most common form of crystalline silica found in nature is quartz, but cristobalite and tridymite also occur in limited circumstances. Quartz accounts for the overwhelming majority of naturally occurring crystalline silica. In fact, quartz accounts for almost 12 percent of the earth's crust by volume. All soils contain at least trace amounts of quartz, and it is present in varying amounts in almost every type of mineral. Quartz is also abundant in most rock types, including granites, sandstones, and shale. Moreover, quartz bands and veins are commonly found in limestone formations, although limestone itself does not contain quartz. Because of its abundance, crystalline silica in the form of quartz is present in nearly all mining operations.

Cristobalite and tridymite are formed at very high temperatures and are associated with volcanic activity. Naturally occurring cristobalite and tridymite are rare, but they can be found in volcanic ash and in a relatively small number of rock types limited to specific geographic regions. Although rare, exposure to cristobalite can occur when volcanic deposits are mined. In addition, when other materials are mined, miners can potentially be exposed to cristobalite during certain processing steps (*e.g.,* heating silica-containing materials) and contact with refractory materials (*e.g.,* replacing fire bricks in mine processing facility furnaces). Tridymite is rarely found in nature and miner exposure to tridymite is much more infrequent.

Most mining activities generate silica dust because silica is often contained in the ore being mined or in the overburden (*i.e.,* the soil and surface material surrounding the commodity being mined). Such activities include, but are not limited to, cutting, sanding, drilling, crushing, grinding, sawing, scraping, jackhammering, excavating, and hauling materials that contain silica. These activities can generate respirable crystalline silica and therefore may lead to miner exposure.

Inhaled small particles of silica dust can be deposited throughout the lungs. Because of their small size, many of these particles can reach and remain in the deep lung (*i.e.,* alveolar region), although some can be cleared from the lungs. Because respirable crystalline silica particles are not water-soluble and do not undergo metabolism into less toxic compounds, those particles remaining in the lungs result in a variety of cellular responses that may lead to pulmonary diseases, such as silicosis and lung cancer. The respirable crystalline silica particles that are cleared from the lungs can be distributed to lymph nodes, blood, liver, spleen, and kidneys, potentially accumulating in those other organ systems and causing renal disease and other adverse health effects.

In the U.S. in 2021, a total of 12,162 mines produced a variety of commodities. As shown in Table IV–1, of those 12,162 total mines, 11,231 mines were MNM mines and 931 mines were coal mines. MNM mines can be broadly divided into five commodity groups: metal, nonmetal, stone, crushed limestone, and sand and gravel. These broad categories encompass approximately 98 different commodities.[2] Table IV–1 shows that a majority of MNM mines produce sand and gravel, while the largest number of MNM miners work at metal mines, not including MNM contract workers (*i.e.,*

[1] One microgram is equal to one-thousandth of a milligram (1 milligram = 1000 micrograms).

[2] Commodities such as sand, gravel, silica, and/or stone are used in road building, concrete construction, the manufacture of glass and ceramics, molds for metal castings in foundries, abrasive blasting operations, plastics, rubber, paint, soaps, scouring cleansers, filters, hydraulic fracturing, and various architectural applications. Some commodities naturally contain high levels of crystalline silica, such as high-quartz industrial and construction sands and granite dimension stone and gravel (both produced for the construction industry).

independent contractors and employees of independent contractors who are engaged in mining operations).

of independent contractors who are engaged in mining operations).

Table IV-1: Number of Mines and Miners by Commodity in 2021

	Number of Mines	**Number of Miners**
MNM Mines		
Metal	264	35,864
Nonmetal	549	15,736
Stone	2,320	33,031
Crushed Limestone	1,866	23,691
Sand and Gravel	6,232	33,296
MNM Contract Workers[1]	–	57,426
MNM Subtotal	11,231	199,044
Coal Mines		
Underground	211	21,108
Surface	720	17,571
Coal Contract Workers[1]	–	16,151
Coal Subtotal	931	54,830
Grand Total	**12,162**	**253,874**

1. The number of MNM and coal contract workers is presented in aggregate because commodity data for contract workers is unavailable.

Source: MSHA MSIS Data (reported on MSHA Form 7000-2).

The 931 coal mines—underground and surface—produce bituminous, subbituminous, anthracite, and lignite coal. Coal mining activities generate mixed coal mine dust that contains respirable silicates such as kaolinite, oxides such as quartz, and other components (IARC, 1997). These activities include the general mining activities previously mentioned (*e.g.,* cutting, sanding, drilling, crushing, hauling, etc.), as well as roof bolter operations, continuous mining machine operations, longwall mining, and other activities. Table IV–1 shows that there are more surface coal mines than underground coal mines, but more miners are working in underground coal mines than surface coal mines (not including coal contract workers).

B. Existing Standards

Since the early 1970s, MSHA has maintained health standards to protect MNM and coal miners from excessive exposure to airborne contaminants, including respirable crystalline silica. These standards require mine operators to use engineering controls as the primary means of suppressing, diluting, or diverting dust generated by mining activities. They also require mine operators to provide miners with respiratory protection in limited situations for a short period. The existing standards for MNM and coal mines differ in some respects, including exposure limits and monitoring requirements. This section describes MSHA's existing standards for respirable crystalline silica and presents respirable crystalline silica sampling data to show how MNM and coal mine operators have complied with the standards in recent years.

1. Existing Standards—Metal and Nonmetal Mines

MSHA's existing standards for exposure to airborne contaminants in MNM mines, including respirable crystalline silica, are found in 30 CFR 56 subpart D (Air Quality and Physical Agents) and 30 CFR 57 subpart D (Air Quality, Radiation, Physical Agents, and Diesel Particulate Matter). These standards include PELs for airborne contaminants (§§ 56.5001 and 57.5001), exposure monitoring (§§ 56.5002 and 57.5002), and control of exposure to airborne contaminants (§§ 56.5005 and 57.5005).

Permissible Exposure Limits. The existing PELs for the three polymorphs of respirable crystalline silica are based on the *TLVs® Threshold Limit Values for Chemical Substances in Workroom Air Adopted by the American Conference of Governmental Industrial Hygienists (ACGIH) for 1973,* incorporated by reference in 30 CFR 56.5001 and 57.5001 (ACGIH, 1974). The 1973 TLV® establishes limits for respirable dust containing 1 percent quartz or greater and is calculated in milligrams per cubic meter of air (mg/m³) for each respirable dust sample. The resulting TLVs® for respirable dust containing 1 percent respirable crystalline silica or greater are designed to limit exposures to less than 0.1 mg/m³ or 100 micrograms per cubic meter of air (μg/m³) for quartz, to less than 0.05 mg/m³ or 50 μg/m³ for cristobalite, and to less than 0.05 mg/m³ or 50 μg/m³ for tridymite. Throughout the remainder of this preamble, the concentrations of respirable dust and respirable crystalline silica are expressed in μg/m³.

Exposure Monitoring. Under 30 CFR 56.5002 and 57.5002, MNM mine operators must conduct respirable dust "surveys . . . as frequently as necessary to determine the adequacy of control measures." Mine operators can satisfy the survey requirement through various activities, such as respirable dust sampling and analysis, walk-through inspections, wipe sampling, examination of dust control system and ventilation system maintenance, and review of information obtained from injury, illness, and accident reports.

MSHA encourages MNM mine operators to conduct sampling for airborne contaminants to ensure a healthy and safe work environment for miners, because sampling provides more accurate information about miners' exposures and the effectiveness of existing controls in reducing exposures. When a mine operator's respirable dust survey indicates that miners have been overexposed to any airborne contaminant, including respirable crystalline silica, the operator is expected to adjust its control measures (*e.g.,* exhaust ventilation) to reduce or eliminate the identified hazard. After doing so, the mine operator is expected to conduct additional surveys to determine whether its adjustments to control measures were successful. Re-surveying should be done as frequently as necessary to ensure that the sampling results comply with the PEL and the implemented control measures remain adequate.

Exposure Controls. MSHA's existing standards for controlling a miner's exposure to harmful airborne contaminants in §§ 56.5005 and 57.5005 require, if feasible, prevention of contamination, removal by exhaust ventilation, or dilution with uncontaminated air. These requirements to use feasible engineering controls, supplemented by administrative controls, are consistent with widely accepted industrial hygiene principles and NIOSH's recommendations (NIOSH, 1974). Engineering controls designed to remove or reduce the hazard at the source are the most effective. Although administrative controls are considered a supplementary or secondary measure to engineering controls, mine operators may use administrative controls to further reduce miners' exposures to respirable crystalline silica and other airborne contaminants.

The use of respiratory protective equipment is also allowed under specified circumstances, such as where engineering controls are not yet developed or when it is necessary due to the nature of the work—for example, while establishing controls or during occasional entry into hazardous atmospheres to perform maintenance or investigation. Respirators approved by NIOSH and suitable for their intended purpose must be provided by mine operators at no cost to the miner and must be used by miners to protect themselves against the health and safety hazards of respirable crystalline silica and other airborne contaminants. When respiratory protective equipment is used, MNM mine operators must implement a respiratory protection program consistent with the requirements of *American National Standards Practices for Respiratory Protection ANSI Z88.2–1969* (ANSI Z88.2–1969).

2. Existing Standards—Coal Mines

Under the existing coal mine standards, there is no separate standard for respirable crystalline silica. MSHA's existing standards for exposure to respirable quartz in coal mines, found in 30 CFR 70.101 and 71.101, establish a respirable dust standard when quartz is present for underground and surface coal mines, respectively. Under 30 CFR part 90 (Mandatory Health Standards—Coal Miners Who Have Evidence of the Development of Pneumoconiosis), § 90.101 also sets the respirable dust standard when quartz is present for Part 90 miners.[3] Coal miners' exposures to respirable quartz are indirectly regulated through reductions in the overall respirable dust standards.

Under its existing respirable coal mine dust standards, MSHA defines quartz as crystalline silicon dioxide (SiO_2), which includes not only quartz but also two other polymorphs, cristobalite and tridymite.[4] Therefore, the terms quartz and respirable crystalline silica are used interchangeably in the discussions of MSHA's existing standards for controlling exposures to respirable crystalline silica in coal mines.

Exposure Limits. The exposure limit for respirable crystalline silica during a coal miner's shift is 100 μg/m³, reported as an equivalent concentration as measured by the Mining Research Establishment (MRE) instrument.[5] The equivalent concentration of respirable crystalline silica must not be exceeded during the miner's entire shift, regardless of duration. When the equivalent concentration of respirable quartz exceeds 100 μg/m³, under §§ 70.101, 71.101, and 90.101, MSHA imposes a reduced respirable dust standard designed to ensure that respirable quartz will not exceed 100 μg/m³. Various sections within a mine may have different reduced respirable coal mine dust (RCMD) exposure limits. Therefore, when a respirable dust sample collected by MSHA indicates that the average concentration of respirable quartz dust exceeds the exposure limit, the mine operator is required to comply with the applicable dust standard. Because respirable crystalline silica is a percentage of RCMD, by reducing the amount of respirable dust to which miners are exposed during their shifts, the miners' exposures to respirable crystalline silica are reduced to a level at or below the exposure limit of 100 μg/m³.

Exposure Monitoring. Under §§ 70.208, 70.209, 71.206, and 90.207, coal mine operators are required to sample for respirable dust on a quarterly basis for specified occupations and work areas. The occupations and work areas specified in the existing coal dust standards are the occupations and work areas at a coal mine that are expected to have the highest concentrations of respirable dust—typically in locations where respirable dust is generated. Respirable dust sampling must be representative of respirable dust exposures during a normal production shift and must occur while miners are performing routine, day-to-day activities. Part 90 miners must be sampled for the air they breathe while performing their normal work duties, in their normal work locations, from the start of their work day to the end of their work day.

Exposure Controls. Under §§ 70.208, 70.209, 71.206, and 90.207, coal mine operators are required to use engineering or environmental controls as the primary means of complying with the respirable dust standards. For many underground coal mines, providing adequate ventilation is the primary engineering control for respirable dust, ensuring that dust concentrations are continuously diluted with fresh air and exhausted away from miners.

When a respirable dust sample exceeds the exposure limit of 100 μg/m³ for respirable quartz, the operator must reduce the average concentration of RCMD to a level designed to maintain the quartz level at or below 100 μg/m³. If operators exceed the RCMD standard, they are required to take corrective

[3] A "Part 90 miner" is defined in 30 CFR 90.3 as a miner employed at a coal mine who shows evidence of having contracted pneumoconiosis based on a chest X-ray or based on other medical examinations, and who is afforded the option to work in an area of a mine where the average concentration of respirable dust in the mine atmosphere during each shift to which that miner is exposed is continuously maintained at or below the applicable standard.

[4] Quartz is defined in 30 CFR 70.2, 71.2, and 90.2 as crystalline silicon dioxide (SiO_2) not chemically combined with other substances and having a distinctive physical structure. Crystalline silicon dioxide is most commonly found in nature as quartz but sometimes occurs as cristobalite or, rarely, as tridymite. Quartz accounts for the overwhelming majority of naturally occurring crystalline silica and is present in varying amounts in almost every type of mineral.

[5] As defined in 30 CFR 70.2, an MRE instrument is a gravimetric dust sampler with a four channel horizontal elutriator developed by the Mining Research Establishment of the National Coal Board, London, England. MSHA inspectors use Dorr-Oliver 10-mm nylon cyclones operated at a 2.0 L/min flow rate (reported as MRE-equivalent concentrations) for coal mine sampling.

action to reduce exposure and comply with the reduced standard. Corrective actions that lower respirable coal mine dust, thus lowering respirable quartz exposures, are selected after evaluating the cause or causes of the overexposure.

When taking corrective actions to reduce the exposure to respirable dust, coal mine operators must make approved respiratory equipment available to miners under §§ 70.208, 70.209, and 71.206. Whenever respiratory protection is used, § 72.700 requires coal mine operators to comply with requirements specified in ANSI Z88.2–1969.

C. MSHA Inspection and Respirable Dust Sampling

Under the existing standards, MSHA collects respirable dust samples at mines and analyzes them for respirable crystalline silica to determine whether the respirable crystalline silica exposure limits are exceeded and whether exposure controls are adequate. MSHA's inspection and respirable dust sampling were discussed in detail in the proposal (88 FR 44862). This section, for ease of reference, briefly summarizes the process for MSHA's inspection and respirable dust sampling.

1. Respirable Dust Sample Collection

Under the existing standards, MSHA inspectors arrive at mines, determine which miners and which areas of the mine to select for respirable dust sampling, and place gravimetric samplers on the selected miners and at the selected locations. The gravimetric samplers capture air from the breathing zone of each selected miner and from each selected work area for the entire duration of the work shift. Full-shift sampling is used to minimize errors associated with fluctuations in airborne contaminant concentrations during the miners' work shifts and to avoid any speculation about the miners' exposures during unsampled periods of the work shift. Once sampling is completed, MSHA inspectors send cassettes containing the full-shift respirable dust samples to the MSHA Laboratory for analysis.

2. Respirable Dust Sample Analysis

The MSHA Laboratory analyzes respirable dust samples following the standard operating procedures summarized below.[6] Any samples that are broken, torn, or visibly wet are voided and removed before analysis. Samples are weighed and then examined for validity based on mass gain. All valid samples that meet the minimum mass gain criteria per the associated MSHA analytical method are then analyzed for respirable crystalline silica and for the compliance determination.[7]

The MSHA Laboratory uses two analytical methods to determine the concentration of quartz (and cristobalite and tridymite, if requested) in respirable dust samples: X-ray diffraction (XRD) for samples from MNM mines and Fourier transform infrared spectroscopy (FTIR) for samples from coal mines.[8] The percentage of silica in the MNM mine dust sample is calculated using the mass of quartz or cristobalite determined from the XRD analysis and the measured mass of respirable dust. Similarly, in the respirable coal mine dust sample, the percentage of quartz is calculated using the quartz mass determined from the FTIR analysis and the sample's mass of dust. Current FTIR methods, however, cannot quantify quartz and cristobalite, and/or tridymite, in the same sample.

MSHA calculates full-shift exposures to respirable crystalline silica (and other airborne contaminants) in the same way for MNM and coal miners when the miner works an 8-hour shift, but the calculated exposures differ for longer shifts. For work shifts that last longer than 8 hours, a coal miner's full-shift exposure is calculated using the entire duration of the coal miner's shift. For the MNM miner, by contrast, MSHA calculates extended full-shift exposure for respirable dust samples using 480 minutes (8 hours) as the sampling time, meaning that contaminants collected over extended shifts (*e.g.,* 600–720 minutes) are calculated as if they had been collected over 480 minutes.

D. Respirable Crystalline Silica Sampling Results—Metal and Nonmetal Mines

MSHA's respirable crystalline silica sampling results for MNM mines were discussed in detail in the proposal (88 FR 44863). This section, for ease of reference, summarizes the results of respirable dust samples that were collected by MSHA inspectors at MNM mines from 2005 to 2019. From January 1, 2005, to December 31, 2019, a total of 104,354 valid samples were collected. Of this total, 57,769 samples met the minimum mass gain criteria and were analyzed for respirable crystalline silica. The vast majority of the 46,585 valid samples that were excluded from the analysis did not meet the mass gain criteria. Further information on the valid respirable dust samples that were excluded from the analysis can be found in Appendix A of the preamble.

1. Annual Results of MNM Respirable Crystalline Silica Samples

Table IV–2 below shows the variation between 2005 and 2019 in: (1) the number of MNM respirable dust samples analyzed for respirable crystalline silica; and (2) the number and percentage of samples that had concentrations of respirable crystalline silica greater than 100 μg/m³. Of the 57,769 MNM respirable dust samples analyzed for respirable crystalline silica over the 15-year period, about 6 percent (3,539 samples) had respirable crystalline silica concentrations exceeding the existing PEL of 100 μg/m³. The average annual rates of overexposure ranged from a maximum of approximately 10 percent in 2006 (the second year) to a minimum of approximately 4 percent in 2019 (the last year of the time series). Compared with the rates in 2005–2008, overexposure rates were substantially lower in 2009–2017, with a further drop in 2018–19.

BILLING CODE 4520–43–P

[6] The MSHA Laboratory has fulfilled the requirements of the AIHA Laboratory Accreditation Programs (AIHA–LAP), LLC accreditation to the ISO/IEC 17025:2017 international standard for industrial hygiene.

[7] The minimum mass gain criteria used by the MSHA Laboratory for the different samples are:

- MNM mine respirable dust samples: greater than or equal to 0.100 mg;
- Underground coal mine respirable dust samples: greater than or equal to 0.100 mg; and
- Surface coal mine respirable dust samples: greater than or equal to 0.200 mg.

Exception: For six surface occupations that have been deemed ''high risk,'' the laboratory uses a minimum mass gain criterion of greater than or equal to 0.100 mg.

If cristobalite analysis is requested for MNM mine respirable dust samples, filters having a mass gain of 0.05 mg or more are analyzed. In the rare instance when tridymite analysis is requested, a qualitative analysis for the presence of the polymorph is conducted concurrently with the cristobalite analysis.

[8] Details on MSHA's analytical procedures for respirable crystalline silica analysis can be found in ''MSHA P–2: X-Ray Diffraction Determination of Quartz and Cristobalite in Respirable Metal/Nonmetal Mine Dust'' and ''MSHA P–7: Determination of Quartz in Respirable Coal Mine Dust by Fourier Transform Infrared Spectroscopy.'' Department of Labor, Mine Safety and Health Administration, Pittsburgh Safety and Health Technology Center, X-Ray Diffraction Determination of Quartz and Cristobalite in Respirable Metal/Nonmetal Mine Dust. *https://arlweb.msha.gov/Techsupp/pshtcweb/MSHA%20P2.pdf* (last accessed Jan. 10, 2024). Department of Labor, Mine Safety and Health Administration, Pittsburgh Safety and Health Technology Center, MSHA P–7: Determination of Quartz in Respirable Coal Mine Dust By Fourier Transform Infrared Spectroscopy. *https://arlweb.msha.gov/Techsupp/pshtcweb/MSHA%20P7.pdf* (last accessed Jan. 10, 2024).

Table IV-2: MNM Respirable Dust Samples, 2005–2019

Year	Number of Samples	Number of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³	Percent of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³
2005	6,982	503	7.2%
2006	3,385	338	10.0%
2007	3,879	297	7.7%
2008	2,806	269	9.6%
2009	5,937	320	5.4%
2010	4,992	259	5.2%
2011	3,938	234	5.9%
2012	3,422	205	6.0%
2013	3,150	140	4.4%
2014	3,067	153	5.0%
2015	3,015	169	5.6%
2016	2,958	150	5.1%
2017	3,526	205	5.8%
2018	3,227	152	4.7%
2019	3,485	145	4.2%
Total	**57,769**	**3,539**	**6.1%**

Source: MSHA MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220812).

BILLING CODE 4520–43–C

2. Analysis of MNM Respirable Crystalline Silica Samples by Commodity

Because the MNM mining industry produces commodities that contain varying degrees of respirable crystalline silica, it is important to examine each commodity separately. MNM mines can be grouped by five commodities: metal, sand and gravel, stone, crushed limestone, and nonmetal (where nonmetal includes all other materials that are not metals, besides sand, gravel, stone, and limestone). This grouping is based on the mine operator-reported mining products and the North American Industry Classification System (NAICS) codes. (Appendix B of the preamble provides a list of the NAICS codes relevant for MNM mining and how each code is assigned to one of the five commodities.)

Table IV–3 shows the distribution of the respirable dust samples analyzed for respirable crystalline silica by mine commodity. The percentage of samples with respirable crystalline silica concentrations greater than the existing exposure limit of 100 μg/m³ varies across the different commodities. It is highest for the metal, sand and gravel, and stone commodities (at approximately 11, 7, and 7 percent, respectively), and lowest for the nonmetal and crushed limestone commodities (at approximately 4 and 3 percent, respectively).

Table IV-3: MNM Respirable Dust Samples by Commodity, 2005-2019

Commodity	Number of Samples	Number of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³	Percent of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³
Metal Mines	3,499	376	10.8%
Nonmetal Mines	5,165	232	4.5%
Stone Mines	15,415	1,134	7.4%
Crushed Limestone Mines	15,184	434	2.9%
Sand and Gravel Mines	18,506	1,363	7.4%
Total	**57,769**	**3,569**	**6.1%**

Source: MSHA MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220812).

3. Analysis of MNM Respirable Crystalline Silica Samples by Occupation

To examine how miners who perform different tasks differ in occupational exposure to respirable crystalline silica, MSHA grouped MNM mining jobs into 11 occupational categories. These categories include jobs that are similar in terms of tasks performed, equipment used, and engineering or administrative controls used to control miners' exposure. For example, backhoe operators, bulldozer operators, and tractor operators were grouped into ''operators of large powered haulage equipment,'' whereas belt crew, belt cleaners, and belt vulcanizers were grouped into ''conveyer operators.'' The 121 MNM job codes used by MSHA inspectors were grouped into the following occupational categories: [9]

(1) Drillers (*e.g.,* Diamond Drill Operator, Wagon Drill Operator, and Drill Helper),

(2) Stone Cutting Operators (*e.g.,* Jackhammer Operator, Cutting Machine Operator, and Cutting Machine Helper),

(3) Kiln, Mill, and Concentrator Workers (*e.g.,* Ball Mill Operator, Leaching Operator, and Pelletizer Operator),

(4) Crushing Equipment and Plant Operators (*e.g.,* Crusher Operator/Worker, Scalper Screen Operator, and Dry Screen Plant Operator),

(5) Packaging Equipment Operators (*e.g.,* Bagging Operator and Packaging Operations Worker),

(6) Conveyor Operators (*e.g.,* Belt Cleaner, Belt Crew, and Belt Vulcanizer),

(7) Truck Loading Station Tenders (*e.g.,* Dump Operator and Truck Loader),

(8) Operators of Large Powered Haulage Equipment (*e.g.,* Tractor Operators, Bulldozer Operator, and Backhoe Operators),

(9) Operators of Small Powered Haulage Equipment (*e.g.,* Bobcat Operator, Scoop-Tram Operator, and Forklift Operator),

(10) Mobile Workers (*e.g.,* Laborers, Electricians, Mechanics, and Supervisors), and

(11) Miners in Other Occupations (*e.g.,* Welder, Dragline Operator, Ventilation Crew and Dredge/Barge Operator).

Table IV–4 shows sample numbers and overexposure rates by MNM occupation. Operators of large powered haulage equipment accounted for the largest number of samples analyzed for silica (17,016 samples), whereas conveyor operators accounted for the fewest (215 samples). Table IV–4 also shows the number and percentage of the samples exceeding the existing respirable crystalline silica PEL of 100 μg/m³. In every occupational category, some MNM miners were exposed to respirable crystalline silica levels above the existing PEL. In 9 out of the 11 occupational categories, the percentage of samples exceeding the existing PEL is less than 10 percent, although two have higher rates, ranging up to more than 19 percent (in the case of stone cutting operators).

BILLING CODE 4520–43–P

[9] For a full crosswalk of job codes included in each of these 11 Occupational Categories, please see Appendix C of the preamble. Also, note that the order of the presentation of the 11 Occupational Categories here follows the general sequence of mining activities: first development and production, then ore/mineral processing, then loading, hauling, and dumping, and finally all others.

Table IV-4: MNM Respirable Dust Samples by Occupation, 2005-2019

Occupation	Number of Samples	Number of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³	Percent of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³
Drillers	2,092	107	5.1%
Stone Cutting Operators	2,446	474	19.4%
Kiln, Mill, and Concentrator Workers	1,802	125	6.9%
Crushing Equipment Operators and Plant Operators	11,565	816	7.1%
Packing Equipment Operators	2,980	278	9.3%
Conveyor Operators	215	24	11.2%
Truck Loading Station Tenders	453	32	7.1%
Operators of Large Powered Haulage Equipment	17,016	378	2.2%
Operators of Small Powered Haulage Equipment	1,110	77	6.9%
Mobile Workers	15,216	1,108	7.3%
Miners in Other Occupations	2,874	120	4.2%
Total	**57,769**	**3,539**	**6.1%**

Source: MSHA MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220812).

BILLING CODE 4520–43–C

4. Conclusion

This analysis of MSHA inspector sampling data shows that MNM operators have generally met the existing standard. Of the 57,769 respirable dust samples from MNM mines, approximately 6 percent exceeded the existing respirable crystalline silica PEL of 100 μg/m³, although there are several outliers with much higher overexposures. For 9 of the 11 occupational categories, less than 10 percent of the respirable dust samples had concentrations over the existing PEL of 100 μg/m³ for respirable crystalline silica. While stone-cutting operators have historically had high exposures to respirable dust and respirable crystalline silica[10] and continue to experience the highest overexposures of any MNM occupation, about 80 percent of samples taken from stone cutting operators did not exceed the existing PEL. For the categories of drillers, miners in other occupations, and operators of large powered haulage equipment, approximately 5 percent or less of the respirable dust samples showed concentrations over the existing exposure limit.

In summary, the analysis of MSHA inspector sampling data indicates that the controls that MNM mine operators are using, together with MSHA's enforcement, have generally been effective in keeping miners' exposures at or below the existing limit of 100 μg/m³.

E. Respirable Crystalline Silica Sampling Results—Coal Mines

MSHA's respirable crystalline silica sampling results for coal mines were discussed in detail in the proposal (88 FR 44866). This section, for ease of reference, summarizes the results of RCMD samples collected by MSHA inspectors from 2016 to 2021. (The data analyses for this rulemaking do not include any respirable dust samples collected by coal mine operators.) The analysis below is based on the samples collected by MSHA inspectors starting on August 1, 2016, when Phase III of MSHA's 2014 *Lowering Miners' Exposure to Respirable Coal Mine Dust, Including Continuous Personal Dust Monitors* (referred to throughout the preamble as the 2014 RCMD Standard) (79 FR 24813) went into effect. At that time, the exposure limits for RCMD were lowered from 2.0 mg/m³ to 1.5 mg/m³ (MRE equivalent) at underground and surface coal mines, and from 1.0 mg/m³ to 0.5 mg/m³ (MRE equivalent) for intake air at underground coal mines and for Part 90 miners. From August 1, 2016, to July 31, 2021, MSHA inspectors collected a total of 113,607 valid RCMD samples. Of the valid samples, only those collected from the breathing zones of miners were used in the analysis for this rulemaking; no environmental dust

[10] Analysis of MSHA respirable dust samples from 2005 to 2010 showed that stone and rock saw operators had approximately 20 percent of the sampled exposures exceeding the PEL. Watts *et al.* (2012).

samples were included.[11] Of the valid breathing zone samples, there were 63,127 samples that met the minimum mass gain criteria and were analyzed for respirable quartz. The majority of the non-environmental valid samples excluded from this rulemaking analysis were excluded due to insufficient mass. Further information on the valid respirable dust samples that are not included in the rulemaking analysis can be found in Appendix A of the preamble.

Of the 63,127 valid samples analyzed for respirable crystalline silica and used for this analysis, about 1 percent (777 samples) were over the existing quartz exposure limit of 100 μg/m³ (MRE equivalent) for a full shift, calculated as a TWA.[12] Overexposure rates decreased by nearly a quarter between the first half and the second half of the 2016–2021 period. As in MNM mines, different miner occupations had different overexposure rates. Using broader groupings, surface mines experienced higher rates of overexposure than underground mines (2.4 percent versus 1.0 percent, respectively).

1. Annual Results of Coal Respirable Crystalline Silica Samples

In examining trends from one year to the next, the discussion below focuses on the samples collected in the 6 calendar years from 2016 to 2021. The number of samples per year was stable from 2017 to 2019 before decreasing in 2020.[13] The overexposure rate decreased across the entire 2016 to 2021 period, from 1.41 percent in 2016 to 0.95 percent in 2021. As shown in Table IV–5, a review of the 6 calendar years reveals that the overexposure rate decreased by nearly a quarter from 2016–2018 (1.38 percent) to 2019–2021 (1.07 percent).

Table IV-5: Respirable Coal Mine Dust Samples, 2016–2021

Year	Number of Samples	Number of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³ MRE	Percent of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³ MRE
2016[1]	4,879	69	1.4%
2017	13,787	190	1.4%
2018	14,054	194	1.4%
2019	13,745	153	1.1%
2020	10,267	110	1.1%
2021[1]	6,395	61	1.0%
Total	**63,127**	**777**	**1.2%**

1. The 2016 data represents respirable crystalline silica samples from August 1 to December 31, 2016, and the 2021 data represents respirable crystalline silica samples from January 1 to July 31, 2021.

Source: MSHA MSIS respirable crystalline silica data for the Coal Industry, August 1, 2016, through July 31, 2021 (version 20220617).

2. Analysis of Coal Respirable Crystalline Silica Samples by Location

Coal mining activities differ depending on the characteristics and locations of coal seams. When coal seams are several hundred feet below the surface, miners tunnel into the earth and use underground mining equipment to extract coal, whereas miners at surface coal mines remove topsoil and layers of rock to expose coal seams. Due to these differences, it is important to examine the respirable crystalline silica data by location to determine how underground and surface coal miners differ in occupational exposure to respirable crystalline silica.

Table IV–6, which presents the overexposure rate by type of mine where respirable coal mine dust samples were collected, shows that samples from surface coal mines reflected higher rates of overexposure than samples from underground mines. Out of the 53,095 respirable coal mine dust samples from underground mines, 1 percent (537 samples) were over the existing exposure limit. By contrast, there were 10,032 samples from surface coal mines, and approximately 2.4 percent (240 samples) of those samples were over the existing exposure limit.

[11] Environmental samples were not included in the analysis to be consistent with the proposed sampling requirements to determine individual miner exposure.

[12] The conversion between ISO values and MRE values uses the NIOSH conversion factor of 0.857. In the 1995b Criteria Document, NIOSH presented an empirically derived conversion factor of 0.857 for comparing current (MRE) and recommended (ISO) respirable dust sampling criteria using the 10 mm Dorr-Oliver nylon cyclone operated at 2.0 and 1.7 L/min, respectively (*i.e.,* 1.5 mg/m³ BMRC–MRE = 1.29 mg/m³ ISO).

[13] The coal samples for 2016 begin in August of that year and the coal samples for 2021 end in July of that year.

Table IV-6: Respirable Coal Mine Dust Samples by Location, 2016 - 2021

Location	Number of Samples	Number of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³ MRE	Percent of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³ MRE
Underground Mines	53,095	537	1.0%
Surface Mines	10,032	240	2.4%
Total	**63,127**	**777**	**1.2%**

Source: MSHA MSIS respirable crystalline silica data for the Coal Industry, August 1, 2016, through July 31, 2021 (version 20220617).

3. Analysis of Coal Respirable Crystalline Silica Samples by Occupation

To assess the exposure to respirable crystalline silica of miners in different occupations, MSHA has consolidated the 220 job codes for coal mines into 9 occupational categories (using a similar process to the one it used for the MNM mines, but with different job codes and categories). For the coal mine occupational categories,[14] a distinction is made between occupations based on whether the job tasks are being performed at the surface of a mine or underground. For example, bulldozer operators are assigned to the job category of operators of large powered haulage equipment grouping and then sorted into separate occupational categories based on whether they are working at the surface of a mine or underground.

Of the nine occupational categories used for coal miners, the five underground categories are:

(1) Continuous Mining Machine Operators (*e.g.,* Coal Drill Helper and Coal Drill Operator),

(2) Longwall Workers (*e.g.,* Headgate Operator and Jack Setter (Longwall)),

(3) Roof Bolters (*e.g.,* Roof Bolter and Roof Bolter Helper),

(4) Operators of Large Powered Haulage Equipment (*e.g.,* Shuttle Car Operator, Tractor Operator/Motorman, Scoop Car Operator), and

(5) All Other Underground Miners (*e.g.,* Electrician, Mechanic, Belt Cleaner and Laborer, etc.).

The four surface occupational categories are:

(1) Drillers (*e.g.,* Coal Drill Operator, Coal Drill Helper, and Auger Operator),

(2) Crusher Operators (*e.g.,* Crusher Attendant, Washer Operator, and Scalper-Screen Operator),

(3) Operators of Large Powered Haulage Equipment (*e.g.,* Backhoe Operator, Forklift Operator, and Bulldozer Operator), and

(4) Mobile Workers (*e.g.,* Electrician, Mechanic, Blaster, Laborer, etc.).

The most sampled occupational category was operators of large powered haulage equipment (underground), representing approximately 34 percent of the samples taken. The least sampled occupational category was crusher operators (surface), consisting of 1 percent of the samples taken. Table IV–7 displays the number and percent of respirable coal mine dust samples with quartz greater than the existing exposure limit for each occupational category.

[14] For a full crosswalk of which job codes were included in each of these nine Occupational Categories, please see Appendix C of the preamble.

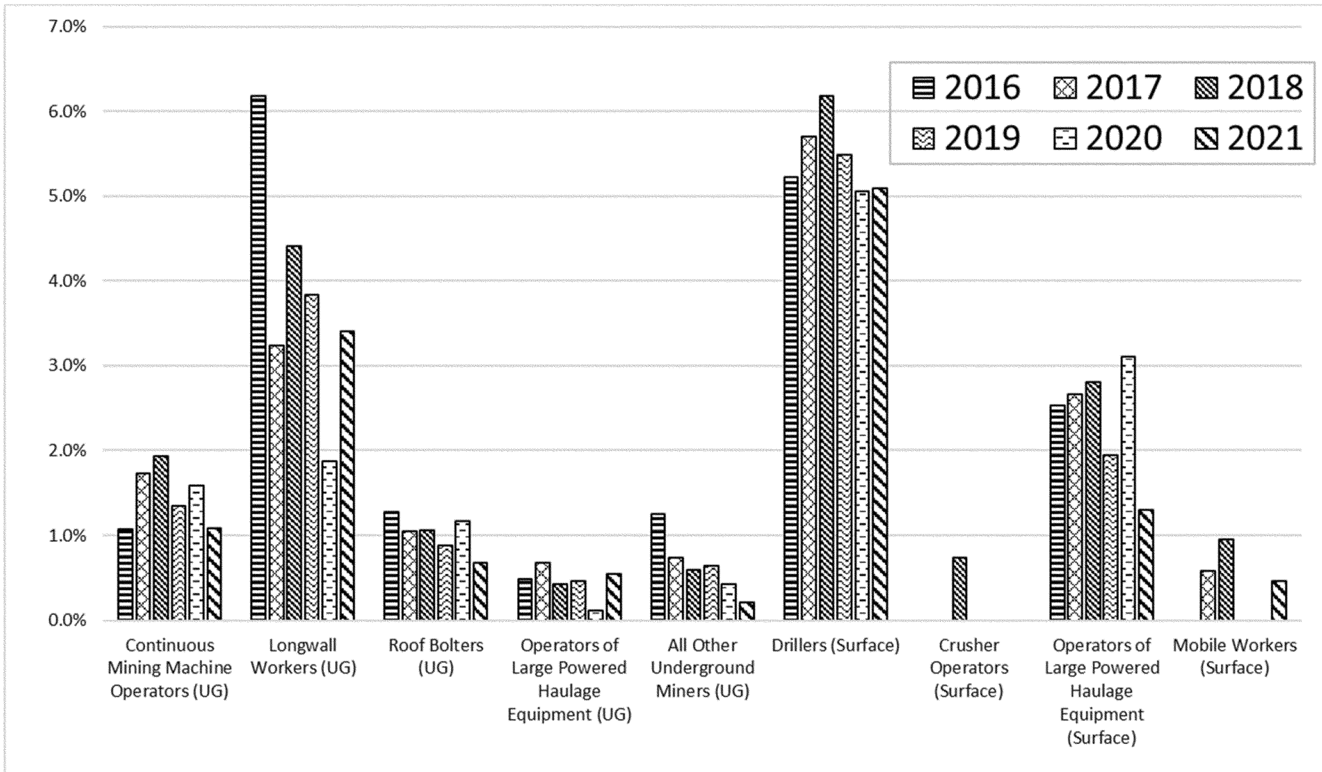
Table IV-7: Respirable Coal Mine Dust Samples by Occupation, 2016–2021

Occupation	Number of Samples	Number of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³ MRE	Percent of Samples with Respirable Crystalline Silica Concentration Greater than 100 μg/m³ MRE
Continuous Mining Machine Operators (UG)	9,910	154	1.6%
Longwall Workers (UG)	3,176	115	3.6%
Roof Bolters (UG)	14,306	145	1.0%
Operators of Large Powered Haulage Equipment (UG)	21,777	99	0.5%
All Other Underground Miners (UG)	3,926	24	0.6%
Drillers (Surface)	1,762	98	5.6%
Crusher Operators (Surface)	631	1	0.2%
Operators of Large Powered Haulage Equipment (Surface)	5,313	132	2.5%
Mobile Workers (Surface)	2,326	9	0.4%
Total	**63,127**	**777**	**1.2%**

Source: MSHA MSIS respirable crystalline silica data for the Coal Industry, August 1, 2016, through July 31, 2021 (version 20220617).

Looking at trends, every occupational category shows a decrease in overexposure rates over time. See Figure IV–1. Most of the nine categories had lower rates of overexposure in the 2019–2021 period than in the 2016–2018 period.

Figure IV–1: Percent of RCMD Samples With Respirable Crystalline Silica Concentration Greater Than 100 MRE μg/m³ (MRE) by Occupational Category *



* For Crusher Operators (Surface), only one sample with a quartz concentration greater than 100 μg/m³ MRE occurred (in 2018); and for Mobile Workers (Surface), only nine samples with a quartz concentration greater than 100 μg/m³ MRE occurred (three in 2017, five in 2018 and one in 2021). Source: MSHA MSIS respirable crystalline silica data for the Coal Industry, August 1, 2016, through July 31, 2021 (version 20220617).

In all occupational categories, coal miners were sometimes exposed to respirable crystalline silica levels above the existing exposure limit. But the sampling data showed that coal mine operators can generally comply with the existing exposure limit. For example, although mining tasks performed by the occupational category of roof bolters (underground) historically resulted in high levels of overexposure to quartz, the low levels of overexposure for that occupation in 2016–2021 (*i.e.,* 1 percent) suggest that roof bolters now benefit from the improved respirable dust standard, improved technology, and better training.[15] Over the 2016–2021 period, coal miners in the occupational category drillers (surface) were the most frequently overexposed, with approximately 6 percent of samples over the existing quartz limit; they were followed by longwall workers (underground) (about 4 percent), operators of large powered haulage equipment (surface) (about 3 percent), and continuous mining machine operators (underground) (about 2 percent). For all other occupational categories, the overexposure rate was less than 1 percent.

[15] The drilling operation in the roof bolting process, especially in hard rock, generates excessive respirable coal and quartz dusts, which could expose the roof bolting operator to continued health risks (Jiang and Luo, 2021).

4. Conclusion

This analysis of MSHA inspector sampling data shows that coal mine operators generally comply with the existing standards related to quartz. Of the 63,127 valid respirable dust samples from coal mines over the most recent 5-year period, 1.2 percent had respirable quartz over the existing exposure limit of 100 μg/m³ (MRE equivalent) for a full-shift exposure, calculated as a TWA. Seven of the nine occupational categories had overexposure rates of 2.5 percent or less. Roof bolters (underground), which historically have had high exposures to respirable dust and respirable crystalline silica, had overexposure rates of 1 percent over this recent period. The data demonstrates that the controls that coal mine operators are using, together with MSHA's enforcement, have generally been effective in keeping miners' exposure to respirable crystalline silica at or below the existing exposure limit.

V. Health Effects Summary

This section summarizes the health effects from occupational exposure to respirable crystalline silica. MSHA's full analysis of the health effects literature is contained in the standalone document, entitled "*Effects of Occupational Exposure to Respirable Crystalline Silica on the Health of Miners*" (referred to as the standalone Health Effects document throughout the preamble), which is placed in the rulemaking docket for the MSHA silica rulemaking (RIN 1219–AB36, Docket No. MSHA–2023–0001). MSHA reviewed a wide range of health effects literature that included more than 600 studies exploring the relationship between respirable crystalline silica exposure and resultant health effects in miners and other workers across various industries. The purpose of this summary is to briefly present MSHA's findings on the nature of the hazards of exposure to respirable crystalline silica. Based on its review of the health effects literature and the weight-of-evidence approach, MSHA makes the following conclusions:

1. Miners in MNM and coal mines exposed to respirable crystalline silica at MSHA's existing exposure limits are subject to material impairment of health or functional capacity. The illnesses associated with exposure to respirable crystalline silica develop independent of other exposures.

2. Occupational exposure to respirable crystalline silica (as quartz and/or cristobalite) causes silicosis,

nonmalignant respiratory disease (NMRD) (*e.g.,* emphysema and chronic bronchitis), lung cancer, and renal disease. Each of these health effects outcomes is exposure-dependent, potentially chronic, irreversible, potentially disabling, and can be fatal.

3. Exposure to respirable crystalline silica contributes to the development of autoimmune disorders through inflammatory pathways.

4. The development of silicosis, NMRD, lung cancer, renal disease, and autoimmune disorders is largely dependent upon cumulative respirable crystalline silica exposure.

These conclusions are the basis of MSHA's Final Risk Analysis (FRA) on miners' exposure to respirable crystalline silica. In the FRA, MSHA quantifies risks associated with the five specific health outcomes mentioned above. The FRA summary is presented in *Section VI. Final Risk Analysis Summary* and a standalone document, entitled ''*Final Risk Analysis*'' (referred to as the standalone FRA document throughout the preamble), has been placed in the rulemaking docket for the MSHA silica rulemaking (RIN 1219–AB36, Docket No. MSHA–2023–0001).

From its health effects literature review and FRA, MSHA determines that miners exposed to respirable crystalline silica continue to face a risk of material impairment of health or functional capacity under MSHA's existing exposure limits. Thus, MSHA also makes the following conclusions:

(1) The rate of silicosis and other diseases caused by respirable crystalline silica exposure would decrease with reduction in occupational exposures, which is the most effective way to prevent these types of diseases.

(2) Regulatory action is necessary to reduce these occupational exposures and protect miners' health. Section 101(a)(6)(A) of the Federal Mine Safety and Health Act of 1977, as amended (Mine Act), requires MSHA to ''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.'' 30 U.S.C. 811(a)(6)(A).

Regulatory action to protect miners' health is required by section 101(a)(6)(A) of the Mine Act, and MSHA's statutory authority and mission has been recognized and upheld by reviewing courts. ''[T]he Mine Act evinces a clear bias in favor of miner health and safety.'' *Nat'l Min. Ass'n* v. *Sec'y, U.S. Dep't of Lab.,* 812 F.3d 843, 866 (11th Cir. 2016). Courts interpret MSHA's obligation to promulgate standards to protect the health of the nation's miners to include '' 'prevent[ing],' not merely reduc[ing] the incidence of, 'occupational diseases originating in . . . mines.' '' *Id.* at 883 (quoting 30 U.S.C. 801(c)). Where occupational disease ''incidence has not been reduced *to zero* . . . MSHA has not completely fulfilled its mission to 'protect the health . . . of the Nation's coal or other miners.' '' *Id.* (quoting 30 U.S.C. 801(g)). Case law instructs that MSHA must demonstrate risk before regulating: ''[B]efore promulgating a health or safety standard under the Mine Act, MSHA must show that the substance being regulated presents a risk of 'material impairment of health or functional capacity' for miners who are regularly exposed to the substance.'' *Kennecott Greens Creek Min. Co.* v. *Mine Safety & Health Admin.,* 476 F.3d 946, 952 (D.C. Cir. 2007) (quoting 30 U.S.C. 811(a)(6)(A)). Although the Mine Act requires MSHA to consider the best available evidence, the ''duty to use the best available evidence . . . cannot be wielded as a counterweight to MSHA's overarching role to protect the life and health of workers in the mining industry.'' *Nat'l Min. Ass'n,* 812 F.3d at 866. With this regulatory action, MSHA is addressing this urgent need. See 30 U.S.C. 801(c).

On July 13, 2023, MSHA published a notice of proposed rulemaking, entitled ''*Lowering Miners' Exposure to Respirable Crystalline Silica and Improving Respiratory Protection*'', along with supplemental documents. The Agency specifically sought comments on its preliminary determination from the literature review that miners' exposure to respirable crystalline silica presents a risk of material health impairment or functional capacity. MSHA also requested input on any additional adverse health effects that should be included or more recent literature that offers a different perspective. MSHA received numerous comments in response to this request and considered them in preparing the final standalone Health Effects document and the final rule.

This section will describe how MSHA conducted its review of the health effects literature on respirable crystalline silica and what the Agency has found about the toxicity of respirable crystalline silica. This section will also present the findings on the following health effects: (1) Silicosis; (2) Non-malignant respiratory disease (NMRD), excluding silicosis; (3) Lung cancer and cancer at other sites; (4) Renal disease; and (5) Autoimmune diseases. Public comments received are reflected throughout this section.

A. General Approach to Health Effects Literature Review

MSHA reviewed a wide range of health effects literature totaling over 600 studies that explore the relationship between respirable crystalline silica exposure and resultant adverse health effects in miners and other workers across various industries. The health effects literature reviewed by MSHA included both studies reviewed by OSHA for its 2016 respirable crystalline silica standard and many other newer studies and studies that focused specifically on the mining industry.

OSHA's ''Health Effects Analysis and Preliminary Quantitative Risk Assessment'' (2013b) included studies that were identified from previously published scientific reviews, such as the IARC (1997) and NIOSH (2002), and from newer evaluations of scientific literature, literature searches, and contact with experts and stakeholders. That document underwent extensive peer review by a panel of nationally recognized experts in occupational epidemiology, biostatistics and risk assessment, animal and cellular toxicology, and occupational medicine who had no conflict of interest (COI) or apparent bias in performing the review. These experts were asked to consider the strengths, weaknesses, interpretations, and inclusion of studies used to support the findings, and OSHA revised the document based on their feedback.

To ensure that its literature review was thorough and up to date, MSHA reviewed a large body of additional evidence beyond the studies considered by OSHA. It added many studies focused on miners' exposures to respirable crystalline silica, as well as newer studies published over the past decade. MSHA drew upon numerous studies conducted by NIOSH, the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), and other researchers. These studies provided epidemiological data, analyses of morbidity (having a disease or a symptom of disease) and mortality (disease resulting in death), progression and pathology evaluations, death certificate and autopsy reviews, medical surveillance data, health hazard assessments, in vivo (animal) and in vitro (cell-based) toxicity data, and other toxicological reviews. These studies are cited throughout this summary and are listed in the References section of MSHA's standalone Health Effects document. Additionally, these studies appear in the rulemaking docket.

MSHA received some comments from industry stakeholders who disagreed with MSHA's selection of studies for its literature review and therefore with its findings. The Nevada Mining Association (NVMA) and the Sorptive Minerals Institute (SMI) stated that not all relevant studies were discussed in the Health Effects literature review (Document ID 1441; 1446). NVMA also stated that the studies referenced are outdated. The National Stone, Sand, & Gravel Association (NSSGA) stated that MSHA's review is overly reliant on OSHA's review (2013b) (Document ID 1448, Attachment 3). The state mining association stated that the studies MSHA considered do not recognize that the likelihood of prolonged exposure to respirable crystalline silica has been dramatically reduced over the years, noting improvements to respirators, equipment, and engineering controls (Document ID 1441).

However, commenters from health and labor organizations stated that MSHA's review was thorough, was consistent with the scientific consensus, and addressed the primary health effects of concern. These commenters agreed with MSHA's findings and conclusions related to health risks from exposure to respirable crystalline silica (Document ID 1398; 1405; 1410; 1416). The American Public Health Association (APHA) also noted the inclusion of several recent peer-reviewed publications included in MSHA's review (Document ID 1416). The American College of Occupational and Environmental Medicine (ACOEM) commented that there has been an explosion of new information about the molecular basis for silica's adverse effects since OSHA's comprehensive summary of the medical literature in its preamble to the 2016 revisions to the silica standard (Document ID 1405). This commenter stressed that this new information only adds to the urgency of establishing and enforcing MSHA's proposed standard and applauded the Agency's review of the medical and epidemiologic literature on the health effects of silica exposure.

MSHA has taken several steps to ensure that its review of health effects literature represents the current understanding of health risks related to exposures to respirable crystalline silica. In its initial standalone Health Effects document, which was published alongside the proposed rule, MSHA included several recent publications (published as late as 2022), and since then, it has added more recent publications (through 2023) in its final standalone Health Effects document. Examples of recent literature included in the standalone Health Effects document are: Carrington and Hershberger (2022), Cohen *et al.* (2022), Descatha *et al.* (2022), Hall *et al.* (2022), and Keles *et al.* (2022). Furthermore, many of the more recent studies included miners regulated under the existing MSHA PEL of 100 μg/m³ (*e.g.,* Almberg *et al.,* 2017, 2018a; Graber *et al.,* 2017; Blackley *et al.,* 2018a; Cohen *et al.,* 2022). In response to the comment that the initial standalone Health Effects document did not take into account improved mining conditions or contemporary engineering controls, the Agency notes that it considered several studies featuring miners in a larger range of exposure groups, including some that had lower exposure levels (*e.g.,* Mannetje *et al.,* 2002b; Park *et al.,* 2002; Buchanan *et al.,* 2003; Attfield and Costello, 2004; Chen *et al.,* 2012).

Two commenters (an industry trade association and a training consulting company) stated that MSHA presented a significant amount of data showing the consequences of the various chronic health effects that silica can and does have on the human body but no viable data on mortality and morbidity among MNM miners (Document ID 1442; 1392).

As discussed elsewhere, MSHA is not required to prove a risk of death due to silica exposure to justify regulating to reduce a silica health risk. But the evidence shows that respirable silica exposure causes death as well as chronic disease. MSHA reviewed and discussed multiple studies that reported an increase in mortality rates throughout the standalone Health Effects document (*e.g.,* Bang *et al.,* 2005; Mazurek and Wood, 2008a; Liu *et al.,* 2017a; Wang *et al.,* 2020a). Examples of MNM morbidity studies included are Mamuya *et al.* (2007), Tse *et al.* (2007a), Rego *et al.* (2008), Reynolds *et al.* (2016), and Wang *et al.* (2020b); while MNM specific mortality studies include Attfield and Costello (2004), Chen *et al.* (2005, 2012), Schubauer-Berigan *et al.* (2009), and Vacek *et al.* (2011), among others. MSHA considered the best available evidence for MNM and concludes that MNM miners have an increased mortality and morbidity due to exposure to respirable crystalline silica.

Commenters from health and labor organizations suggested additional studies for MSHA to include in the final standalone Health Effects document (Document ID 1405; 1373; 1449). These studies included topics such as new information regarding the molecular basis for silica's adverse health effects or related to engineered stone workers. One commenter stated that MSHA should include studies from outside of the mining industry (Document ID 1448, Attachment 3).

MSHA thoroughly reviewed these studies and did not find sufficient evidence to alter MSHA's overall conclusions of health risk, as discussed in detail in the sections that follow. However, MSHA did add many of the recommended studies to its final standalone Health Effects document (*e.g.,* Chilosi *et al.,* 2003; Chen *et al.,* 2018; Cao *et al.,* 2020). MSHA also reviewed other suggested literature, including promising animal studies exploring novel drug treatments for diseases caused by exposure to respirable crystalline silica; however, it determined that these studies are not sufficiently developed for inclusion at this time (*e.g.,* Guo *et al.,* 2019; Huang *et al.,* 2019; Jia *et al.,* 2022). MSHA has already included several studies related to non-mining occupations throughout its standalone Health Effects document. Examples of other occupational studies include studies of health effects on granite workers (*e.g.,* Davis *et al.,* 1983; Attfield and Costello, 2004), brick workers (*e.g.,* Merlo *et al.,* 1991), agate stone grinders (Rastogi *et al.,* 1991), pottery workers (*e.g.,* McDonald *et al.,* 1995; Cherry *et al.,* 1998), industrial sand workers (*e.g.,* McDonald *et al.,* 2001; Rando *et al.,* 2001), concrete workers (*e.g.,* Meijers *et al.,* 2001), ceramic workers (*e.g.,* Forastiere *et al.,* 2002), and foundry workers (*e.g.,* Hertzberg *et al.,* 2002; Vihlborg *et al.,* 2017), among others. Occupations such as granite, industrial sand, or concrete workers, represent similar job tasks and exposures which may overlap with mining occupations. Others such as brick, pottery, and ceramic workers involve processing of mined materials into a commercial product.

To analyze the extensive literature that it considered, MSHA used the widely accepted weight-of-evidence (WoE) approach. Under this approach, studies with varied methodologies and conclusions are evaluated for their overall quality. Causal inferences are drawn based on a determination of whether there is substantial evidence that exposure increases the risk of a particular adverse health effect. This approach is a well-accepted method of conducting health hazard assessments (NRC, 2009; NIOSH, 2019a). Additionally, it was used by OSHA in its review of health effects literature (2013b) for its 2016 respirable crystalline silica standard. Factors that MSHA considered in its WoE analysis include: (1) size of the cohort studied and power of the study to detect a sufficiently low level of disease risk; (2) duration of follow-up of the study population; (3) potential for study bias, such as selection bias or healthy worker effects, and (4) adequacy of underlying exposure information for examining exposure-response relationships. Of the studies examined in the standalone Health Effects document, studies were deemed suitable for inclusion in the FRA if they provided adequate quantitative information on exposure and disease risks and were judged to be of sufficiently high quality according to the above criteria. MSHA's literature review expanded upon OSHA's (2013b) review of the health effects literature to support its final respirable crystalline silica rule (81 FR 16286), reviewing pertinent new research. MSHA's assessment of the literature is consistent with OSHA's conclusion from its silica literature review.

MSHA received one comment from the NSSGA challenging the validity of MSHA's literature review methodology (Document ID 1448, Attachment 3). This commenter submitted a report analyzing MSHA's health effects literature review, arguing that MSHA's review cannot be replicated or fully evaluated for its scientific validity and claiming that it is unclear whether MSHA's interpretations are sufficiently reliable as a basis for decision-making. The commenter asserted the need for literature reviews to be done pursuant to Lynch *et al.*'s (2022) framework of a ''systematic review,'' a review method that seeks to eliminate bias by adhering to a transparent, *a priori* protocol. The commenter also expressed concerns that MSHA's methodology is inadequately explained and possibly dated. The commenter suggested further studies to be included in MSHA's review and provided specific responses to some of MSHA's statements in its literature review.

On the other hand, the APHA provided a different perspective on the methodology (Document ID 1416). This commenter stated that MSHA thoroughly describes the health risks, which include developing chronic silicosis, accelerated silicosis, progressive massive fibrosis, chronic obstructive pulmonary disease, lung cancer and kidney disease. Further, the commenter noted that MSHA's review of the health effects literature included more than three dozen peer-reviewed papers published in just the last few years. This commenter concurred with MSHA's determination that miners' exposure to respirable crystalline silica presents a risk of material impairment of health or functional capacity.

MSHA disagrees with the comment challenging MSHA's methodology. Although the ''systematic review'' framework outlined in Lynch *et al.* (2022) is increasingly used in review publications, it is not the only valid method of conducting a literature review of the current science. As explained in the standalone Health Effects document, MSHA's review of the scientific literature on respirable crystalline silica used a widely accepted WoE approach.

The term, ''weight-of-evidence'' was coined as early as 40 years ago by the NRC (1983) in their seminal publication ''*Risk Assessment in the Federal Government: Managing the Process*''. It has become a fundamental element of the risk assessment process (NRC, 2009; EPA, 1986; Martin *et al.,* 2018; Lee *et al.,* 2023). MSHA selected this approach for use in its respirable crystalline silica risk analysis for a variety of reasons. First, it has withstood the scrutiny of scientists throughout the world (Suter *et al.,* 2020). Second, it has been used successfully throughout the world for conducting a wide variety of risk assessments and analyses involving a wide range of exposures in both occupational and environmental settings (*e.g.,* drugs, pesticides, industrial chemicals) (EPA, 1986, 2016; National Research Council (NRC), 2009; Suter *et al.,* 2020; Government of Canada, 2022). Third, it continues to be a solid and accepted approach that is still used today (EPA, 1986, 2016; National Research Council (NRC), 2009; Martin *et al.,* 2018; Suter *et al.,* 2020; Government of Canada, 2022; Lee *et al.,* 2023). Current searches of the scientific literature (*e.g.,* using search engines such as PubMed or Google Scholar) continue to identify studies in which the WoE approach has been employed. Finally, numerous courts have approved of federal agencies relying on this methodology in rulemaking for over 40 years. *See Mississippi* v. *E.P.A.,* 744 F.3d 1334, 1344–45 (D.C. Cir. 2013) (upholding the ''weight of evidence approach'' because ''one type of study might be useful for interpreting ambivalent results from another type . . . and though a new study does little besides confirm or quantify a previous finding, such incremental (and arguably duplicative) studies are valuable precisely because they confirm or quantify previous findings or otherwise decrease uncertainty'') (citing *Ethyl Corp.* v. *EPA,* 541 F.2d 1, 26 (D.C. Cir. 1976) (en banc)); *N. Am.'s Bldg. Trades Unions* v. *OSHA,* 878 F.3d 271, 284 (D.C. Cir. 2017) (rejecting challenges to OSHA's ''weight of evidence'' approach supporting its silica rulemaking). Thus, MSHA finds that the WoE approach is appropriate for use in its respirable crystalline silica rulemaking.

In summary, MSHA's weight-of-evidence analysis is based on OSHA's extensive literature review and peer review process; includes a substantial number of studies and data published after the OSHA rulemaking; and has received support from NIOSH experts.[16]

As described in greater detail in MSHA's standalone Health Effects document, the scientific understanding of how respirable crystalline silica causes adverse health effects has evolved greatly in the more than 45 years since the Mine Act was passed in 1977. MSHA's review of the literature indicates that under the existing standards found in 30 CFR parts 56, 57, 70, 71, and 90, miners are still developing preventable diseases that are material impairments of health or functional capacity. Regulatory action to reduce occupational exposures that cause these diseases is necessary to ensure no miner suffers material impairment of health or functional capacity, as required by section 101(a)(6)(A) of the Mine Act.

Based on an extensive review of health effects literature, MSHA determines that occupational exposure to respirable crystalline silica causes silicosis (acute silicosis, accelerated silicosis, chronic silicosis, and progressive massive fibrosis (PMF)), NMRD (including COPD), lung cancer, and end-stage renal disease (ESRD). Each of these effects is exposure-dependent, potentially chronic, irreversible, potentially disabling, and can be fatal. In addition, MSHA's review of the health effects literature has shown that respirable crystalline silica exposure is causally related to the development of some autoimmune disorders through inflammatory pathways. Current health information cited in the final standalone Health Effects document indicates that miners are suffering material impairment of health or functional capacity due to their occupational exposures to respirable crystalline silica. MSHA's review of respirable crystalline silica health effects concludes that the final rule, which lowers the exposure limits in MNM and coal mining to 50 μg/m³ and establishes an action level of 25 μg/m³ for a full-shift exposure, calculated as an 8-hour TWA, will reduce the risk

[16] MSHA's review benefitted from feedback and review from experts at NIOSH, both informally and through the interagency review process organized by OMB, during the literature review process and preparation of the standalone Health Effects document.

of miners developing silicosis, NMRD, lung cancer, and renal disease.

B. Toxicity of Respirable Crystalline Silica

Respirable crystalline silica is released into the environment during mining or milling processes, thus creating an airborne hazard. The particles may be freshly generated or re-suspended from surfaces on which they are deposited in mines or mills. Respirable crystalline silica particles may be irregularly shaped and variable in size. These particles may be inhaled by miners and can be deposited throughout the lungs. Some pulmonary clearance of particles deposited in the alveolar region (deep lung) may occur, but many particles can be retained and initiate or advance the disease process. The toxicity of these retained particles is amplified because the particles are not water-soluble and are not metabolized into less toxic compounds. This is important because insoluble dusts may remain in the lungs for prolonged periods, resulting in a variety of cellular responses that can lead to pulmonary disease (ATSDR, 2019). Respirable crystalline silica particles that are cleared from the lungs by the lymphatic system are distributed to the lymph nodes, blood, liver, spleen, and kidneys, potentially accumulating in these other organ systems and causing renal disease and other adverse health effects (ATSDR, 2019).

Physical characteristics relevant to the toxicity of respirable crystalline silica primarily relate to its size and surface characteristics, both of which play important roles in how respirable crystalline silica causes tissue damage. Any factor that influences or modifies these physical characteristics may alter the toxicity of respirable crystalline silica by affecting the mechanistic processes (ATSDR, 2019).

Inflammatory pathways affect disease development in various systems and tissues in the human body. For instance, it has been proposed that lung fibrosis caused by exposure to respirable crystalline silica results from a cycle of cell damage, oxidant generation, inflammation, scarring, and ultimately fibrosis. This has been reported by: Nolan *et al.* (1981), Shi *et al.* (1989, 1998), Lapp and Castranova (1993), Brown and Donaldson (1996), Parker and Banks (1998), Castranova and Vallyathan (2000), Castranova (2004), Fubini *et al.* (2004), Hu *et al.* (2017), Benmerzoug *et al.* (2018), and Yu *et al.* (2020).

Respirable crystalline silica entering the lungs could cause damage by a variety of mechanisms, including direct damage to lung cells. In addition, activation or stimulation by respirable crystalline silica of alveolar macrophages (after phagocytosis) and/or alveolar epithelial cells may lead to: (1) release of cytotoxic enzymes, reactive oxygen species (ROS), reactive nitrogen species (RNS), inflammatory cytokines and chemokines; (2) eventual cell death with the release of respirable crystalline silica; and (3) recruitment and activation of polymorphonuclear leukocytes (PMNs) and additional alveolar macrophages (Castranova and Vallyathan, 2000; Castranova, 2004; Hamilton *et al.,* 2008). The elevated production of ROS/RNS could result in oxidative stress and lung injury that stimulate alveolar macrophages, ultimately resulting in fibroblast activation and pulmonary fibrosis (Li *et al.,* 2018; Feng *et al.,* 2020). The prolonged recruitment of macrophages and PMN causes persistent inflammation, regarded as a primary step in the development of silicosis.

The strong immune response in the lung following exposure to respirable crystalline silica may also be linked to a variety of extra-pulmonary adverse effects such as hypergammaglobulinemia (overproduction of more than one class of immunoglobulins by plasma cells), production of rheumatoid factor, anti-nuclear antibodies, and release of other immune complexes (Haustein and Anderegg, 1998; Green and Vallyathan, 1996; Parks *et al.,* 1999). Respirable crystalline silica exposure has also been associated with ESRD through the initiation of immunological injury to the glomerulus of the kidney (Calvert *et al.,* 1997).

Proposed mechanisms involved in respirable crystalline silica-induced carcinogenesis have included: direct DNA damage, inhibition of the p53 tumor suppressor gene, loss of cell cycle regulation; stimulation of growth factors, and production on oncogenes (Nolan *et al.,* 1981; Shi *et al.,* 1989, 1998; Brown and Donaldson, 1996; Castranova, 2004; Fubini *et al.,* 2004).

Three commenters expressed concerns about the findings of the health effects literature review and their relevance to the sorptive minerals industry (Document ID 1446, Attachment 1; 1442; 1419). The SMI and Essential Minerals Association (EMA) stated that MSHA has an incomplete understanding of the latest available scientific research (Document ID 1446, Attachment 1; 1442). Asserting that occluded quartz in sorptive clays is not fractured (either in the clay formation in which it exists or during the mining and processing of the material to form sorptive mineral-based products), the SMI concluded that occluded quartz in sorptive clays does not pose the health risk posed by fractured quartz (Document ID 1446, Attachment 1). Discussing at length studies it recommended MSHA include in its health effects literature review, SMI and EMA said that much of this research was previously considered by OSHA (2013b) and that it had led to OSHA's decision to exempt sorptive clays from coverage under OSHA's silica standard. SMI also noted that additional research since OSHA's revised silica standard was promulgated has advanced the question of how quartz causes disease and the difference in risk potential between fractured and unfractured and occluded quartz. Asserting that, without consideration of the additional research provided, the proposed standard would not be based on the best available evidence and would not reflect the latest available scientific data in the field, this commenter discussed Mine Act statutory provisions and case law that it asserted demonstrate the high level of scientific evidence and scrutiny required of MSHA when setting health and safety standards.

A more detailed response to SMI's overall comment can be found in *Section VIII.A. General Issues* of this preamble. In response to the suggestion to consider additional studies, MSHA reviewed the suggested references and added some to the final standalone Health Effects document (Creutzenberg *et al.,* 2008; Borm *et al.,* 2018; Pavan *et al.,* 2019). MSHA also notes that some of these studies were already cited in the version of the standalone Health Effects document published alongside the proposed rule (*e.g.,* Donaldson and Borm, 1998; Fubini, 1998; Bruch *et al.,* 2004; Fubini *et al.,* 2004). Overall, many of the studies suggested by the commenter have argued that occluded or aged quartz is less toxic but have not suggested that occluded or aged quartz is not toxic or carries no risk of disease. MSHA agrees that there is some evidence to suggest that occluded silica is less toxic than unoccluded silica (Wallace *et al.,* 1996), but there is no evidence that occlusion and the initial reduced toxicity persist following deposition and retention of the crystalline silica particles in the lungs. Similarly, animal studies involving respirable crystalline silica suggest that the aged form has lower toxicity than the freshly fractured form; however, the aged form still retains toxicity (Shoemaker *et al.,* 1995; Vallyathan *et al.,* 1995; Porter *et al.,* 2002c). From these studies, MSHA concludes that exposure to the crystalline silica present in sorptive minerals poses a risk of material impairment of health or functional capacity to miners.

Others appeared to be irrelevant to the scope of the rule, such as those focused on amorphous silica, microscopy techniques, or workshop discussions (*e.g.,* Mercer *et al.,* 2018; Weber *et al.,* 2018; Driscoll and Borm, 2020). MSHA notes that none of the suggested animal studies included acute or chronic inhalation exposures to aged or occluded respirable crystalline silica. One suggested review, Poland *et al.* (2023) described a 2020 animal inhalation study (nose-only) which did not include exposures to aged or occluded respirable crystalline silica; the 2020 study was conducted using amorphous silica and the data were compared to a 1988 animal study that included whole-body (as opposed to nose-only) exposures to respirable crystalline silica.[17] Since this 2020 surface area comparison study described by Poland *et al.* (2023) focused on amorphous silica, which is not a part of this rulemaking, it was deemed unsuitable for inclusion in MSHA's final standalone Health Effects document. Other animal studies discussing aged or occluded respirable crystalline silica suggested used either intratracheal instillation or oropharyngeal aspiration, which do not reflect the behavior of particles that enter the lungs via inhalation, including lung clearance (Foster *et al.,* 2001; Wong, 2007; Driscoll and Borm, 2020). *Section VIII.A. General Issues* of this preamble responds more fully to these comments. In its response, MSHA notes that several studies of occluded or fractured quartz discussed their methods, including careful handling of occluded samples, but did not include analysis of occluded quartz that was analyzed with less than careful handling. This is not applicable to real-world conditions; MSHA's experience with mining and processing of sorptive minerals includes the use of grinding and milling processes.

After reviewing the available literature, MSHA concludes that miners working in the sorptive minerals industry are exposed to respirable crystalline silica. OSHA (2013b) concluded that while there was considerable evidence that several environmental influences can modify surface activity to either enhance or diminish the toxicity of silica, the available information was insufficient to determine in any quantitative way how these influences may affect disease risk to workers in any particular workplace setting (81 FR at 16311). MSHA agrees with OSHA (2013b) that there is evidence to support that surface activity of respirable crystalline silica may play a role in producing disease. However, mining is significantly different from other industries regulated by OSHA, for instance, in that it involves milling, grinding and removal of overburden. While the available information is insufficient to determine how these influences may affect disease risk to miners in any quantitative way and in any mining sector. MSHA is permitted "'to err on the side of overprotection by setting a fully adequate margin of safety.'" *Kennecott Greens Creek Min. Co.* v. *Mine Safety & Health Admin.,* 476 F.3d 946, 952 (D.C. Cir. 2007) (quoting *Nat'l Min. Ass'n* v. *Mine Safety & Health Admin.,* 116 F.3d 520, 528 (D.C. Cir. 1997)).

[17] These two studies (1988 and 2020) described by Poland *et al.* (2023) had limited comparability for a variety of reasons; they differ in: (1) rat strains (types of rats), (2) exposure durations, (3) recovery periods, as well as (4) types of inhalation exposure, among others.

C. Diseases

1. Silicosis

Silicosis is a material impairment of health or functional capacity, as defined by the Mine Act, and refers to a group of lung diseases caused by the inhalation of respirable crystalline silica. See 30 U.S.C. 811(a)(6)(A). Silicosis is a progressive, occupational disease, in which accumulation of respirable crystalline silica particles causes an inflammatory reaction in the lung. This reaction leads to lung damage and scarring and, in some cases, progresses to disability and death. Respirable crystalline silica has long been identified as a cause of lung diseases in miners, and adverse health effects were noted and described as early as 1550 by Georgius Agricola (Agricola, as translated by Banner in 1950). Based on the review of the literature, MSHA has determined that exposure to respirable crystalline silica causes silicosis in MNM and coal miners and that it is a significant cause of premature morbidity and mortality (Mazurek and Attfield, 2008; Mazurek and Wood, 2008a,b; Mazurek *et al.,* 2015, 2018).

When respirable crystalline silica accumulates in the lungs, it causes an inflammatory reaction, leading to lung damage and scarring. Silicosis can continue to develop even after silica exposure has ceased (Hughes *et al.,* 1982; Ng *et al.,* 1987a; Hessel *et al.,* 1988; Kreiss and Zhen, 1996; Miller *et al.,* 1998; Yang *et al.,* 2006). It is not reversible, and there is only symptomatic treatment, including bronchodilators to maintain open airways, oxygen therapy, and lung transplants in the most severe cases (Cochrane *et al.,* 1956; Ng *et al.,* 1987a; Lee *et al.,* 2001; Mohebbi and Zubeyri, 2007; Kimura *et al.,* 2010; Laney *et al.,* 2017; Almberg *et al.,* 2020; Hall *et al.,* 2022). Respirable crystalline silica exposure in miners can lead to all three forms of silicosis (acute, accelerated, and chronic). These forms differ in the rate of exposure, pathology (structural and functional changes produced by the disease), and latency period from exposure to disease onset.

Acute silicosis is an aggressive inflammatory process following intense exposure to respirable crystalline silica for "periods measured in months rather than years" (Cowie and Becklake, 2016). It causes alveolar proteinosis, an accumulation of lipoproteins in the alveoli of the lungs. This restructuring of the lungs leads to symptoms such as coughing and difficult or labored breathing, and often progresses to profound disability and death due to respiratory failure or infectious complications. In addition, symptoms often advance even after exposure has stopped, primarily due to the massive amount of protein debris and fluid that collects in the alveoli, which leads to the impairment of gas exchange (oxygen) in the lungs and respiratory distress of the patient. The X-ray appearance and results of microscopic examination of acute silicosis are like those of idiopathic (having an unknown cause) pulmonary alveolar proteinosis.

Accelerated silicosis includes both inflammation and fibrosis and is associated with intense respirable crystalline silica exposure. Accelerated silicosis usually manifests over a period of three to ten years (Cowie and Becklake, 2016), but it can develop in as little as two to five years if exposure is sufficiently intense (Davis, 1996). Accelerated silicosis may have features of both chronic and acute silicosis, with alveolar proteinosis in addition to X-ray evidence of fibrosis, seen as small opacities or the large opacities of PMF. Although the symptoms are like those of chronic silicosis, the clinical and radiographic progression of accelerated silicosis evolves more rapidly, and often leads to PMF, severe respiratory impairment, and respiratory failure. Accelerated silicosis can progress with associated morbidity and mortality, even if exposure ceases. Accelerated silicosis is frequently fatal.

Chronic silicosis is the most frequently observed form of silicosis in the United States today (Banks, 2005; OSHA, 2013b; Cowie and Becklake, 2016). It is also the most common form of silicosis diagnosed in miners. Chronic silicosis is a fibrotic process that typically follows less intense respirable crystalline silica exposure of ten or more years (Becklake, 1994; Balaan and Banks, 1998; NIOSH, 2002b; Kambouchner and Bernaudin, 2015; Cowie and Becklake, 2016; Rosental, 2017; ATSDR, 2019; Barnes *et al.,* 2019; Hoy and Chambers, 2020). It is identified histopathologically by the presence of the silicotic islet or nodule that is an agent-specific fibrotic lesion and is recognized by its pathology (Balaan and Banks, 1998). Chronic silicosis develops slowly and creates rounded whorls of scar tissue that progressively destroy the normal structure and function of the lungs. In addition, the scar tissue opacities become visible by chest X-ray or computerized tomography (CT) only after the disease is well-established and the lesions become large enough to view. As a result, surveys based on identification of small and large opacity disease on chest X-ray films usually underestimate the true prevalence of silicosis (Craighead and Vallyathan, 1980; Hnizdo *et al.,* 1993; Rosenman *et al.,* 1997; Cohen and Velho, 2002). The lesions eventually advance and result in lung restriction, reduced lung volumes, decreased pulmonary compliance, and reduction in the gas exchange capabilities of the lungs (Balaan and Banks, 1998). As the disease progresses, affected miners may have chronic cough, sputum production, shortness of breath, and reduced pulmonary function.

Among coal miners, silicosis is usually found in conjunction with simple coal workers' pneumoconiosis (CWP) because of the miners' exposures to RCMD that also contains respirable crystalline silica (Castranova and Vallyathan, 2000). Coal miners also face an added risk of developing mixed-dust pneumoconiosis (MDP) (includes the presence of coal dust macules), mixed-dust fibrosis (MDF), and/or silicotic nodules (Honma *et al.,* 2004; Green, 2019). The autopsy studies on coal miners that MSHA reviewed support a pathological relationship between mixed-RCMD or respirable crystalline silica exposures and PMF, silicosis, and CWP (Davis *et al.,* 1979; Ruckley *et al.,* 1981, 1984; Douglas *et al.,* 1986; Fernie and Ruckley, 1987; Green *et al.,* 1989, 1998b; Attfield *et al.,* 1994; Vallyathan *et al.,* 2011; Cohen *et al.,* 2016, 2019, 2022). Autopsy studies in British coal miners indicated that the more advanced the disease, the more mixed-RCMD components were retained in the lung tissue (Ruckley *et al.,* 1984; Douglas *et al.,* 1986). Green *et al.* (1998b) determined that of 4,115 coal miners with pneumoconiosis autopsied as part of the National Coal Workers' Autopsy Study (NCWAS), 39 percent had mixed dust nodules and 23 percent had silicotic nodules.

PMF or ''complicated silicosis'' has been diagnosed in both coal and MNM miners exposed to dusts containing respirable crystalline silica. Recent literature on the pathophysiology of PMF supports the importance of crystalline silica as a cause of PMF in silica-exposed workers such as coal miners (Cohen *et al.,* 2016, 2022), sandblasters (Hughes *et al.,* 1982; Abraham and Wiesenfeld, 1997), industrial sand workers (Vacek *et al.,* 2019), hard rock miners (Verma *et al.,* 1982, 2008), and gold miners (Carneiro *et al.,* 2006a; Tse *et al.,* 2007b).

a. Classifying Radiographic Findings of Silicosis

The studies reviewed by MSHA used one of two established methods for identifying findings of pneumoconiosis: the International Labour Office (ILO) Classification System or the Chinese categorization system, each of which is described below. In addition, the NIOSH case definition of silicosis used in surveillance systems relies on the ILO system.

The ILO developed a standardized system to classify the radiographic appearances of pneumoconiosis identified in chest X-rays films or digital chest radiographic images (ILO, 1980, 2002, 2011, 2022). One aspect of the ILO system involves grading the size, shape, and profusion (density) of opacities in the lungs. The density of opacities is classified on a four-point major category scale (category 0, 1, 2, or 3), with each major category divided into three subcategories, giving a 12-point scale between 0/− and 3/+. Differences between ILO categories are subtle. For each subcategory, the top number indicates the major category that the profusion most closely resembles, and the bottom number indicates the major category that was given secondary consideration. For example, film readers may assign classifications such as 1/0, which means the reader classified it as category 1, but category 0 (normal) was also considered (ILO, 2022). Major category 0 indicates the absence of visible opacities consistent with pneumoconiosis and categories 1 to 3 reflect increasing profusion of opacities and a concomitant increase in severity of disease.

However, some studies in MSHA's literature review used the Chinese system of X-ray classification based on the ''Radiological Diagnostic Criteria of Pneumoconiosis and Principles for Management of Pneumoconiosis'' (GB5906–86). This includes four categories of pneumoconiosis findings: a suspected case (0+), stage I, stage II, or stage III. Under this scheme, a panel of three radiologists determines the presence and severity of radiographic changes consistent with pneumoconiosis. The four categories correspond to ILO profusion category 0/1, category 1, category 2, and category 3, respectively. A suspected case of silicosis (0+) in a dust-exposed worker refers to a dust response in the lung and its corresponding lymph nodes, or a scale and severity of small opacities that fall short of the level observed in a stage I case of silicosis (Chen *et al.,* 2001; Yang *et al.,* 2006).

MSHA's analysis of silicosis studies uses NIOSH's surveillance case definition to determine the presence of silicosis. As described further in the final standalone Health Effects document, NIOSH defines the presence of silicosis in terms of the ILO system and considers a small opacity profusion score of 1/0 or greater to indicate pneumoconiosis (NIOSH, 2014b). This definition originated from testimony before Congress regarding the 1969 Coal Act in which the Public Health Service recommended that miners be removed from dusty environments as soon as they showed ''minimal effects'' of dust exposure on a chest X-ray (*i.e.,* pinpoint, dispersed micro-nodular lesions). MSHA interprets ''minimal effects'' to mean an X-ray ILO profusion score of category 1/0 or greater. This is also consistent with Hnizdo *et al.* (1993), which recommended that, due to the low sensitivity of chest x-rays for detecting silicosis, radiographs consistent with an ILO category of 0/1 or greater be considered indictive of silicosis among workers exposed to a high concentration of silica-containing dust.

b. Progression and Associated Impairment

MSHA reviewed studies referenced by OSHA (2013b) that examined the relationship between exposure and progression, as well as between X-ray findings and pulmonary function. Additionally, MSHA considered literature not previously reviewed by OSHA (2013b) (Mohebbi and Zubeyri, 2007; Wade *et al.,* 2011; Dumavibhat *et al.,* 2013).

Progression of silicosis is recognized when there are changes or worsening of the opacities in the lungs, and sequential chest radiographs are classified higher by one or more subcategories (*e.g.,* from 1/0 to 1/1) because of changes in the location, thickness, or extent of lung abnormalities and/or the presence of calcifications. The higher the category number, the more severe the disease. Due to the variability in film technique and classification of films, some investigators count progression as advancing two or more subcategories, such as 1/0 to 1/2.

Overall, the studies indicate that progression is more likely with continued exposure, especially high average levels of exposure. Progression is also more likely for miners with higher ILO profusion classifications. As discussed previously, progression of disease may continue after miners are no longer exposed to respirable crystalline silica (Cochrane *et al.,* 1956; Maclaren and Soutar, 1985; Hurley *et al.,* 1987; Kimura *et al.,* 2010; Almberg *et al.,* 2020; Hall *et al.,* 2020b). In addition, although lung function impairment is highly correlated with chest X-ray films indicating silicosis, researchers caution that respirable crystalline silica exposure could impair lung function before it is detected by X-ray.

Of the studies in which silicosis progression was documented in populations of workers, four included quantitative exposure data that were based on either existing exposure levels or historical measurements of respirable crystalline silica (Ng *et al.,* 1987a study of granite miners; Hessel *et al.,* 1988 study of gold miners; Miller *et al.,* 1998 study of coal miners; Miller and MacCalman, 2010 study of coal miners). In some studies, episodic exposures to high average concentrations were documented and considered in the analysis. These exposures were strong predictors of more rapid progression beyond that predicted by cumulative exposure alone. Otherwise, the variable most strongly associated in these studies with progression of silicosis was cumulative respirable crystalline silica exposure (the product of the concentration times duration of exposure, which is summed over time) (Ng *et al.,* 1987a; Hessel *et al.,* 1988; Miller *et al.,* 1998; Miller and MacCalman, 2010). In the absence of concentration measurements, duration of employment in specific occupations known to involve exposure to high levels of respirable dust has been used as a surrogate for cumulative exposure to respirable crystalline silica. Duration of employment has also been found to be associated with the progression of silicosis (Ogawa *et al.,* 2003a).

Miller *et al.* (1998) examined the impact of high quartz exposures on silicosis disease progression in 547 British coal miners from 1990 to 1991 and evaluated chest X-ray changes after the mines closed in 1981. The study reviewed chest X-rays taken during health surveys conducted between 1954 and 1978 and data from extensive exposure monitoring conducted between 1964 and 1978. For some occupations, exposure was high because miners had to dig through a sandstone stratum to reach the coal. For example, quarterly mean respirable crystalline silica (quartz) concentrations ranged from 1,000 to 3,000 μg/m³ and for a brief period, concentrations exceeded 10,000 μg/m³ for one job. Some of these high exposures were associated with accelerated disease progression in these miners.

Buchanan *et al.* (2003) reviewed the exposure history and chest X-ray progression of 371 retired miners and found that short-term exposures (i.e., ''a few months'') to high concentrations of respirable crystalline silica (*e.g.,* >2,000 μg/m³) increased the silicosis risk by three-fold (compared to the risk of cumulative exposure alone) (see the standalone FRA document).

The risks of increased rate of progression predicted by Buchanan *et al.* (2003) have been seen in coal miners (Miller *et al.,* 1998; Laney *et al.,* 2010, 2017; Cohen *et al.,* 2016), metal (Hessel *et al.,* 1988; Hnizdo and Sluis-Cremer, 1993; Nelson, 2013), and nonmetal miners such as silica plant and ground silica mill workers, whetstone cutters, and silica flour packers (NIOSH, 2000a,b; Ogawa *et al.,* 2003a; Mohebbi and Zubeyri, 2007). Accordingly, it is important to limit higher exposures to respirable crystalline silica to minimize the risk of rapid progressive pneumoconiosis (RPP) in miners. RPP is the development of progressive massive fibrosis (PMF) and/or an increase in small opacity profusion greater than one subcategory over five years or less (Antão *et al.,* 2005).

The results of many surveillance studies conducted by NIOSH as part of the Coal Workers' Health Surveillance Program indicate that the pathology of pneumoconiosis in coal miners has changed over time, in part due to increased exposure to respirable crystalline silica. The studies of Cohen *et al.* (2016, 2022) indicate that RPP develops due to increased exposure to respirable crystalline silica among contemporary coal miners as compared to historical coal miners. Through the examination of pathologic materials from 23 contemporary (born in or after 1930) and 62 historical coal miners (born between 1910 and 1930) with severe pneumoconiosis, who were autopsied as part of NCWAS, Cohen *et al.* (2022) found a significantly higher proportion of silica-type PMF among contemporary miners (57 percent vs. 18 percent, $p < 0.001$). They also found that mineral dust alveolar proteinosis (MDAP) was more common in the current generation of miners and that the lung tissues of contemporary coal miners contained a significantly greater percentage and concentration of silica particles than those of past generations of miners.

Many studies found an association between pulmonary function decrements and ILO profusion category 2 or 3. Additionally, the review of the literature indicated a decreased lung function among workers who were exposed to respirable crystalline silica. MSHA therefore concludes that respirable crystalline silica exposure may impair lung function in some instances before silicosis can be detected by chest X-rays.

c. Occupation-Based Epidemiological Studies

MSHA reviewed the occupation-based epidemiological literature, which examines health outcomes among workers and their potential association with conditions in the workplace. In addition, MSHA reviewed additional occupation-based literature specific to respirable crystalline silica exposure in MNM and coal miners and concludes that respirable crystalline silica exposure increases the risk of silicosis morbidity and early mortality.

One study examined the acute and accelerated silicosis outbreak that occurred during and after construction of Hawk's Nest Tunnel in West Virginia from 1930 to 1931. There, an estimated 2,500 men worked in a tunnel drilling rock consisting of 90 percent silica or more. The study later estimated that at least 764 of the 2,500 workers (30.6 percent) died from acute or accelerated silicosis (Cherniack, 1986). There was also high turnover among the tunnel workers, with an average length of employment underground of only about two months.

MSHA's review included the occupation-based literature cited by OSHA (2013b) in developing its respirable crystalline silica standard (OSHA, 2016a). Overall, MSHA found substantial evidence suggesting that occupational exposure to respirable crystalline silica increases the risk of silicosis. This conclusion is consistent with OSHA's conclusion.

In a population of granite quarry workers (mean length of employment:

23.4 years) exposed to an average respirable crystalline silica concentration of 480 μg/m^3, 45 percent of those diagnosed with simple silicosis showed radiological progression of disease two to ten years after diagnosis (Ng *et al.,* 1987a). Among a population of gold miners, 92 percent showed progression after 14 years (Hessel *et al.,* 1988). Chinese factory workers and miners who were categorized under the Chinese system of X-ray classification as ''suspected'' silicosis cases (analogous to ILO 0/1) had a progression rate to stage I (analogous to ILO major category 1) of 48.7 percent, with an average interval of about 5.1 years (Yang *et al.,* 2006).

The risk of silicosis, and particularly its progression, carries with it an increased risk of reduced lung function. Strong evidence has shown that lung function deteriorates more rapidly in miners exposed to respirable crystalline silica, especially in those with silicosis (Hughes *et al.,* 1982; Ng and Chan, 1992; Malmberg *et al.,* 1993; Cowie, 1998). The rates of decline in lung function are greater where disease shows evidence of radiologic progression (Bégin *et al.,* 1987; Ng *et al.,* 1987a; Ng and Chan, 1992; Cowie, 1998). Additionally, the average deterioration of lung function exceeds that in smokers (Hughes *et al.,* 1982).

Blackley *et al.* (2015) found progressive lung function impairment across the range of radiographic profusion of simple CWP in a cohort of 8,230 coal miners that participated in the Enhanced Coal Workers' Health Surveillance Program from 2005 to 2013. There, 269 coal miners had category 1 or 2 chronic CWP. This study also found that each increase in profusion score was associated with decreases in various lung function parameters: 1.5 percent (95 percent CI, 1.0 percent–1.9 percent) in forced expiratory volume in one second (FEV_1) percent predicted, 1.0 percent (95 percent CI, 0.6 percent–1.3 percent) forced vital capacity (FVC) percent predicted, and 0.6 percent (95 percent CI, 0.4 percent–0.8 FEV1/FVC).

Accordingly, MSHA concludes that respirable crystalline silica exposure increases the risk of silicosis morbidity and mortality among miners. This conclusion is consistent with OSHA's conclusion that there is substantial evidence that occupational exposure to respirable crystalline silica increases the risk of silicosis.

d. Surveillance Data

In addition to occupation-based epidemiological studies, MSHA reviewed surveillance studies, including those submitted by commenters, which provide and interpret data to facilitate the prevention and control of disease, and ultimately MSHA finds that the prevalence of silicosis generally increases with duration of exposure (work tenure). This is evident from the statistically significant proportional mortality ratios (PMRs) reported in the National Occupational Mortality System (NORMS) data previously reviewed by OSHA and reported by MSHA in its standalone Health Effects document. Several small and *ad hoc* surveillance reports reported in the standalone Health Effects document also found a prevalence of silicosis of up to 50 percent among working and retired miners (Hnizdo and Sluis-Cremer, 1993; Ng and Chan, 1994; Kreiss and Zhen, 1996; Finkelstein, 2000).

However, the available statistics may underestimate silicosis-related morbidity and mortality in miners. It has been widely reported that statistics underestimate silicosis cases due to: (1) misclassification of causes of death (as TB, chronic bronchitis, emphysema, or *cor pulmonale*); (2) errors in recording occupation on death certificates; and (3) misdiagnosis of disease (Windau *et al.,* 1991; Goodwin *et al.,* 2003; Rosenman *et al.,* 2003; Blackley *et al.,* 2017). Furthermore, reliance on chest X-ray findings may lead to missed silicosis cases when fibrotic changes in the lung are not yet visible on chest X-rays. In other words, silicosis may be present but not yet detectable by chest X-ray, or it may be more severe than indicated by the assigned profusion score (Craighead and Vallyathan, 1980; Hnizdo *et al.,* 1993; Rosenman *et al.,* 1997).

e. Pulmonary Tuberculosis

In addition to the relationship between silica exposure and silicosis, studies indicate a relationship between silica exposure, silicosis, and pulmonary TB. MSHA reviewed these studies and concluded that silica exposure and silicosis increase the risk of pulmonary TB (Cowie, 1994; Hnizdo and Murray, 1998; teWaterNaude *et al.,* 2006), concurring with the conclusion reached by OSHA in its review.

Although early descriptions of dust diseases of the lung did not distinguish between TB and silicosis and most fatal cases described in the first half of the 20th century were likely a combination of silicosis and TB (Castranova *et al.,* 1996), more recent findings have demonstrated that respirable crystalline silica exposure, even without silicosis, increases the risk of infectious (active) pulmonary TB (Sherson and Lander, 1990; Cowie, 1994; Hnizdo and Murray, 1998; teWaterNaude *et al.,* 2006). These co-morbid conditions hasten the development of respiratory impairment and increased mortality risk even beyond the risk in unexposed persons with active TB (Banks, 2005).

Ng and Chan (1991) hypothesized that silicosis and TB ''act synergistically'' (are more than additive) to increase fibrotic scar tissue (leading to massive fibrosis) or to enhance susceptibility to active mycobacterial infection. The authors found that lung fibrosis is common to both diseases, and that both diseases decrease the ability of alveolar macrophages to aid in the clearance of dust or infectious particles.

These findings are also supported by studies published since OSHA's (2013b) review (Oni and Ehrlich, 2015; Ndlovu *et al.,* 2019). Oni and Ehrlich (2015) reviewed a case of silico-TB in a former gold miner with ILO category 2/2 silicosis. Ndlovu *et al.* (2019) found that in a study sample of South African gold miners who had died from causes other than silicosis between 2005 and 2015, 33 percent of men (n=254) and 43 percent of women (n=29) at autopsy were found to have TB, whereas seven percent of men (n=54) and three percent of women (n=4) were found to have pulmonary silicosis.

Overall, MSHA finds, consistent with OSHA's conclusion, that silica exposure increases the risk of pulmonary TB, and that pulmonary TB can be a complication of chronic silicosis.

2. Nonmalignant Respiratory Disease (Excluding Silicosis)

In addition to causing silicosis, exposure to respirable crystalline silica causes other NMRD. NMRD is an umbrella term that includes chronic obstructive pulmonary disease (COPD). Emphysema and chronic bronchitis are two lung diseases included within COPD. In patients with COPD, either chronic bronchitis or emphysema may be present or both conditions may be present together (ATS, 2010a).

Based on its review of the literature, MSHA concludes that exposure to respirable crystalline silica increases the risk for mortality from NMRD. The following summarizes MSHA's review of the literature.

a. Emphysema

Emphysema results in the destruction of lung architecture in the alveolar region, causing airway obstruction and impaired gas exchange. Based on its health effects literature review, MSHA concludes that exposure to respirable crystalline silica can increase the risk of emphysema, regardless of whether silicosis is present. In addition, MSHA concludes that this is the case for smokers and that smoking amplifies the effects of respirable crystalline silica exposure, increasing the risk of emphysema. MSHA's conclusions are consistent with those drawn by OSHA (2013b). The reviewed studies are summarized below.

Becklake *et al.* (1987) determined that a miner who had worked in a high dust environment for 20 years had a greater chance of developing emphysema than a miner who had never worked in a high dust environment. In a retrospective cohort study, Hnizdo *et al.* (1991a) used autopsy lung specimens from 1,553 gold miners to investigate the types of emphysema caused by respirable crystalline silica and found that the occurrence of emphysema was related to both smoking and dust exposure. This study also found a significant association between emphysema, both panacinar and centriacinar emphysema types, and length of employment for miners working in high dust occupations. A separate study by Hnizdo *et al.* (1994) on lifelong non-smoking South African gold miners found that the degree of emphysema was significantly associated with the degree of hilar gland nodules, which the authors suggested might serve as a surrogate for respirable crystalline silica exposure. While Hnizdo *et al.* (2000) conversely found that emphysema prevalence was decreased in relation to dust exposure, the authors suggested that selection bias was responsible for this finding.

The findings of several cross-sectional and case-control studies were more mixed. For example, de Beer *et al.* (1992) found an increased risk for emphysema; however, the reported odds ratio (OR) was smaller than that previously reported by Becklake *et al.* (1987). A study by Cowie *et al.* (1993) found that the presence and grade of emphysema were statistically significant in Black underground gold miners. Bégin *et al.* (1995) found that respirable crystalline silica-exposed smokers without silicosis had a higher prevalence of emphysema than a group of asbestos-exposed workers with a similar smoking history.

Several of the studies found that emphysema might occur in respirable crystalline silica-exposed workers who did not have silicosis and suggested a causal relationship between respirable crystalline silica exposure and emphysema (Becklake *et al.,* 1987; Hnizdo *et al.,* 1994; Bégin *et al.,* 1995). Experimental (animal) studies found that emphysema occurred at lower respirable crystalline silica exposure concentrations than fibrosis in the airways or the appearance of early silicotic nodules (Wright *et al.,* 1988). These findings tend to support human studies that respirable crystalline silica-induced emphysema can occur absent signs of silicosis.

OSHA (2013b) and others have concluded that there is a relationship between respirable crystalline silica exposure and emphysema. Green and Vallyathan (1996) reviewed several studies of emphysema in workers exposed to silica and found an association between cumulative dust exposure and death from emphysema. The IARC (1997) also reviewed several studies and concluded that exposure to respirable crystalline silica increases the risk of emphysema. Additionally, NIOSH (2002b) concluded in its Hazard Review that occupational exposure to respirable crystalline silica is associated with emphysema; however, it noted some epidemiological studies that suggested that this effect might be less frequent or absent in non-smokers.

Overall, MSHA concludes that exposure to respirable crystalline silica causes emphysema even in the absence of silicosis. Thus, MSHA concurs with the conclusions previously reached by OSHA (2013b).

b. Chronic Bronchitis

MSHA considered many studies that examined the association between respirable crystalline silica exposure and chronic bronchitis and concluded the following: (1) exposure to respirable crystalline silica causes chronic bronchitis regardless of whether silicosis is present; (2) an exposure-response relationship may exist; and (3) smokers may be at an increased risk of chronic bronchitis compared to non-smokers. Chronic bronchitis is long-term inflammation of the bronchi, increasing the risk of lung infections. This condition develops slowly by small increments and ''exists'' when it reaches a certain stage, specifically the presence of a productive cough with sputum production for at least three months of the year for at least two consecutive years (ATS, 2010b). MSHA's conclusions are supported by OSHA's review of the literature.

Miller *et al.* (1997) reported a 20 percent increased risk of chronic bronchitis in a British mining cohort compared to the disease occurrence in the general population. Using British pneumoconiosis field research data, Hurley *et al.* (2002) calculated estimates of mixed-RCMD-related disease in British coal miners at exposure levels that were common in the late 1980s and related their lung function and development of chronic bronchitis with their cumulative dust exposure. The authors estimated that by the age of 58, 5.8 percent of these men would report breathlessness for every 100 gram-hour/m^3 dust exposure. The authors also estimated the prevalence of chronic bronchitis at age 58 would be four percent per 100 gram-hour/m^3 of dust exposure. These miners averaged over 35 years of tenure in mining and a cumulative respirable dust exposure of 132 gram-hour/m^3 (Hurley *et al.,* 2002).

Cowie and Mabena (1991) found that chronic bronchitis was present in 742 of 1,197 (62 percent) South African gold miners, and Ng *et al.* (1992b) found a higher prevalence of respiratory symptoms, independent of smoking and age, in Singaporean granite quarry workers exposed to high levels of dust (rock drilling and crushing) compared to those exposed to low levels of dust (maintenance and transport workers). However, Irwig and Rocks (1978) compared symptoms of chronic bronchitis in silicotic and non-silicotic South African gold miners. They did not find as clear a relationship as did the above studies and concluded that the symptoms were not statistically more prevalent in the silicotic miners, although prevalence was slightly higher.

Sluis-Cremer *et al.* (1967) found that dust-exposed male smokers had a higher prevalence of chronic bronchitis than non-dust exposed smokers in a gold mining town in South Africa. Similarly, Wiles and Faure (1975) found that the prevalence of chronic bronchitis rose significantly with increasing dust concentration and cumulative dust exposure in South African gold miners who were smokers, nonsmokers, and ex-smokers. Rastogi *et al.* (1991) found that female grinders of agate stones in India had a significantly higher prevalence of acute bronchitis, but they had no increase in the prevalence of chronic bronchitis compared to controls matched by socioeconomic status, age, and smoking. However, the study noted that the grinders' respirable crystalline silica exposure durations were very short, and control workers may also have been exposed to respirable crystalline silica (Rastogi *et al.,* 1991).

Studies examining the effect of years of mining on chronic bronchitis risk were mixed. Samet *et al.* (1984) found that prevalence of symptoms of chronic bronchitis was not associated with years of mining in a population of underground uranium miners, even after adjusting for smoking. However, Holman *et al.* (1987) studied gold miners in West Australia and found that the prevalence of chronic bronchitis, as indicated by ORs (controlled for age and smoking), was significantly increased in those who had worked in the mines for over one year, compared to lifetime non-miners. In addition, while other studies found no effect of years of mining on chronic bronchitis risk, those studies often qualified this result with possible confounding factors. For example, Kreiss *et al.* (1989) studied 281 hard-rock (molybdenum) miners and 108 non-miner residents of Leadville, Colorado. They did not find an association between the prevalence of chronic bronchitis and work in the mining industry (Kreiss *et al.,* 1989); however, it is important to note that the mine had been temporarily closed for five months when the study began, so miners were not exposed at the time of the study.

Some reviews concluded that respirable crystalline silica exposure causes the development of bronchitis. The American Thoracic Society (ATS) (1997) published a review that found chronic bronchitis to be common among worker groups exposed to dusty environments contaminated with respirable crystalline silica. NIOSH (2002b) also published a review demonstrating that occupational exposure to respirable crystalline silica has been associated with bronchitis; however, some epidemiological studies suggested this effect might be less frequent or absent in non-smokers.

Additionally, Hnizdo *et al.* (1990) re-analyzed data from an earlier investigation (Wiles and Faure, 1975) and found an independent exposure-response relationship between respirable crystalline silica exposure and impaired lung function. For miners with less severe impairment, the effects of smoking and dust together were additive. The authors also found that for miners with the most severe impairment, the effects of smoking and dust were synergistic (more than additive) (Hnizdo *et al.,* 1990).

Overall, MSHA concludes that exposure to respirable crystalline silica causes chronic bronchitis, regardless of whether silicosis is present, and that an exposure-response relationship may exist. This conclusion is consistent with the findings of OSHA's Health Effects document (2013b).

c. Pulmonary Function Impairment

Pulmonary function impairment is a common feature of NMRD and may be assessed via spirometry (lung volumes, flows) and gas diffusion tests. MSHA has reviewed the studies cited by OSHA and agrees with their conclusions. Based on its review of the evidence in numerous longitudinal and cross-sectional studies and reviews, OSHA concluded that there is an exposure-response relationship between respirable crystalline silica and the development of impaired lung function. OSHA also concluded that the effect of tobacco smoking on this relationship may be additive or synergistic, and workers who were exposed to respirable crystalline silica, but did not show signs of silicosis, may also have pulmonary function impairment.

OSHA reviewed several longitudinal studies regarding the relationship between respirable crystalline silica exposure and pulmonary function impairment. To evaluate whether exposure to silica affects pulmonary function in the absence of silicosis, the studies focused on workers who did not exhibit progressive silicosis.

Among both active and retired Vermont granite workers exposed to an average quartz dust exposure level of 60 μg/m^3, researchers found no exposure-related decreases in pulmonary function (Graham *et al.,* 1981, 1994). However, Eisen *et al.* (1995) found significant pulmonary decrements among a subset of granite workers who left work (termed ''dropouts'') and consequently did not voluntarily participate in the last of a series of annual pulmonary function tests. This group experienced steeper declines in lung function compared to the subset of workers who remained at work (termed ''survivors'') and participated in all tests, and these declines were significantly related to dust exposure. Exposure-related changes in lung function were also reported in a 12-year study of granite workers (Malmberg *et al.,* 1993), in two five-year studies of South African miners (Hnizdo, 1992; Cowie, 1998), and in a study of foundry workers whose lung function was assessed between 1978 and 1992 (Hertzberg *et al.,* 2002). Similar reductions in FEV_1 (indicating an airway obstruction) were linked to respirable crystalline silica exposure.

Each of these studies reported its findings in terms of rates of decline in any of several pulmonary function measures (*e.g.,* FEV_1, FVC, FEV_1/FVC). To put these declines in perspective, Eisen *et al.* (1995) reported that the rate of decline in FEV_1 seen among the ''dropout'' subgroup of Vermont granite workers was 4 ml per 1,000 μg/m^3-year (4 ml per mg/m^3-year) of exposure to respirable granite dust. By comparison, FEV_1 declines at a rate of 10 ml/year from smoking one pack of cigarettes daily. From their study of foundry workers, Hertzberg *et al.* (2002) reported a 1.1 ml/year decline in FEV_1 and a 1.6 ml/year decline in FVC for each 1,000 μg/m^3-year of respirable crystalline silica exposure after controlling for ethnicity and smoking. From these rates of decline, they estimated that exposure to 100 μg/m^3 of respirable crystalline silica for 40 years would result in a total loss of FEV_1 and FVC that was less than, but still comparable to, smoking a pack of cigarettes daily for 40 years. Hertzberg *et al.* (2002) also estimated that exposure to the existing MSHA standards (100 μg/m^3) for 40 years would increase the risk of developing abnormal FEV_1 or FVC by factors of 1.68 and 1.42, respectively.

OSHA reviewed cross-sectional studies that described relationships between lung function loss and respirable crystalline silica exposure (or exposure measurement surrogates such as tenure). The results of these studies were like those of the longitudinal studies previously discussed. In several studies, respirable crystalline silica exposure was found to reduce lung function of:

(1) White South African gold miners (Hnizdo *et al.,* 1990),

(2) Black South African gold miners (Irwig and Rocks, 1978; Cowie and Mabena, 1991),

(3) Respirable crystalline silica-exposed workers in Quebec (Bégin *et al.,* 1995),

(4) Rock drilling and crushing workers in Singapore (Ng *et al.,* 1992b),

(5) Granite shed workers in Vermont (Theriault *et al.,* 1974a,b),

(6) Aggregate quarry workers and coal miners in Spain (Montes *et al.,* 2004a,b),

(7) Concrete workers in the Netherlands (Meijers *et al.,* 2001),

(8) Chinese refractory brick manufacturing workers in an iron-steel plant (Wang *et al.,* 1997),

(9) Chinese gemstone workers (Ng *et al.,* 1987b),

(10) Hard-rock miners in Manitoba, Canada (Manfreda *et al.,* 1982) and in Colorado (Kreiss *et al.,* 1989),

(11) Pottery workers in France (Neukirch *et al.,* 1994),

(12) Potato sorters in the Netherlands (Jorna *et al.,* 1994),

(13) Slate workers in Norway (Suhr *et al.,* 2003), and

(14) Men in a Norwegian community with years of occupational exposure to respirable crystalline silica (quartz) (Humerfelt *et al.,* 1998).

OSHA (2013b) recognized that many of these studies found that pulmonary function impairment: (1) can occur in respirable crystalline silica-exposed workers without silicosis, (2) was still observable when controlling for silicosis in the analysis, and (3) was related to the magnitude and duration of respirable crystalline silica exposure, rather than to the presence or severity of silicosis. Many other studies described by OSHA (2013b) have also found a relationship between respirable crystalline silica exposure and lung function impairment, including IARC (1997), the ATS (1997), and Hnizdo and Vallyathan (2003).

MSHA reviewed the studies and concludes that there is an exposure-response relationship between respirable crystalline silica and the impairment of lung function. MSHA also concludes that that the effect of tobacco smoking on this relationship may be additive or synergistic, and that workers who were exposed to respirable crystalline silica, but did not show signs of silicosis, may also have pulmonary function impairment. MSHA's conclusions are consistent with OSHA's findings from its literature review.

3. Lung Cancer

Commenters from United Steelworkers (USW), American Industrial Hygiene Association (AIHA), and Vanderbilt Minerals, agreed with MSHA's conclusion that miners exposed to respirable crystalline silica have an increased risk of lung cancer (Document ID 1447; 1351; 1419). The AIHA also cited research by the International Agency for Research on Cancer (IARC) as documenting the health risks from inhalation of respirable crystalline silica, specifically cancers of the lung, stomach, and esophagus (Document ID 1351). MSHA agrees with this comment for the reasons discussed below.

a. Lung Cancer

Lung cancer, an irreversible and usually fatal disease, is a type of cancer that forms in lung tissue. MSHA has found that the scientific literature supports that respirable crystalline silica exposure significantly increases the risk of lung cancer mortality among miners. This determination is consistent with the conclusions of other government and public health organizations, including the ATS (1997), the IARC (1997, 2012), the NTP (2000, 2016), NIOSH (2002b), and the ACGIH (2010), which have classified respirable crystalline silica as a ''known human carcinogen.'' The Agency's determination also is supported by epidemiological literature, encompassing more than 85 studies of occupational cohorts from more than a dozen industrial sectors including: granite/stone quarrying and processing (Guénel *et al.,* 1989a,b; Costello *et al.,* 1995; Carta *et al.,* 2001; Attfield and Costello, 2004), industrial sand (Sanderson *et al.,* 2000; Hughes *et al.,* 2001; McDonald *et al.,* 2001, 2005; Rando *et al.,* 2001; Steenland and Sanderson, 2001), MNM mining (Hessel *et al.,* 1986, 1990; Hnizdo and Sluis-Cremer, 1991; Meijers *et al.,* 1991; Chen *et al.,* 1992, 2006, 2012; McLaughlin *et al.,* 1992; Hua *et al.,* 1994; Roscoe *et al.,* 1995; Steenland and Brown, 1995a; Reid and Sluis-Cremer, 1996; Hnizdo *et al.,* 1997; deKlerk and Musk, 1998; Finkelstein, 1998; Chen and Chen, 2002; Schubauer-Berigan *et al.,* 2009; Liu *et al.,* 2017a; Wang *et al.,* 2020a,b, 2021), coal mining (Meijers *et al.,* 1988; Miyazaki and Une, 2001; Miller *et al.,* 2007; Miller and MacCalman, 2010; Tomaskova *et al.,* 2012, 2017, 2020, 2022; Graber *et al.,* 2014a,b; Kurth *et al.,* 2020), pottery (Winter *et al.,* 1990; McLaughlin *et al.,* 1992; McDonald *et al.,* 1995), ceramic industries (Starzynski *et al.,* 1996), diatomaceous earth (Checkoway *et al.,* 1993, 1996, 1997, 1999; Seixas *et al.,* 1997; Rice *et al.,* 2001), and refractory brick industries (cristobalite exposures) (Dong *et al.,* 1995).

One commenter stated that the work of Steenland and Sanderson should not be ''discounted'' and that Miller and MacCalman ''did not report on occupational exposure monitoring concentrations'' reported by Steenland and Sanderson (Document ID 1351).

MSHA chose Miller and MacCalman (2010) rather than the Steenland *et al.* (2001a) pooled cohort study for its lung cancer mortality risk model but has not discounted the study of Steenland and Sanderson. MSHA has cited the Steenland and Sanderson (2001) study at multiple points in the final standalone Health Effects document and has also cited other investigations from both researchers. The Miller and MacCalman (2010) study contained detailed time-exposure measurements of both respirable crystalline silica (quartz) and total mine dust, detailed individual work histories, and individual smoking histories. Further discussion regarding the selection of the risk model of Miller and MacCalman (2001) is located in the standalone FRA document.

The strongest evidence comes from the worldwide cohort and case-control studies reporting excess lung cancer mortality among workers exposed to respirable crystalline silica in various industrial sectors. This evidence is confirmed by the ten-cohort pooled case-control analysis by Steenland *et al.* (2001a); the more recent pooled case-control analysis of seven European countries by Cassidy *et al.* (2007); and two national death certificate registry studies, Calvert *et al.* (2003) in the United States and Pukkala *et al.* (2005) in Finland.

Recent studies examined lung cancer mortality among coal and non-coal miners (Meijers *et al.,* 1988, 1991; Starzynski *et al.,* 1996; Miyazaki and Une, 2001; Attfield and Kuempel, 2008; Tomaskova *et al.,* 2012, 2017, 2020, 2022; Graber *et al.,* 2014a,b; NIOSH, 2019a; Kurth *et al.,* 2020). These studies also discuss the associations between RCMD and respirable crystalline silica exposures with lung cancer in coal mining populations. Furthermore, the findings of these newer studies are consistent with the conclusion of OSHA's final Quantitative Risk Assessment (QRA) (2016a) that respirable crystalline silica is a human carcinogen. MSHA concludes that miners, both MNM and coal miners, are at risk of developing lung cancer due to their occupational exposure to respirable crystalline silica.

In addition, based on its review of the health effects literature, MSHA has determined that radiographic silicosis is a marker for lung cancer risk. Reducing exposure to levels that lower the silicosis risk would reduce the lung cancer risk to exposed miners (Finkelstein, 1995, 2000; Brown, 2009). MSHA has also found that, based on the available epidemiological and animal data, respirable crystalline silica causes lung cancer (IARC, 2012; RTECS, 2016; ATSDR, 2019). Miners who inhale respirable crystalline silica over time are at increased risk of developing silicosis and lung cancer (Greaves, 2000; Erren *et al.,* 2009; Tomaskova *et al.,* 2017, 2020, 2022).

Other toxicity studies (non-animal) provide additional evidence of the carcinogenic potential of respirable crystalline silica. Studies using DNA exposed directly to freshly fractured respirable crystalline silica demonstrate that respirable crystalline silica directly increases DNA breakage. Cell culture research has investigated the processes by which respirable crystalline silica disrupts normal gene expression and replication. Studies have demonstrated that chronic inflammatory and fibrotic processes resulting in oxidative and cellular damage may lead to neoplastic changes in the lung (Goldsmith, 1997). In addition, the biologically damaging physical characteristics of respirable crystalline silica and its direct and indirect genotoxicity support MSHA's determination that respirable crystalline silica is an occupational carcinogen (Borm and Driscoll, 1996; Schins *et al.,* 2002).

b. Cancers of Other Sites

In addition to examining studies on lung cancer, MSHA has reviewed studies examining the relationship between respirable crystalline silica exposure and cancers at other sites. MSHA has reviewed the studies examined by OSHA, together with additional studies focusing on miners' exposure, and has concluded (as OSHA did) that there is insufficient evidence to demonstrate a causal relationship between respirable crystalline silica exposure and other (non-lung) cancer mortality. MSHA notes that OSHA reviewed mortality studies, on cancer of the larynx and the digestive system, including the stomach and esophagus, and found that studies suggesting a dose-response relationship were too limited in terms of size, study design, or potential for confounding variables, to be conclusive. In addition, NIOSH (2002b) in their respirable crystalline silica review concluded that no association has been established between respirable crystalline silica exposure and excess mortality from cancer at other sites. The following summarizes the studies reviewed with inconclusive findings.

(1) Laryngeal Cancer

MSHA reviewed three lung cancer studies also discussed by OSHA (2013b) which suggested an association between respirable crystalline silica exposure and increased mortality from laryngeal cancer (Davis *et al.,* 1983; Checkoway *et al.,* 1997; McDonald *et al.,* 2001). However, a small number of cases were reported in those studies, and the researchers were unable to determine a statistically significant effect. Therefore, MSHA found that there was little evidence of an association based on these studies. OSHA also reached this conclusion.

(2) Gastric (Stomach) Cancer

MSHA reviewed the literature discussed by OSHA (2013b) to assess a potential relationship between respirable crystalline silica exposures and stomach cancers. OSHA concurred with observations made previously by Cocco *et al.* (1996) and in the NIOSH (2002b) respirable crystalline silica hazard review, which found that most epidemiological studies of respirable crystalline silica and stomach cancer did not sufficiently adjust for the effects of confounding factors. In addition, some of these studies were not properly designed to assess a dose-response relationship (Selikoff, 1978; Stern *et al.,* 2001; Moshammer and Neuberger, 2004; Finkelstein and Verma, 2005) or did not demonstrate a statistically significant dose-response relationship (Tsuda *et al.,* 2001; Calvert *et al.,* 2003). For these reasons, MSHA determined these studies were inconclusive in the context of this rulemaking.

(3) Esophageal Cancer

MSHA has reviewed studies that focused on miners and concludes that the literature does not support attributing increased esophageal cancer mortality with exposure to respirable crystalline silica. The studies by Meijers *et al.* (1991) and Swaen *et al.* (1995) assessed mortality from esophageal cancer in Dutch underground coal miners. Meijers *et al.* (1991) reported an elevated standardized mortality ratio (SMR) of 396, which was not statistically significant. The SMR was based on two cases out of 334 confirmed pneumoconiosis cases followed through the end of 1983 (case selection based on health screening between 1956–1960). Swaen *et al.* (1995) reported a SMR of 62 (95 percent CI: 25–127) based on seven cases out of 3,790 underground coal miners who were diagnosed with pneumoconiosis between 1956 and 1960. This result was not statistically significant.

MSHA reviewed the studies presented by OSHA (2013b) and agrees with OSHA's conclusion that the literature does not support attributing increased esophageal cancer mortality to exposure to respirable crystalline silica. OSHA considered several studies that examined the relationship between respirable crystalline silica exposures and esophageal cancer and found that the studies were limited in terms of size, study design, or potential for confounding variables. Three nested case-control studies of Chinese workers demonstrated a dose-response association between increased risk of esophageal cancer mortality and respirable crystalline silica exposure (Pan *et al.,* 1999; Yu *et al.,* 2005; Wernli *et al.,* 2006). Other studies also indicated elevated rates of esophageal cancer mortality with respirable crystalline silica exposure (Xu *et al.,* 1996a; Tsuda *et al.,* 2001). However, OSHA (2013b) identified that in all studies, confounding due to other occupational exposures was possible. Additionally, two large national mortality studies in Finland and the United States did not show a positive association between respirable crystalline silica exposure and esophageal cancer mortality (Calvert *et al.,* 2003; Weiderpass *et al.,* 2003).

(4) Other Sites

MSHA's review of additional studies specific to miners further establishes that respirable crystalline silica exposure increases the risk of lung cancer, although there is insufficient evidence to demonstrate a causal relationship between respirable crystalline silica exposure and other (non-lung) cancer mortalities. Specifically, MSHA concludes that the epidemiological literature is not sufficient to conclude that there is an association between respirable crystalline silica exposures and increased cancer of the larynx, gastric cancer mortality, or esophageal cancer mortality.

MSHA's conclusion is consistent with OSHA's conclusion. Overall, OSHA concluded that there was insufficient evidence of an association between silica exposure and cancer at sites other than the lungs. OSHA included a health literature review by NIOSH (2002b) that examined effects potentially associated with respirable crystalline silica exposure; that review identified only infrequent reports of statistically significant excesses of deaths for other cancers. Cancer studies have been reported on the following organs/systems: salivary gland, liver, bone, pancreas, skin, lymphopoietic or hematopoietic, brain, and bladder (see NIOSH, 2002b for full bibliographic references). However, the findings were not observed consistently among epidemiological studies, and NIOSH (2002b) concluded that no association has been established between these cancers and respirable crystalline silica exposure. OSHA concurred with NIOSH that these isolated reports of excess cancer mortality were insufficient to determine the role of respirable crystalline silica exposure.

MSHA has reviewed the studies cited by OSHA and agrees with OSHA's conclusion. MSHA's review of additional studies specific to miners further establishes that respirable crystalline silica exposure increases the risk of lung cancer, though there is insufficient evidence to demonstrate a causal relationship between respirable crystalline silica exposure and other (non-lung) cancer mortalities.

4. Renal Disease

MSHA received two comments related to MSHA's conclusions related to renal disease. The AIHA agreed that silica probably causes renal disease, quoting a paper by Steenland (2005b) (Document ID 1351). In contrast, the NSSGA stated that it was unclear whether renal disease is causally related to occupational crystalline silica exposure, citing a 2017 German Federal Institute for Occupational Safety and Health systematic review that conducted a meta-analysis on respirable crystalline silica and non-malignant renal disease (Möhner *et al.,* 2017) (Document ID 1448).

MSHA acknowledges that some studies have not found associations between respirable crystalline silica exposures and renal disease; however, those studies are generally statistically underpowered, meaning that their sample sizes are too small to detect even some substantial health effects. In contrast, as discussed below, studies with large cohort sizes and well-documented, validated job-exposure matrices found statistically significant effects on renal disease. MSHA reviewed the study by Möhner *et al.* (2017) and found that it was not suitable for inclusion in the literature review. The selection terms used by Möhner *et al.* (2017) appear to be overly limiting and did not appear to capture many of the studies that were included in MSHA's previous standalone Health Effects document published with its proposed silica rule (*e.g.,* Gregorini *et al.,* 1993; Hotz *et al.,* 1995; Fenwick and Main, 2000; Rosenman *et al.,* 2000; Kurth *et al.,* 2020). MSHA also notes that several studies included in the review by Möhner *et al.* (2017) were already cited in MSHA's previous standalone Health Effects document published with its proposed silica rule (*e.g.,* Koskela *et al.,* 1987; Brown *et al.,* 1997; Checkoway *et al.,* 1997; Calvert *et al.,* 2003; Brown and Rushton, 2005b).

Renal disease is characterized by the loss of kidney function and, in the case of ESRD, a permanent loss of kidney function leading to the need for a regular course of long-term dialysis or a kidney transplant to maintain life. MSHA reviewed a wide variety of longitudinal and mortality epidemiological studies, including case series, case-control, and cohort studies, as well as case reports, and concludes that there is substantial evidence in the literature suggesting that occupational exposures to respirable crystalline silica exposure increases the risk of morbidity and mortality related to ESRD. However, MSHA notes that the available literature on respirable crystalline silica exposures and renal disease in coal miners is less conclusive than the literature related to MNM miners.

Epidemiological studies have found statistically significant associations between occupational exposure to respirable crystalline silica and chronic renal disease (*e.g.,* Calvert *et al.,* 1997), sub-clinical renal changes, including proteinuria and elevated serum creatinine (*e.g.,* Ng *et al.,* 1992a; Hotz *et al.,* 1995; Rosenman *et al.,* 2000), ESRD morbidity (*e.g.,* Steenland *et al.,* 1990), ESRD mortality (Steenland *et al.,* 2001b, 2002a), and Wegener's granulomatosis (now known as granulomatosis with polyangiitis, GPA), which is severe injury to the glomeruli that, if untreated, rapidly leads to renal failure (Nuyts *et al.,* 1995). The pooled analysis conducted by Steenland *et al.* (2002a) is particularly convincing because it involved a large number of workers from three combined cohorts and had well-documented, validated job exposure matrices. Steenland *et al.* (2002a) found a positive and monotonic exposure-response trend for both multiple-cause mortality and underlying cause data. MSHA has determined that the underlying data from Steenland *et al.* (2002a) are sufficient to provide useful estimates of risk.

Possible mechanisms suggested for respirable crystalline silica-induced renal disease include: (1) a direct toxic effect on the kidney, (2) a deposition in the kidney of immune complexes (*e.g.,* Immunoglobulin A (IgA), an antibody blood protein) in the kidney following respirable crystalline silica-related pulmonary inflammation, and (3) an autoimmune mechanism (Gregorini *et al.,* 1993; Calvert *et al.,* 1997). Steenland *et al.* (2002a) demonstrated a positive exposure-response relationship between respirable crystalline silica exposure and ESRD mortality.

Overall, MSHA determines that respirable crystalline silica exposure in mining increases the risk of renal disease.

5. Autoimmune Disease

Two commenters—AIHA and National Coalition of Black Lung and Respiratory Disease Clinics (hereafter referred to as ''Black Lung Clinics'')—agreed with MSHA's finding that there is evidence of a relationship between respirable crystalline silica exposure and autoimmune diseases (Document ID 1351; 1410). The Black Lung Clinics also qualified that there is insufficient data to model the risk of disease (Document ID 1410). This is consistent with MSHA's conclusion that there is a casual association between occupational exposure to respirable crystalline silica and the development of systematic autoimmune diseases in miners; however, there are no studies available to date that can be used to model respirable crystalline silica-exposure risk of autoimmune diseases in the Agency's risk analysis.

Autoimmune diseases occur when the immune system mistakenly attacks healthy tissues within the body, causing inflammation, swelling, pain, and tissue damage. Examples of autoimmune diseases include autoimmune rheumatic diseases, sarcoidosis and seropositive rheumatoid arthritis (RA), Crohn's disease (CD), ulcerative colitis (UC), systemic lupus erythematosus (SLE), scleroderma, and systemic sclerosis (SSc). Some studies reviewed by MSHA suggest a casual association between occupational exposure to respirable crystalline silica and the development of systematic autoimmune diseases, particularly RA.

Wallden *et al.* (2020) found that respirable crystalline silica exposure is correlated with an increased risk of developing UC, and that the risk increases with duration of exposure (work tenure) and the level of exposure. This effect was especially significant in men. Schmajuk *et al.* (2019) found that RA was significantly associated with coal mining and other non-coal occupations exposed to respirable crystalline silica. Vihlborg *et al.* (2017) found a significant increased risk of seropositive RA with high exposure (>48 $\mu g/m^3$) to respirable crystalline silica when compared to rates for individuals with lower or no exposure. They examined detailed exposure-response relationships across four different groups, each of which was exposed to a different concentration of respirable crystalline silica (quartiles): <23 $\mu g/m^3$, 24 to 35 $\mu g/m^3$, 36 to 47 $\mu g/m^3$, and >48 $\mu g/m^3$. However, these researchers did not report the risk of sarcoidosis (a condition in which groups of cells in the immune system form granulomas in various organ systems) and seropositive RA in relation to respirable crystalline silica exposure using models that could be used in MSHA's risk analysis. In addition, the meta-analysis of 19 published case-control and cohort studies on scleroderma by Rubio-Rivas *et al.* (2017) found statistically significant risks among individuals exposed to respirable crystalline silica, solvents, silicone, breast implants, epoxy resins, pesticides, and welding fumes, but did not provide detailed quantitative exposure information that could be used in the risk analysis.

Based on its literature review, MSHA concludes that there is a causal association between occupational exposure to respirable crystalline silica and the development of systemic autoimmune diseases in miners, but that no studies are available to date that can be used to model respirable crystalline silica-exposure risk in a risk analysis.

D. Conclusion

MSHA concludes that exposure to respirable crystalline silica causes silicosis (acute, accelerated, chronic, and PMF), NMRD (including COPD), lung cancer, and renal disease. Each of these effects is exposure-dependent, potentially chronic, irreversible, potentially disabling, and can be fatal.

Respirable crystalline silica exposure is also linked to the development of some autoimmune disorders through inflammatory pathways.

The health effects literature, including peer-reviewed medical, toxicological, public health, and other related disciplinary publications, is robust and compelling. It shows that miners exposed to the existing respirable crystalline silica exposure limits of 100 μg/m³ still have an unacceptable amount of excess risk, for developing and dying from diseases related to their occupational respirable crystalline silica exposures.

MSHA is entrusted with ensuring 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'' (30 U.S.C. 811(a)(6)(A)). The Agency believes that when the final rule is implemented and enforced effectively, it will reduce the rate of silicosis and other diseases caused by respirable crystalline silica exposure and will substantially improve miners' lives.

VI. Final Risk Analysis Summary

MSHA's FRA quantifies risks associated with five specific health outcomes identified in the standalone Health Effects document: silicosis morbidity and mortality, and mortality from NMRD, lung cancer, and ESRD. This section serves as a summary of the standalone FRA document, which is placed into the rulemaking docket for the MSHA respirable crystalline silica rulemaking (RIN 1219–AB36, Docket No. MSHA–2023–0001) and is available at *Regulations.gov*.

MSHA developed an FRA to support its risk determinations and to quantify the health risk to miners exposed to respirable crystalline silica under the existing exposure limits for MNM and coal miners, at the new PEL of 50 μg/m³, and at the action level of 25 μg/m³.

This analysis addresses three questions related to the final rule:

(1) whether potential health effects associated with existing exposure conditions constitute material impairment to any miner's health or functional capacity;

(2) whether existing exposure conditions place miners at risk of incurring any material impairment if regularly exposed for the period of their working life; and

(3) whether the final rule will reduce those risks.

To answer these questions, MSHA relied on the large body of research on the health effects of respirable crystalline silica and published, peer-reviewed, quantitative risk assessments that describe the risk of exposed workers to silicosis mortality and morbidity, NMRD mortality, lung cancer mortality, and ESRD mortality. These quantitative risk assessments are based on several studies of occupational cohorts in a variety of industrial sectors. The underlying studies are described in the standalone Health Effects document and are summarized in *Section V. Health Effects Summary.*

Based on its analysis, MSHA found that, once the current mining workforce is replaced with new entrants to the mining industry so that all working miners and retired miners have been exposed only under the new PEL, the final rule will decrease lifetime excess deaths by at least 1,067 and will decrease lifetime excess cases of non-fatal silicosis by at least 3,746 among the working and future retired miner population. In the FRA, MSHA also increases its estimate of the number of miners who will benefit from this rule to include future retired miners. While the Preliminary Risk Analysis (PRA) did consider reductions in excess risk during years of retirement, the PRA did not account for the fact that future retired miners are among the population that will benefit from the rule. Once the entire mining workforce, including future retired miners, has worked only under the new PEL (*i.e.,* 60 years after the start of implementation of the rule), both the retired and working miners will experience fewer deaths and illnesses. The FRA updates benefit estimates to account for all lifetime excess cases that will be avoided among all working miners and future retired miners. It is important to note that the FRA (as well as the FRIA, discussed below in Section IX) only monetizes benefits to future retired miners. The FRA methodology does not attribute any health benefits to individuals who retired before the start of implementation of the final rule.

This summary highlights the main findings from the FRA, briefly describes how they were derived, and directs readers interested in more detailed information to corresponding sections of the standalone FRA document.

A. Summary of MSHA's Final Risk Analysis Process and Methods

MSHA evaluated the literature and selected an exposure-response model for each of the five health endpoints—silicosis morbidity, silicosis mortality, NMRD mortality, lung cancer mortality, and ESRD mortality. The selected exposure-response models were used to estimate lifetime excess risks and lifetime excess cases among the current population of working and the future population of retired MNM and coal miners based on real exposure conditions, as indicated by the samples in the compliance sampling datasets.

MSHA's FRA is largely based on the methodology and findings from OSHA's 2013 preliminary quantitative risk assessment (PQRA), OSHA's 2016 final quantitative risk assessment (QRA), and the associated analysis of health effects in connection with OSHA's promulgation of a rule setting PELs for workplace exposure to respirable crystalline silica. OSHA's PQRA presented quantitative relationships between respirable crystalline silica exposure and multiple health endpoints. Following multiple legal challenges, the U.S. Court of Appeals for the D.C. Circuit rejected challenges to OSHA's risk assessment methodology and its findings on different health risks. *N. Am.'s Bldg. Trades Unions* v. *OSHA,* 878 F.3d 271, 283–89 (D.C. Cir. 2017).

MSHA's FRA presents detailed quantitative analyses of health risks over a range of exposure concentrations that have been observed in MNM and coal mines. MSHA applied exposure-response models to estimate the respirable crystalline silica-related risk of material impairment of health or functional capacity of miners exposed to respirable crystalline silica at three levels—(1) the existing standards, (2) the new PEL, and (3) the action level. As in past MSHA rulemakings, MSHA estimated and compared lifetime excess risks associated with exposures at the existing and new PEL (and at the action level) over a miner's full working life of 45 years and 15 years of retirement.

MSHA's FRA is also based on a compilation of miner exposure data to respirable crystalline silica. For the MNM sector, MSHA evaluated 57,769 valid respirable dust samples collected between January 2005 and December 2019; and for the coal sector, MSHA evaluated 63,127 valid respirable dust samples collected between August 2016 and July 2021. The compiled data set characterizes miners' exposures to respirable crystalline silica in various locations (*i.e.,* underground, surface), occupations (*e.g.,* drillers, underground miners, equipment operators), and commodities (*e.g.,* metal, nonmetal, stone, crushed limestone, sand and gravel, and coal). MSHA enforcement sampling indicates a wide range of exposure concentrations. These include exposures from below the action level (25 μg/m³) to above the existing standards (100 μg/m³ in MNM standards and 100 μg/m³ MRE in coal standards, which is approximately 85.7 μg/m³ ISO).[18] [19]

[18] As discussed in the FRA, the existing PEL for coal is 100 μg/m³ MRE, measured as a full-shift time-weighted average (TWA). To calculate risks consistently for both coal and MNM miners, the FRA converts the MRE full-shift TWA concentrations experienced by coal miners to ISO 8-hour TWA concentrations. (See Section 4 of the standalone FRA document for a full explanation.) The equation used to convert MRE full-shift TWA concentrations into ISO 8-hour TWA concentrations is:

$$\text{ISO 8-hour TWA concentration} = (\text{MRE TWA}) \times \frac{(\text{original sampling time})}{(\text{480 minutes})} \times 0.857$$

Exposures at TWA 100 μg/m³ MRE and SWA 85.7 μg/m³ ISO are only equivalent when the sampling duration is 480 minutes (eight hours). However, for the sake of simplicity and for comparison purposes, the risk analysis approximates exposures at the existing coal exposure limit of 100 MRE μg/m³ as 85.7 μg/m³ ISO. Thus, ISO concentration values (measured as an 8-hour TWA) were used as the exposure metric when (a) calculating risk under the assumption of full compliance with the existing standards and (b) calculating risk under the assumption that no exposure exceeds the new PEL of 50 μg/m³. To simulate compliance among coal miners at the existing exposure limit, exposures were capped at 85.7 μg/m³ measured as an ISO 8-hour TWA.

[19] A sample-specific exposure limit is calculated for each sample based on the polymorphs present. For samples with >1% quartz by mass, the formula is:

$$\text{Sample respirable dust exposure limit} = \frac{(10\ \text{mg/m}^3)}{(\%\ \text{respirable quartz} + 2)}$$

When quartz is the only respirable crystalline silica polymorph in the sample, the existing MNM standard limits respirable crystalline silica exposures to 100 μg/m³ or less in MNM operations. Cristobalite exposures are currently limited to 50 μg/m³ or less when cristobalite is the only polymorph present, and the same is true for tridymite [19]. When more than one polymorph is present in the same sample, then a Threshold Limit Value for mixtures is used.

One commenter (a safety compliance consultant) stated that the [20] 2005–2019 MNM respirable dust samples analyzed for respirable crystalline silica show a downward trend in average annual rates of overexposure and requested access to data for 2020–2022 (Document ID 1383). In response, MSHA notes that the 2020–2022 data may be skewed by the reduction in mining during the COVID–19 pandemic and would therefore bias the analysis. Further, 2019 is recent enough to adequately capture the current exposure profile of working miners.

In addition, commenters from the United Mine Workers of America (UMWA), the Black Lung Clinics, and the Appalachian Citizens' Law Center (ACLC) expressed concern that MSHA used coal mine dust data from 2016–2021, a historically low period for quartz levels in coal mining, according to the commenters (Document ID 1398; 1410; 1445). The ACLC asserted that, as a result, the estimate of avoided illnesses and deaths in MSHA's PRA is low and urged the Agency to include a longer history of coal dust sampling data when estimating miners' future exposures (Document ID 1445). As discussed below, MSHA chose this time period to account for the 2014 RCMD Standard, which came into full effect in 2016. The ACLC also stated that, because the 2014 RCMD Standard does not directly regulate respirable crystalline silica, there is no justification for excluding prior sampling data (Document ID 1445).

MSHA believes the 2014 RCMD Standard impacted respirable crystalline silica exposures, in part because (a) the coal dust exposure limit is based on a formula that reduces the limit when the respirable crystalline silica content exceeds 100 μg/m³, and (b) measures that coal mine operators may have taken to reduce exposures to coal dust under that rule would have also reduced exposures to other respirable hazards including crystalline silica. Using more recent coal exposure data from 2016–2021 thus avoids possibly attributing benefits from the 2014 RCMD Standard to this rule. However, MSHA agrees that if respirable crystalline silica concentrations were to rise in the future—while remaining within the limits of the 2014 RCMD Standard and complying with all existing regulations—there would be additional unquantified benefits from the final rule.[21] For example, some researchers have attributed the increase in pneumoconiosis prevalence among miners since the 1990s to respirable crystalline silica (Cohen *et al.,* 2022; Hall *et al.,* 2020b). Cohen *et al.* (2022) states that respirable crystalline silica has become more concentrated due to improvements in mining equipment and processing technology, which allow ''recovery of thin coal seams, which involves the extraction of large quantities of surrounding rock strata that can contain crystalline silica.'' The possibility that respirable crystalline silica exposure could increase in the future in the absence of this rule underscores the rule's importance.

The primary results of the FRA are the calculated number of deaths and illnesses avoided assuming full compliance after implementation of MSHA's final rule. These calculations were performed for non-fatal silicosis illnesses (morbidity) and for deaths (mortality) due to silicosis, lung cancer, NMRD, and ESRD. For each health outcome, the reduced number of illnesses or deaths is calculated as the difference between (a) the number of excess illnesses and deaths currently occurring in the industry, assuming mines fully comply with the previous standards (100 μg/m³ for MNM and 85.7 μg/m³ ISO for coal) and (b) the number of excess deaths and illnesses expected to occur following implementation of the final rule, which includes a new PEL of 50 μg/m³ for a full-shift exposure, calculated as an 8-hour TWA.

Excess risks and cases were estimated under two scenarios: (a) a Baseline scenario where all exposures were capped at 100 μg/m³ for MNM miners and at 85.7 μg/m³ for coal miners, and (b) a new PEL 50 μg/m³ scenario where all risks were capped at the new PEL of 50 μg/m³ for both MNM and coal miners. The difference between the two scenarios yields the estimated reduction in lifetime excess risks and in lifetime excess cases due to the new PEL.

[20]

[21] In the analyzed coal compliance data from 2016 through 2021, only 6 percent of samples are above the new PEL of 50 μg/m³. Currently regulation provides protections to keep samples below 85.7 μg/m³, but it is insufficient to prevent increases in the proportion of concentrations in the range of 50 to 85.7 μg/m³. The possibility of such an increase further necessitates this rule.

To calculate excess risks, MSHA grouped MNM miners into the following exposure intervals: ≤25, >25 to ≤50, >50 to ≤100, >100 to ≤250, >250 to ≤500, and >500 μg/m³. MSHA grouped coal miners into the following exposure intervals: ≤25, >25 to ≤50, >50 to ≤85.7, >85.7 to ≤100, >100 to ≤250, >250 to ≤500, and >500 μg/m³. MSHA calculated the median of all exposure samples in each exposure interval and assumed the population of miners is distributed across the exposure intervals in proportion to the number of exposure samples from the compliance dataset in each interval. Then, miners were assumed to encounter constant exposure at the median value of their assigned exposure interval. MSHA adjusted the annual cumulative exposure by a full-time equivalency (FTE) factor to account for the fact that miners may experience more or less than 2,000 hours of exposure per year. MSHA calculated the FTE adjustment factor as the weighted average of the miner (excluding contract miner) FTE ratio (0.99 for MNM and 1.14 for coal) and the contract miner FTE ratio (0.59 for MNM and 0.64 for coal), where the weights are the number of miners [150,928 for MNM miners (excluding contract miners), 60,275 for MNM contract miners, 51,573 for coal miners (excluding contract miners), and 22,003 for coal contract miners]. For example, the weighted average FTE ratio for MNM is (0.987 × 150,928 + 0.591 × 60,275)/(150,928 + 60,275) = 0.87 and is (1.139 × 51,573 + 0.636 × 22,003)/(51,573 + 22,003) = 0.99 for coal.

MSHA uses weighted average FTE ratios to account for the fact that contract miners may experience lower exposures per year from mining. However, this underestimates the cumulative exposures that miners (excluding contract miners) experience. The average coal miner (excluding contract miners), for example, works approximately 2,280 hours per year, which equates to an average shift of over 9.1 hours when assuming 250 working days per year.[22] Additionally, the studies the FRA relied on to model excess risks define a full working year as 1,740 hours, in instances where such a definition is given (Buchanan *et al.,* 2003; Miller and MacCalman, 2010). Based on these studies' definition of a year, MNM miners (excluding contract miners) have an FTE ratio of 1.13 and coal miners (excluding contract miners) have an FTE ratio of 1.31. Additionally, the contract miner FTE ratios likely have some negative bias since any individual who works for multiple contracting companies is counted multiple times in the data, inflating the denominator in the FTE ratio calculation. MSHA also notes that the contract miner FTE ratios may underrepresent the true overall cumulative exposures since contract miners may have other jobs involving exposure to respirable crystalline silica (*e.g.,* in construction or the oil and gas industry).

MSHA calculated *excess* risk, which refers to the additional risk of disease and death attributable to exposure to respirable crystalline silica. For silicosis morbidity, MSHA used an exposure-response model that directly yields the accumulated or lifetime excess risk of silicosis morbidity, assuming there is no background rate [23] of silicosis in an unexposed (*i.e.,* non-miner) group. For the four mortality endpoints (silicosis mortality, lung cancer mortality, NMRD mortality, and ESRD mortality), MSHA used cohort life tables to calculate excess risks, assuming all miners enter the workforce at the start of age 21, retire at the end of age 65, and do not live past the end of age 80. From the life tables, MSHA acquired the lifetime excess risk of mortality by summing the miner cohort's excess mortality risks in each year from age 21 through age 80. Life tables were also constructed for unexposed (*i.e.,* non-miner) groups assumed to die from a given disease at typical rates for the U.S. male population. MSHA used 2018 data for all males in the U.S. (published by the National Center for Health Statistics, 2020b) to estimate (a) the disease-specific mortality rates among unexposed males and (b) the all-cause mortality rates among both groups (exposed miners and unexposed non-miners).

For a given scenario (either Baseline or New PEL 50 μg/m³), MSHA constructed life tables in the manner described above, both for a miner cohort exposed to respirable crystalline silica and for an unexposed non-miner cohort. MSHA calculated excess risk of disease as the difference between the two cohorts' disease-specific mortality risk (due to silicosis, lung cancer, NMRD, or ESRD). MSHA determined the lifetime excess cases by multiplying the lifetime excess risk by the number of exposed miner FTEs (including contract miner FTEs). Risks and cases were calculated separately for each exposure interval listed above. Then, the lifetime excess cases were aggregated across all exposure intervals. MSHA calculated the final lifetime excess risks per 1,000 miners in the full population of working and future retired miners by dividing the total number of lifetime excess cases by the total number of miners in the population (exposed at any interval). Finally, to estimate the risk reductions and avoided cases of illness due to the new PEL, MSHA compared the lifetime excess risks and lifetime excess cases across the two scenarios (Baseline and New PEL 50 μg/m³).

In the PRA, MSHA underestimated the number of miners who will benefit from the proposed rule. Based on the 2019 Quarterly Employment Production Industry Profile (MSHA, 2019a) and the 2019 Quarterly Contractor Employment Production Report (MSHA, 2019b), the current number of working miner FTEs is estimated to be 184,615 for MNM and 72,768 for coal. In the PRA, MSHA assumed excess cases of disease would be reduced only among these working miners. However, once the current mining workforce is replaced with new entrants to the mining industry so that the entire workforce has worked only under the new PEL for their 45 years of working life, the future mining workforce will experience fewer excess deaths and illnesses from exposure to respirable crystalline silica. The PRA's methodology did not include the number of future retired miners who will experience lower exposure for their working lives under the final rule and will continue to benefit during retirement, and therefore, the PRA underestimated the number of avoided lifetime excess cases attributable to the rule. In the FRA, the estimates are updated to account for all excess cases that will be avoided among not only working miners but also future retired miners. As discussed in greater detail in the FRA, the number of future retired miners who are expected to benefit from the rule can be calculated from the survival rates (which are computed in the life tables) and from the assumption that the mining workforces in MNM and coal will remain the same size as they are today.

On the related question raised by the ACLC about whether new clinical data suggests that the PRA underestimated benefits of the lower PEL, MSHA

[22] The fact that miners work over 8-hour shifts is also supported by MSHA's compliance data, which show an average shift duration of approximately 9.2 hours for MNM (MSHA, 2022a) and 9.6 hours for coal (MSHA, 2022b). These values differ from the average hours per day implied by the FTE ratios because the compliance data is only a sample of full shifts, whereas the FTE data is based on comprehensive reporting of all full-time and part-time shifts.

[23] Here, the ''background'' risk (or rate) refers to the risk of disease that the exposed person would have experienced in the absence of exposure to respirable crystalline silica. These background morbidity and mortality rates are measured using the disease-specific rates among the general population, which is not exposed to respirable crystalline silica.

determines that the approach in the PRA is the appropriate one (Document ID 1445). The risk models that MSHA uses are exposure-response models, originally selected through OSHA's peer review process and silica rulemaking, based on past clinical data on patients whose exposure history was known. Newer data from Black Lung Clinics can provide suggestive evidence of the risks, but because it is not yet incorporated into these peer-reviewed risk models, it cannot be included in this analysis as this commenter recommends.

B. Overview of Epidemiologic Studies

MSHA reviewed extensive research on the health effects of respirable crystalline silica and quantitative risk assessments published in the peer-reviewed scientific literature regarding occupational exposure risks of illness and death from silicosis, NMRD, lung cancer, and ESRD. The standalone Health Effects document describes the specific studies reviewed by MSHA. Of the many studies evaluated, MSHA believes that the 13 studies used by OSHA (2013b) to estimate risks provide reliable estimates of the disease risk posed by miners' exposure to respirable crystalline silica. These studies are summarized in Table VI–1.

BILLING CODE 4520–43–P

Table VI-1: Epidemiologic Studies of Miner Exposures to Respirable Crystalline Silica Reviewed in MSHA's FRA

Study	Population Studied	Exposure Measure	Health Risks Modeled					
			Morbidity		Mortality			
			Silicosis	RPP[1]	Silicosis	NMRD	Lung Cancer	ESRD
1. Attfield and Costello (2004)	Vermont granite workers	Job/exposure matrix					X	
2. Buchanan *et al.* (2003)	Scottish coal miners	Cumulative dust and respirable crystalline silica exposure	X	X				
3. Chen *et al.* (2001)	Chinese tin miners	Cumulative dust exposure, job/exposure matrix	X					
4. Chen *et al.* (2005)	Chinese tin, tungsten miners and pottery workers	Cumulative dust exposure, job/exposure matrix	X					
5. Hnizdo and Sluis-Cremer (1993)	White South African gold miners	Job/exposure matrix, tenure	X					
6. Hughes *et al.* (2001)	North American industrial sand workers	Cumulative dust exposure, job/exposure matrix					X	
7. Mannetje *et al.* (2002b), ToxaChemica International Inc. (2004)	6 cohorts from U.S., Finnish, and Australian miners	Cumulative dust exposure, job/ exposure matrices			X			
8. Miller and MacCalman (2010)	British coal miners	Tenure, cumulative dust exposure					X	
9. Park *et al.* (2002)	California diatomaceous earth workers	Cumulative dust exposure; cristobalite			X	X		
10. Rice *et al.* (2001)	California diatomaceous earth workers	Cumulative dust exposure; cristobalite					X	
11. Steenland and Brown (1995b)	South Dakota gold miners	Median respirable crystalline silica exposure, job/exposure matrix	X					

Table VI-1: Epidemiologic Studies of Miner Exposures to Respirable Crystalline Silica Reviewed in MSHA's FRA

Study	Population Studied	Exposure Measure	Health Risks Modeled					
			Morbidity		Mortality			
			Silicosis	RPP[1]	Silicosis	NMRD	Lung Cancer	ESRD
12. Steenland *et al.* (2001a), ToxaChemica, International Inc. (2004)	10 cohorts: U.S. Diatomaceous earth workers, Finnish and U.S. granite, U.S. industrial sand, Chinese pottery, tin, and tungsten miners, South African, U.S., and Australian gold miners	Cumulative dust exposure					X	
13. Steenland *et al.* (2002a)	3 cohorts: U.S. gold miners, industrial sand workers, and granite workers	Cumulative dust exposure, job/exposure matrix						X

1. MSHA used the Buchanan *et al* study to assess exposure rate effects on the risks of accelerated silicosis (more common in MNM miners) and rapidly progressive pneumoconiosis (RPP, primarily seen in coal miners, but also reported in silica flour packers). Miners exposed to respirable crystalline silica at variable intensities (i.e., high concentrations and low concentrations) may develop rapid progression of disease, referred to as RPP. It is defined as the development of progressive massive fibrosis and/or an increase in small opacity profusion greater than one subcategory over a 5-year period (Antão *et al.*, 2005).

BILLING CODE 4520–43–C

Of these 13 studies, OSHA selected one per health endpoint for final modeling and estimation of lifetime excess risk and cases. Combining the five selected studies with the observed exposure data yields estimates of actual lifetime excess risks and lifetime excess cases among working and future retired miner populations based on real exposure conditions. Table VI–2 summarizes key characteristics of the models presented in the 13 studies from OSHA's PQRA, including the cohort that was investigated, the specific health endpoint (*e.g.,* chest X-ray of category 2/1+), whether a lag between exposure and excess risk was included, and key model parameters. MSHA evaluated the evidence of OSHA's analysis of the 13 studies and the accompanying risks associated with exposure at 25, 50, 100, 250, and 500 μg/m³. Thorough evaluation has led MSHA to determine that the studies OSHA selected still provide the best available epidemiological models (with the exception of lung cancer mortality). However, MSHA utilized the Miller and MacCalman (2010) study to estimate risks for lung cancer mortality. This study was included in OSHA's health effects assessment and PQRA but was published after OSHA completed much of its modeling for the PQRA. The following lists the studies used by MSHA for each health endpoint:

Silicosis morbidity: Buchanan *et al.* (2003);

Silicosis mortality: Mannetje *et al.* (2002b);

NMRD mortality: Park *et al.* (2002);

Lung cancer mortality: Miller and MacCalman (2010); and

ESRD mortality: Steenland *et al.* (2002a).

As explained in detail in the standalone FRA document, MSHA developed its risk estimates based on recent mortality data and certain assumptions that differed from those used by OSHA. Examples of these MSHA assumptions include a lifetime that ends at age 80, updated background mortality data and all-cause mortality, miner population sizes, and miner-specific full-time equivalents (FTEs).[24]

[24] FTEs were used to adjust the cumulative exposure over a year based on the average number of hours that miners work.

MSHA's modeling has been done using life tables, in a manner consistent with OSHA's PQRA. In general, the life table is a technique that allows estimation of excess risk of disease-specific mortality while factoring in the probability of surviving to a particular age, assuming no exposure to respirable crystalline silica. This analysis accounts for competing causes of death, background mortality rates of disease, and the effect of the accumulation of risk due to elevated mortality rates in each year of a working life. For each cause of mortality, the selected study was used in the life table analysis to compute the increase in miners' disease-specific mortality rates attributable to respirable crystalline silica exposure.

MSHA uses cumulative exposure (*i.e.,* cumulative dose) to characterize the total exposure over a 45-year working life. Cumulative exposure is defined as the product of exposure duration and exposure intensity (*i.e.,* exposure level). Cumulative exposure is the predictor variable in the selected exposure-response models.

BILLING CODE 4520–43–P

Table VI-2: Summary of Exposure Response Models in Studies Considered in MSHA's FRA, Based on OSHA's 13 QRA Models

	Study	**Cohort**	**Exposure Lag (years)[1]**	**Model Parameter (Standard Error (SE))**
Silicosis Morbidity				
	Chest X-ray category of 2/1+ or greater (Buchanan *et al.*, 2003)	British coal miners	No lag	Prob(2/1+ profusions) = 1/ (1+exp-(-4.83 + 0.443*Cum. $Quartz_{<2}$ + 01.323 * $Cum.Exp_{>2\ mg/cubic\ m}$).[2]
	Silicosis mortality and/or X-ray of 1/1 or greater (Steenland and Brown, 1995b)	U.S. gold miners	No lag	Life table approach to estimate silicosis risk based on the silicosis rates that are age- and calendar-time-adjusted, from Table 2 (page 1374) of Steenland and Brown (1995b). Exposure to crystalline silica is assumed to begin at age 20 through age 65.[3]
	Chest X-ray category of 1/1 or greater (Hnizdo and Sluis-Cremer, 1993)	South African gold miners	No lag	Cumulative Risk (CR) = 1 - {1/[1 + exp(2.439/.2199)*$CDE^{1/.2199}$]}.[4]
	Chest X-ray category of 1 or greater (Chen *et al.*, 2001)	Chinese tin miners	No lag	CR = 1-exp(-0.0076*E)$^{2.23}$ where E is cumulative exposure to total dust.[5]
	Chest X-ray category of 1 or greater (Chen *et al.*, 2005)	Chinese tin miners	No lag	Estimated from Figure 2B in Chen *et al.* (2005) showing cumulative risk vs. cumulative exposure to respirable crystalline silica. Average age at onset was 47.9 years for tin miners.
	Chest X-ray category of 1 or greater (Chen *et al.*, 2005)	Chinese tungsten miners	No lag	Estimated from Figure 2B in Chen *et al.* (2005) showing cumulative risk vs. cumulative exposure to respirable crystalline silica. Average age at onset was 41.8 years for tungsten miners.
	Chest X-ray category of 1 or greater (Chen *et al.*, 2005)	Chinese pottery workers	No lag	Estimated from Figure 2B in Chen *et al.* (2005) showing cumulative risk vs. cumulative exposure to respirable crystalline silica. Average age at onset was 52.5 years for pottery workers.
Mortality				
Silicosis	Mannetje *et al.,* 2002b; ToxaChemica International, Inc., 2004	Pooled analysis for silicosis	No lag	Estimates derived from rate ratios based on the categorical model after accounting for exposure measurement uncertainty, from Table 7, page 40 of ToxaChemica, International Inc. (2004). Absolute risk calculated as 1 - exp(-Σtime*rate), where rate is the rate ratio for a given

Table VI-2: Summary of Exposure Response Models in Studies Considered in MSHA's FRA, Based on OSHA's 13 QRA Models

	Study	Cohort	Exposure Lag (years)[1]	Model Parameter (Standard Error (SE))
				cumulative exposure times a base rate of 4.7E-5. (OSHA, 2013b, page 352).
NMRD	Park *et al.*, 2002	California diatomaceous earth workers	No lag	Linear relative rate model: RR=1+(0.5469*E) where E is cumulative respirable crystalline silica exposure in mg/m^3.[6]
Lung Cancer	Steenland *et al.*, 2001a; ToxaChemica International, Inc., 2004	10 pooled cohorts[7]	15	Range based on three models with log cumulative exposure (mg/m^3-years; see Table II-2, OSHA, 2013b, page 290): 1) Log-linear model: β = 0.60 (0.015) (Model with log cumulative exposure (mg/m^3-days + 1)); 2) Linear model: β = 0.074950 (0.024121) (Model with log cumulative exposure (mg/m^3-days + 1)); and 3) Linear spline model: β_1 = 0.16498 (0.0653) and β_2 = -0.1493 (0.0657) Model with cumulative exposure (mg/m^3-years) and 95% confidence interval calculated as follows (where CE = cumulative exposure in mg/m^3-years and SE is standard error of the parameter estimate in parentheses): For CE $\leq$ 2.19: $1 + [(\beta_1 \pm (1.96*SE_1)) *CE]$ For CE > 2.19: $1 + [(\beta_1 * CE) + (\beta_2 * (CE-2.19))] \pm 1.96 * SQRT[(CE^2 * SE_1^2) + ((CE-2.19)^2 *SE_2^2) + (2*CE*(CE-3.29)*-0.00429)]$.[8]
Lung Cancer	Rice *et al.*, 2001	California diatomaceous earth workers	10	Linear relative risk model: β = 0.1441*E Model with cumulative respirable crystalline silica exposure E =mg/m^3-years (Table II-2, OSHA, 2013b, page 290).[9]
Lung Cancer	Attfield and Costello, 2004	U.S. granite workers	15	Log-linear relative risk model: β = exp(0.19*E) where E is cumulative respirable crystalline silica exposure in mg/m^3-years Table II-2 (OSHA, 2013b, page 290).[10]
Lung Cancer	Hughes *et al.*, 2001	North American industrial sand workers	15	Log-linear relative risk model: β = 0.13 *E, SE = 0.074; where E is cumulative respirable crystalline silica exposure in mg/m^3-years (Table II-2, OSHA, 2013b, page 290).[11]

Table VI-2: Summary of Exposure Response Models in Studies Considered in MSHA's FRA, Based on OSHA's 13 QRA Models

	Study	Cohort	Exposure Lag (years)[1]	Model Parameter (Standard Error (SE))
Lung Cancer	Miller and MacCalman, 2010	British coal miners	15	Log-linear relative risk model: B = 0.0524 * E, where E is cumulative respirable crystalline silica exposure in mg/m^3-years, SE = 0.0188, life table analysis (Table II-2, OSHA, 2013b, page 290).
ESRD	Steenland *et al.*, 2002a	3 cohorts	No lag	Log-linear model: R = exp(0.269(lnE)) where E is cumulative respirable crystalline silica exposure in mg/m^3-days, life table analysis.[12,13]

Notes:

1. The exposure-response models may include an exposure lag period that accounts for disease latency (NIOSH, 2019a). Researchers will typically model different lag periods to determine a model's best fit. An exposure lag could potentially improve the model as there is often a delay in the development of disease, such as silicosis and lung cancer, following exposure (OSHA, 2013b).
2. Quartz is cumulative respirable crystalline silica exposure in ghm-3 (i.e., gram-hours/m^3), with one year of work assumed by MSHA to equal 2000 hours (250 days per year × 8 hours per day). Exposure to crystalline silica is assumed to begin at age 20 through age 65. Age of cohort at follow-up was between 50 and 74 years (OSHA, 2013b, page 335).
3. Was used by OSHA in its life table approach.
4. CDE = cumulative respirable dust exposure in mg/m^3-years, assumed quartz content of respirable dust was 30%. Average age of cohort at onset was 55.9 years (range 38-74 years) (Hnizdo and Sluis-Cremer, 1993).
5. Respirable crystalline silica reported by Chen *et al.* (2001) to be 3.6 % of total dust. Average age at onset was 48.3 years.
6. Was used by OSHA in its life table approach.
7. 10 Cohort studies: US diatomaceous earth (Checkoway *et al.*, 1997), South Africa gold (Hnizdo and Sluis-Cremer, 1991; Hnizdo *et al.*, 1997), US gold (Steenland and Brown, 1995b), Australian gold (de Klerk and Musk, 1998), US granite (Costello and Graham, 1988), Finnish granite (Koskela *et al.*, 1994), US industrial sand (Steenland and Sanderson, 2001), Chinese tungsten (Chen *et al.*, 1992), Chinese pottery (Chen *et al.*, 1992), Chinese tin (Chen *et al.*, 1992).
8. Was used by OSHA in its life table approach.
9. Was used by OSHA in its life table approach. Standard error not reported; upper and lower confidence limit on beta estimated from confidence interval of risk estimate reported in Rice *et al.*, 2001. (OSHA, 2013b, Table II-2, page 290).
10. Was used by OSHA in its life table approach. Standard error not reported; upper and lower confidence limit on beta were estimated from originally reported confidence interval of risk estimate (OSHA, 2013b, Table II-2, page 290).
11. Was used by OSHA in its life table approach. Standard error of the coefficient was estimated from the p-value for trend (OSHA, 2013b, Table II-2, page 290).
12. Was used by OSHA in its life table approach.
13. The model parameter used in Steenland et al. (2002a) was shown in the document containing personal communications between OSHA and Steenland (Steenland 2010).

BILLING CODE 4520–43–C

Two commenters (SMI and NVMA) expressed concern that not all relevant studies were considered in MSHA's analysis of the health effects literature on occupational exposure to respirable crystalline silica (Document ID 1446; 1441). For example, the NVMA commented that the studies referenced in the health effects literature review are outdated and do not recognize the changing conditions in mines that reduce the likelihood of prolonged exposure to respirable crystalline silica, such as the updates made by mines in response to the diesel particulate matter standard published in the early 2000s (Document ID 1441). Similarly, the Pennsylvania Coal Alliance stated that the majority of research MSHA relied on did not account for significant technological advancements in mining and dust control technology (Document ID 1378). This commenter further asserted that the rule cannot be justified until the effects of the 2014 RCMD Standard are better understood (Document ID 1378).

MSHA reviewed the relevant literature, including recent publications. Additionally, in response to comments on the PRA, MSHA read and reviewed studies suggested by commenters. MSHA selected the studies which provide the best available epidemiological models to develop the estimates of lifetime excess risks and lifetime excess cases. These models contain information regarding how the cumulative level of exposure relates to the risk of adverse health outcomes. The selected studies were based on analyses of miners with a range of exposure histories. Further, MSHA's modeling of the avoided cases in the FRA directly accounts for any relevant changes in exposure conditions because it includes exposure data from as recently as 2019 for MNM miners and 2021 for coal miners. The exposure data captures actual concentrations of respirable crystalline silica that miners were exposed to during their shifts. To the extent that changing conditions, technological advancements, or the 2014 RCMD Standard have impacted miners' exposures to respirable crystalline silica, these effects are accounted for in MSHA's models, which use recent exposure data. The final provisions of the 2014 RCMD Standard went into effect in 2016, which is the first year of coal exposure data MSHA used when modeling coal miners' exposures to respirable crystalline silica dust.

For each health endpoint, MSHA generated two sets of risk estimates—one representing a scenario of full compliance with the existing standards (herein referred to as the ''Baseline'' scenario) and another representing a scenario wherein no samples exceed the new PEL (herein referred to as the ''New PEL 50 μg/m³'' scenario). In the Baseline scenario, MNM miners in the >100–250, >250–500, and >500 μg/m³ groups were assigned exposure intensities of 100 μg/m³ ISO. Coal miners in the 85.7–100, >100–250, >250–500, and >500 μg/m³ groups were assigned exposure intensities of 85.7 μg/m³ ISO, calculated as an 8-hour TWA. Exposure intensities were not changed for miners with lower exposure concentrations, because their exposures were considered compliant with the existing standards. A similar procedure was used for the New PEL 50 μg/m³ scenario, except that each miner group whose exposure exceeded the new PEL was assigned a new exposure of 50 μg/m³ ISO (for both MNM and coal). This process—of creating an exposure profile based on actual exposure data and modifying it based on the existing standards or the new PEL—allowed MSHA to estimate real exposure conditions that miners would encounter under each scenario, thereby enabling estimates of the actual excess risks the current population of miners would experience under each scenario (Baseline and New PEL 50 μg/m³).

For purposes of calculating risk in the FRA, both for MNM and coal miners, MSHA estimated excess risks by using the concentration of respirable crystalline silica collected over the full shift and calculating it as a full-shift, 8-hour TWA expressed in ISO standards. This metric of exposure intensity—the 8-hour TWA concentration of respirable crystalline silica in ISO standards—was used consistently across all sets of estimates (both MNM and coal sectors, and both the Baseline and New PEL 50 μg/m³ scenarios), thereby facilitating meaningful comparison. MSHA acknowledges that this metric of exposure intensity does not correspond to the manner in which coal exposure concentrations are currently calculated for purposes of evaluating compliance under the existing standard. As discussed in Section 4 of the standalone FRA document, MSHA believes that a full-shift, 8-hour TWA concentration properly represents risks to miners and thus is the most appropriate cumulative exposure metric for computing risk given that FTEs were used to scale exposure durations relative to the assumption of 250 8-hour workdays per year.

Commenters, including MSHA Safety Services Inc.; Silica Safety Coalition (SSC); the NSSGA; Jervois Idaho Cobalt Operations; and the EMA, suggested that disease data show respirable crystalline silica exposure and associated adverse health effects are not a problem or crisis in MNM mining or that there is only negligible exposure to respirable crystalline silica for certain MNM miners (Document ID 1392; 1432; 1448; 1453; 1442). Similarly, the Portland Cement Association stated that silicosis is unknown in the cement industry (Document ID 1407). One miner-related business further stated that silicosis cases are on the rise in coal and are decreasing in MNM and, therefore, MSHA's standard should focus only on coal mining, specifically underground coal mining (Document ID 1392). In addition, MNM mine operators such as K & E Excavating Inc. and K & E Alaska, Inc., also commented that there is little to no evidence of silicosis or other similar symptoms in MNM mining, especially in comparison to coal mining (Document ID 1435; 1436). Finally, the president of N-Compliance Safety Services expressed concern regarding the origin of the mortality reduction data included in the FRA and stated that they could not find deaths reported by MSHA for MNM miners or the associated 7000–1 forms (Document ID 1383).

On the other hand, several commenters from labor unions and health organizations agreed with MSHA's finding that MNM miners are at risk of respirable crystalline silica-related disease from occupational exposures (Document ID 1447; 1449; 1418; 1373). USW asserted that rock crushing in iron and other surface mines can release silica-laden dust and that silica is also a hazard in cement plants (Document ID 1447). The same commenter stated that silica control in MNM mines is becoming increasingly important because of new technologies that are likely to lead to higher dust exposures (Document ID 1447). Further, Miners Clinic of Colorado commented that its data support the need for better control of exposure to respirable crystalline silica in MNM mines, and said that, of the 400 MNM miners the clinic provided medical surveillance for in the past 20 years, 62 percent reported having spent over half of their mining tenure in MNM or at least 10 years as a MNM miner and, of those 62 percent, 26 percent had pneumoconiosis (based on a positive chest radiograph B reading) (Document ID 1418). This commenter concluded that MNM miners are at risk for progressive and potentially disabling work-related lung disease, although information on silicosis disease rates among MNM miners are less readily available than those for coal miners (Document ID 1418). Finally, citing several studies (Kramer *et al.,* 2012; Friedman *et al.,* 2015; Leso *et al.,* 2019; Rose *et al.,* 2019; Wu *et al.,* 2020; LACDHS, 2022; Fazio *et al.,* 2023), the Association of Occupational and Environmental Clinics (AOEC) said that severe silicosis in the engineered stone manufacturing industry has been reported around the world, including in the United States (Document ID 1373).

MSHA disagree with the assertion that silicosis or other diseases linked to respirable crystalline silica are not risks for MNM miners. MSHA reviewed a wide range of studies that demonstrated disease risks amongst miners occupationally exposed to respirable crystalline silica. These studies were not limited to underground coal miners and show that respirable crystalline exposure produces excess risk for coal and MNM miners as well as underground and surface miners. The studies MSHA evaluated covered occupations relevant to MNM mining such as sandblasters (Abraham and Wiesenfeld, 1997; Hughes *et al.,* 1982), industrial sand workers (Vacek *et al.,* 2019), hard rock miners (Verma *et al.,* 1982, 2008), and gold miners (Carneiro *et al.,* 2006a; Tse *et al.,* 2007b), metal miners (Hessel *et al.,* 1988; Hnizdo and Sluis-Cremer, 1993; Nelson, 2013), and nonmetal miners such as silica plant and ground silica mill workers, whetstone cutters, and silica flour packers (Mohebbi and Zubeyri, 2007; NIOSH, 2000a,b; Ogawa *et al.,* 2003a). Of the MNM exposure samples MSHA collected over the 2016–2021 period, 18.2 percent exceed the new PEL of 50 $\mu g/m^3$ and 6.4 percent exceed the existing PEL of 100 $\mu g/m^3$. Based on the analysis presented in the FRA, MNM miners are exposed to concentrations of respirable crystalline silica that are associated with elevated risks of morbidity and mortality from a variety of diseases.

Further, the ACOEM commented that new information about the molecular basis for silica's adverse health effects since OSHA's 2016 summary of the medical literature highlights the need for establishing and enforcing the 50 $\mu g/m^3$ PEL (Wang *et al.,* 2018; Chanda *et al.,* 2019; Feng *et al.,* 2020; Wu *et al.,* 2021) (Document ID 1405). MSHA's review of the more recent health effects literature also supports a causal association between respirable crystalline silica exposure and increased risk of silicosis morbidity and mortality. Thus, MSHA believes that silicosis and other diseases are a risk to any miner exposed to high levels of silica dust concentrations, regardless of mining commodity.

Regarding the comment about reported deaths, selected surveillance data for both silicosis cases and silicosis deaths are reported in the standalone Health Effects document. Nonetheless, MSHA's estimated risk and case reductions are based on samples MSHA collected from MNM mines and peer-reviewed models of the relationship between exposure to respirable crystalline silica and related diseases. The FRA does not rely on reported mortality data. MSHA previously has not required operators to conduct medical surveillance for MNM miners and becomes aware of cases only when miners inform their employer of their illness. Thus, these case data are not complete enough to serve as a basis for estimating applicable exposure-response models needed for a comprehensive risk analysis. However, MSHA believes that the final rule's MNM medical surveillance provisions, which are discussed in further detail in the FRIA and in the final rule text, will likely help to improve this gap in the data.

Commenters from the SMI, EMA, and Vanderbilt Minerals, argued that the aged and occluded crystalline silica (quartz) encountered in sorptive minerals, does not pose the same health risk of other forms of crystalline silica (Document ID 1446; 1442; 1419). The SMI commented that their mining and processing operations do not pose a risk to miners' health (Document ID 1446). A more comprehensive discussion of these commenters' concerns is addressed in the preamble under *Section VIII.A.3. Sorptive Minerals.*

The Agency notes that, unlike OSHA, MSHA has no requirement to identify a ''significant risk'' before regulating to protect miners' health and safety. *Nat'l Mining Ass'n* v. *United Steel Workers,* 985 F.3d 1309, 1319 (11th Cir. 2021) (''[T]he Mine Act does not contain the 'significant risk' threshold requirement . . . from the OSH Act.''). Moreover, unlike OSHA-regulated industries, the mining of sorptive minerals involves the removal of overburden, which can disturb sedimentary and other silica-rich rock that could contain unoccluded respirable crystalline silica. The mining and milling processes generate and expose miners to hazardous dust surrounding the mined deposits. Also, during mineral processing, sorptive minerals may be crushed, heated, dried to remove moisture, re-crushed, and then screened to produce various grades of finished products. These processes have the potential to fracture and change the nature of the surface characteristics of the quartz in the mined commodity. Sorptive minerals have always been subject to MSHA's previous PEL, without exemption.

MSHA examined evidence and references from the commenters and conducted its own review of the scientific literature. MSHA agrees that there is some evidence to suggest that occluded silica is less toxic than unoccluded silica (Wallace *et al.,* 1996). Animal studies involving respirable crystalline silica suggest that the aged form has lower toxicity than the freshly fractured form; however, the aged form still retains significant toxicity (Shoemaker *et al.,* 1995; Vallyathan *et al.,* 1995; Porter *et al.,* 2002c). MSHA finds that ''lower toxicity'' does not imply the absence of adverse health effects. In addition, there is no evidence that occlusion and the initial reduced toxicity persist following deposition and retention of the crystalline silica particles in the lungs.

There have been few epidemiological studies focused on workers exposed to dust generated from sorptive minerals. Examples include Phibbs *et al.* (1971) and Waxweiler *et al.* (1988). These small cohort studies did not evaluate exposures to a wide variety of sorptive minerals and relied on data from outdated exposure assessment methods. These studies neither disprove the health-based risks associated with exposure to respirable crystalline silica nor support a conclusion that sorptive minerals present no risk. Other epidemiological studies of workers exposed to clay-occluded respirable crystalline silica have shown that occupational silicosis can occur among exposed workers (Phibbs *et al.,* 1971; Love *et al.,* 1995, 1999; Chen *et al.,* 2005, 2006, 2012; Harrison *et al.,* 2005). Therefore, MSHA disagrees with these commenters.

MSHA finds that the limited epidemiological data involving sorptive minerals do not refute the conclusions drawn from other epidemiological and toxicological studies included in MSHA's standalone Health Effects document. MSHA concludes, from the best available evidence, that exposure to the crystalline silica present in sorptive minerals poses a risk of material impairment of health or functional capacity to miners. In the Posthearing Brief to OSHA, NIOSH (2014) concluded that ''currently available information is not adequate to inform differential quantitative risk management approaches for crystalline silica that are based on surface property measurements.'' MSHA concurs with NIOSH's recommendation for a single PEL for respirable crystalline silica without consideration of surface properties.

C. Summary of Studies Selected for Modeling

After reviewing the available studies that support quantitative modeling, MSHA selected one exposure-response model from literature for each of the five health outcomes that are modeled in the FRA. These selections and the exposure-response models are discussed below.

1. Silicosis Morbidity

Due to the long latency periods associated with chronic silicosis, OSHA's respirable crystalline silica standard relied on the subset of studies that were able to contact and evaluate many workers through retirement. Studies that included retired workers provides the best available evidence of lifetime risk of silicosis morbidity.

The health endpoint of interest in these studies was the appearance of opacities on chest radiographs indicative of pulmonary pneumoconiosis (a group of lung diseases caused by the lung's reaction to inhaled dusts). The most reliable estimates of silicosis morbidity, as detected by chest X-rays, come from the studies that evaluated those X-rays over time, included radiographic evaluation of workers after they left employment, and derived cumulative or lifetime estimates of silicosis disease risk.

To describe the presence and severity of pneumoconiosis, including silicosis, the International Labour Organization (ILO) developed a standardized system to classify lung opacities identified on chest radiographs (X-rays) (ILO, 1980, 2002, 2011, 2022). The ILO system grades the size, shape, and profusion of opacities. Although silicosis is defined and categorized based on chest X-ray, the X-ray is an imprecise tool for detecting pulmonary pneumoconiosis (Craighead and Vallyathan, 1980; Hnizdo *et al.,* 1993; Rosenman *et al.,* 1997; Cohen and Velho, 2002). Hnizdo *et al.* (1993) recommended that an ILO category 0/1 (or greater) should be considered indicative of silicosis among workers exposed to high respirable crystalline silica concentrations. They noted that the sensitivity of the chest X-ray as a screening test increases with disease severity and to maintain high specificity, category 1/0 (or 1/1) chest X-rays should be considered as a positive diagnosis of silicosis for miners who work in low dust occupations (Hnizdo *et al.,* 1993). MSHA, consistent with NIOSH's use of chest X-rays in their occupational respiratory disease surveillance program (NIOSH, 2014b), agrees that a small opacity profusion score of 1/0 is consistent with chronic silicosis stage 1. Most of the studies reviewed by MSHA considered a finding consistent with an ILO category of 1/1 or greater to be a positive diagnosis of silicosis, although some also considered an X-ray classification of 1/0 or 0/1 to be positive. The low sensitivity of chest radiography to detect minimal silicosis suggests that risk estimates derived from radiographic evidence likely underestimate the true risk of this disease (Craighead and Vallyathan, 1980; Hnizdo *et al.,* 1993; Rosenman *et al.,* 1997; Cohen and Velho, 2002; Hoy *et al.,* 2023).

OSHA summarized the Miller *et al.* (1995, 1998) and Buchanan *et al.* (2003) studies in their final respirable crystalline silica standard in 2016 (OSHA 2016a, 81 FR 16286, 16316). These researchers reported on a 1991 follow-up study of 547 survivors of a 1,416-member cohort of Scottish coal workers from a single mine. These men had all worked in the mine during the period between early 1971 and mid-1976, during which time they had experienced ''unusually high concentrations of freshly cut quartz in mixed coal mine dust.'' The population's exposures to quartz dust had been measured in unique detail for a considerable proportion of the men's working lives (OSHA, 2013b, page 333).

The 1,416 men had previous chest X-rays dating from before, during, or just after this high respirable crystalline silica exposure period. Of these 1,416 men, 384 were identified as having died by 1990/1991. Of the 1,032 remaining men, 156 were untraced, and, of the 876 who were traced and replied, 711 agreed to participate in the study. Of these, the total number of miners who were surveyed was 551. Four of these were omitted, two because of a lack of an available chest X-ray. The 547 surviving miners (age range: 29–85 years, average=59 years) were interviewed and received their follow-up chest X-rays between November 1990 and April 1991. The interviews consisted of questions on current and past smoking habits and occupational history since leaving the coal mine, which closed in 1981. They were also asked about respiratory symptoms and were given a spirometry test (OSHA, 2013b, pages 333–334).

Exposure characterization was based on extensive respirable dust sampling; samples were analyzed for quartz content by IR spectroscopy. Between 1969 and 1977, two coal seams were mined. One had produced quarterly average concentrations of respirable crystalline silica much less than 1,000 μg/m³ (only 10 percent exceeded 300 μg/m³). The other more unusual seam (mined between 1971 and 1976) lay in sandstone strata and generated respirable crystalline silica levels such that quarterly average exposures exceeded 1,000 μg/m³ (10 percent of the quarterly measurements were over 10,000 μg/m³). Thus, this cohort study allowed evaluation of the effects of both higher and lower respirable crystalline silica concentrations and exposure-rate effects on the development of silicosis (OSHA, 2013b, page 334).

Three physicians read each chest film taken during the current survey as well as films from the surveys conducted in 1974 and 1978. Films from an earlier 1970 survey were read only if no films were available from the subsequent two surveys. Silicosis cases were identified if the median classification of the three readers indicated an ILO category of 1/1 or greater (Miller *et al.,* 1995, page 24), plus a progression from the earlier reading. Of the 547 men, 203 (38 percent) showed progression of at least 1 ILO category from the 1970s' surveys to the 1990–91 survey; in 128 of these (24 percent), there was progression of 2 or more ILO categories. In the 1970s' surveys, 504 men had normal chest X-rays; of these, 120 (24 percent) acquired an abnormal X-ray consistent with ILO category 1/0 or greater at the follow-up. Of the 36 men whose X-rays were consistent with ILO category 1/0 or greater in the 1970s' surveys, 27 (75 percent) exhibited further progression at the 1990/1991 follow-up. Only one subject showed a regression from any earlier reading, and that was slight, from 1/0 to 0/1. The earlier Miller *et al.* (1995) report presented results for cases classified as having X-ray films consistent with either 1/0+ and 2/1+ degree of profusion; the Miller *et al.* (1998) analysis and the Buchanan *et al.* (2003) re-analyses emphasized the results from cases having X-rays classified as 2/1+ (OSHA, 2013b, page 334).

MSHA modeled the exposure-response relationship by using cumulative exposure expressed as gram/m³-hours, assuming 2,000 work hours per year and a 45-year working life (after adjusting for full-time equivalents, including miners (excluding contract miners) and contract miners). MSHA estimated risk at the existing standard assuming cumulative exposure to 100 μg/m³ ISO for MNM miners and 85.7 μg/m³ ISO (100 μg/m³ MRE) for coal miners. Respirable crystalline silica exposures were calculated by commodity, and median exposure values were used within a variety of exposure intervals. Risks were computed using a life table methodology which iteratively updated the survival, risk, and mortality rates each year based on the results of the preceding year. Covariates in the regression included smoking, age, amount of coal dust, and percent of quartz in the coal dust during various previous survey periods.

Both Miller *et al.* papers (1995, 1998) presented the results of numerous regression models, and they compared the results of the partial regression coefficients using Z statistics of the coefficient divided by the standard error. Also presented were the residual deviances of the models and the residual degrees of freedom. In the introduction to the results section, Miller *et al.* (1995) stated that, ''in none of the models fitted was there a significant effect of smoking habit (current, ex-smoker, and never smoker), nor was there any evidence of any difference between smoking groups in their relationship of response with age.'' They therefore presented the results of the regression analyses without terms for smoking effects (*i.e.,* without including smoking effects as a variable in the final regression analysis, because they found that smoking did not affect the modeling results). The logistic regression models developed by Miller *et al.* (1995) included terms for cumulative exposure and age. In their later publication, Miller *et al.* (1998) presented models similar to their 1995 report, but without the age variable. Their logistic regression model A from Table 7 of their report (page 56) included only an intercept (−4.32) and the respirable crystalline silica (quartz) cumulative exposure variable (0.416). They estimated that respirable crystalline silica exposure at an average concentration of 100 μg/m³ for 15 years (2.6 gram/m³-hr assuming 1,750 hours worked per year) would result in an increased risk of silicosis (ILO>2/1) of 5 percent (OSHA, 2013b, page 334).

OSHA had a high degree of confidence in the estimates of silicosis morbidity risk from this Scotland coal mine study. This was mainly because of highly detailed and extensive exposure measurements, radiographic records, and detailed analyses of high exposure-rate effects. MSHA has reviewed and agrees with OSHA's conclusion.

Buchanan *et al.* (2003) provided an analysis and risk estimates only for cases having X-ray films consistent with ILO category 2/1+ extent of profusion of opacities, after adjusting for the disproportionately severe effect of exposure to high respirable crystalline silica concentrations. Estimating the risk of 1/0+ profusions from the Buchanan *et al.* (2003) or the earlier Miller *et al.* (1995, 1998) publications can only be roughly approximated because of the summary information included. Table 4 of Miller *et al.* (1998, page 55) presents a cross-tabulation of radiograph progression, using the 12-point ILO scale, from the last baseline examination to the 1990/1991 follow-up visit for the 547 men at the Scottish coal mine. From this table, among miners having both early X-ray films and follow-up films, 44 men had progressed to 2/1+ by the last follow-up and an additional 105 men had experienced the onset of silicosis (*i.e.,* X-ray films were classified as 1/0, 1/1, or 1/2). Thus, by the time of the follow-up, there were three times more miners with silicosis consistent with ILO category 1 than there were miners with a category 2+ level of severity ((105 + 44)/44 = 3.38). This suggests that the Buchanan *et al.* (2003) model, which reflects the risk of progressing to ILO category 2+, underestimates the risk of acquiring radiological silicosis by about three-fold in this population (OSHA, 2013b, page 336). This type of analysis shows that the risk of developing silicosis estimated from the Buchanan *et al.* (2003) and Miller *et al.* (1998) studies is of the same magnitude as the risks reported by Hnizdo and Sluis-Cremer (1993) (OSHA, 2013b, page 338).

MSHA estimated silicosis risk by using the Buchanan *et al.* (2003) model that predicted the lifetime probability of developing silicosis at the 2/1+ category based on cumulative respirable crystalline silica exposures. As discussed previously, MSHA applied the Buchanan *et al.* (2003) model, assuming that miners are exposed for 45 years of working life extending from the start of age 21 through the end of age 65, using a life table approach. Buchanan *et al.* provides an exposure-response model using cumulative exposure in mg/m³-hours as the predictor variable and lifetime risk of silicosis as the outcome variable. MSHA assumed 45 years of exposure, each such year having a duration of 2,000 work hours, scaled by a weighted average FTE ratio that accounts for the average annual hours worked by miners (excluding contract miners) and contract miners.

2. Accelerated Silicosis and Rapidly Progressive Pneumoconiosis (RPP) Study

OSHA concluded in their risk assessment, and MSHA agrees, that there is little evidence of a dose-rate effect at respirable crystalline silica concentrations in the exposure range of 25 μg/m³ to 500 μg/m³ (81 FR 16286, 16396). OSHA noted that the risk estimates derived from the Buchanan *et al.* (2003) study were not appreciably different from those derived from the other studies of silicosis morbidity (see OSHA 2016a, 81 FR 16286, 16386; Table VI–1. *Summary of Lifetime or Cumulative Risk Estimates for Crystalline Silica*). However, OSHA also concluded that some uncertainty related to dose-rate effects exists at concentrations far higher than the exposure range of interest. OSHA stated that it is possible for such a dose-rate effect to impact the results if not properly addressed in study populations with high concentration exposures. OSHA used the model from the Buchanan *et al.* (2003) study in its silicosis morbidity risk assessment to account for possible dose-rate effects at high average concentrations (OSHA 2016a, 81 FR 16286, 16396; OSHA, 2013b, pages 335–342). MSHA has reviewed and agrees with OSHA's conclusions.

NIOSH stated in its post-hearing brief to OSHA that a ''detailed examination of dose rate would require extensive and real time exposure history which does not exist for silica (or almost any other agent)'' (81 FR 16285, 16375). Similarly, Dr. Kenneth Crump, a researcher from Louisiana Tech University Foundation who served on OSHA's peer review panel for the Review of Health Effects Literature and Preliminary Quantitative Risk Assessment, wrote to OSHA that, ''[h]aving noted that there is evidence for a dose rate effect for silicosis, it may be difficult to account for it quantitatively. The data are likely to be limited by uncertainty in exposures at earlier times, which were likely to be higher'' (OSHA 2016a, 81 FR 16286, 16375). OSHA agreed with the conclusions of NIOSH and Dr. Crump. OSHA believed that it used the best available evidence to estimate risks of silicosis morbidity and sufficiently accounted for any dose rate effect at high silica average concentrations by using the Buchanan *et al.* (2003) study as part of their final Quantitative Risk Analysis (QRA) (OSHA 2016a, 81 FR 16286, 16396). MSHA has reviewed and agrees with OSHA's conclusions.

MSHA is using the Buchanan *et al.* (2003) study to explain, in part, the observed cases of progressive lung disease in miners, known as RPP in coal miners (Laney and Attfield, 2010; Wade *et al.,* 2011; Laney *et al.,* 2012b, 2017; Blackley *et al.,* 2016b, 2018b; Almberg *et al.,* 2018a; Reynolds *et al.,* 2018b; Halldin *et al.,* 2019, 2020; Cohen *et al.,* 2022) and accelerated silicosis in MNM miners (Hessel *et al.,* 1988; Mohebbi and Zubeyri, 2007; Dumavibhat *et al.,* 2013). This research explains, in part, the progressive disease observed in shorter-tenured miners. MSHA believes that the risks estimated by the Buchanan *et al.* model can be applied to all mining populations that have similar respirable crystalline silica exposure exceedances. MSHA data also indicate that a smaller number of MSHA samples showed respirable crystalline silica concentrations well above the existing MSHA standard of 100 μg/m³. Over the last 15 years of MNM compliance data, 188 samples (0.3 percent) were over 500 μg/m³; the upper range of exposure was 4,289 μg/m³ ISO (see FRA Table 4 of the FRA document). Over the last 5 years of coal compliance data, eight samples (<0.1 percent) were over 500 μg/m³; the upper range of exposure was 791.4 μg/m³ MRE (see FRA Table 7 of the standalone FRA document).

Analysis provided by Buchanan *et al.* (2003) provides strong evidence of an exposure-rate effect for silicosis in a British Pneumoconiosis Field Research (PFR) coal mining cohort exposed to high levels of respirable crystalline silica over short periods of time (OSHA, 2013b, page 335). Exposure was categorized as pre- and post-1964, the latter period being that of generally higher quartz concentrations used to estimate exposure-rate effects. For the purpose of this analysis, the results were presented for the 371 men (out of the original 547) who were between the ages of 50 and 74 at the time of the 1990/1991 follow-up, ''since they had experienced the widest range of quartz concentrations and showed the strongest exposure-response relations.'' Thus, combined with their exposure history, which went back to pre-1954, many of these men had 30 to 40+ years of highly detailed occupational exposure histories available for analysis. Of these 371 miners, there were 35 men (9.4 percent) who had X-ray films consistent with ILO category 2/1+, with at least 29 of them having progressed from less severe silicosis since the previous follow-up during the 1970s (from Miller *et al.,* 1998) (OSHA, 2013b, page 335).

The Buchanan *et al.* (2003) re-analysis presented logistic regression models in stages. In the final stage of modeling, using only the statistically significant post-1964 cumulative exposures, the authors separated these exposures into, ''two quartz concentration bands, defined by the cut-point 2.0 mg/m³.'' This yielded the final simplified equation, adapted from Buchanan *et al.,* 2003, page 162:

$$\log\left(\frac{p_2}{1-p_2}\right) = -4.83 + 0.443 * E_{<2} + 1.323 * E_{>2})$$

where p_2 is the probability of profusion category 2/1 or higher (2/1+) at follow-up and E is the cumulative exposure.

In this model, both the cumulative exposure concentration variables were ''highly statistically significant in the presence of the other'' (Buchanan *et al.,* 2003, page 162). Since these variables were in the same units, mg/m³-hr, the authors noted that the coefficient for exposure concentrations >2,000 μg/m³ (>2.0 mg/m³) was three times that for the concentrations <2,000 μg/m³ (<2.0 mg/m³). They concluded that their latest analysis showed that ''the risk of silicosis over a working lifetime can rise dramatically with exposure to such high concentrations over a timescale of merely a few months'' (Buchanan *et al.,* 2003, page 163; OSHA, 2013b, page 336).

Buchanan *et al.* (2003) also used these models to estimate the risk of acquiring a chest X-ray classified as ILO category 2/1+, 15 years after exposure ends, as a function of low <2,000 μg/m³ (<2.0 mg/m³) and high >2,000 μg/m³ (>2.0 mg/m³) quartz concentrations. OSHA chose to use this model to estimate the risk of radiological silicosis consistent with an ILO category 2/1+ chest X-ray for several exposure scenarios. They assumed 45 years of exposure, 2,000 hours/year of exposure, and no exposure above a concentration of 2,000 μg/m³ (2.0 mg/m³) (OSHA, 2013b, page 336).

Buchanan *et al.* (2003) used these models to estimate the combined effect on the predicted risk of low quartz exposures (*e.g.,* 100 μg/m³, equal to 0.1 mg/m³) and short-term exposures to high quartz concentrations (*e.g.,* 2,000 μg/m³, equal to 2 mg/m³). Predicted risks were estimated for miners who progressed to silicosis level 2/1+ 15 years after exposure ended. This analysis showed the increase in predicted risk with relatively short periods of quartz exceedance exposures, over 4, 8, and 12 months. Buchanan *et al.* predicted a risk of 2.5 percent for 15 years quartz exposure to 100 μg/m³ (0.1 mg/m³). This risk increased to 10.6 percent with the addition of only 4 months of exposure at the higher concentration. The risk increased further to 72 percent with 12 months at the higher exposure of 2,000 μg/m³ (2.0 mg/m³).

The results indicated miners exposed to exceedances above MSHA's existing standard could develop progression of silicosis at an exaggerated rate. The results of Buchanan *et al.* also indicated that miners' exposure to exceedances at the new PEL will also suffer increased risk of developing progressive disease, though at a reduced rate (see Buchanan *et al.* (2003), Table 4, page 163).

MSHA used a life table approach to estimate the lifetime excess silicosis morbidity from age 21 to age 80, assuming exposure from the start of age 21 through the end of age 65 (45 years of working life) and an additional 15 years of potential illness progress thereafter. MSHA used the Buchanan *et al.* (2003) model to estimate the effect of respirable crystalline silica exposure exceedances as seen in MSHA's compliance data on miners' silicosis risk at the existing and new standard. The model predicted the probability of developing silicosis at the 2/1+ category based on cumulative respirable crystalline silica exposures. Age-specific cumulative risk was estimated as 1/(1+EXP(−(−4.83+0.443*cumulative exposure))). The model determined that even at 17.4 hours on average per year at an exposure of 1,500 μg/m³ (1.50 mg/m³), miners' risk of developing 2/1+ silicosis increased from a baseline of 24.8/1,000 to 29.0/1,000 at the existing standard and 14/1,000 to 16.6/1,000 at the new standard. Of course, the more hours exposed to these levels of respirable crystalline silica resulted in even higher increased risk. It is important to note that NIOSH's X-ray classification of the lowest case of pneumoconiosis is 1/0 profusion of small opacities (NIOSH, 2008c, page A–2). Using a case definition of level 2/1+, the miners studied by Buchanan *et al.* (2003) would be more likely to show clinical signs of disease. MSHA emphasizes the importance of maintaining miner exposure to respirable crystalline silica at or below the 50 μg/m³ PEL to minimize these health risks as much as possible.

3. Silicosis and NMRD Mortality

Silicosis mortality was ascertained in the studies included in the pooled analysis by Mannetje *et al.* (2002b). These studies included cohorts of U.S. diatomaceous earth workers (Checkoway *et al.,* 1997), Finnish granite workers (Koskela *et al.,* 1994), U.S. granite workers (Costello and Graham, 1988), U.S. industrial sand workers (Steenland and Sanderson, 2001), U.S. gold miners (Steenland and Brown, 1995b), and Australian gold miners (de Klerk and Musk, 1998). The researchers analyzed death certificates across all cohorts for cause of death. OSHA relied upon the published, peer-reviewed, pooled analysis of six epidemiological studies first published by Mannetje *et al.* (2002b) and a sensitivity analysis of the data conducted by ToxaChemica International, Inc. (2004). OSHA used the model described by Mannetje *et al.* (2002b) and the rate ratios that were estimated from the ToxaChemica, International Inc. sensitivity analysis to estimate the risks of silicosis mortality. This process better controlled for age and exposure measurement uncertainty (OSHA, 2013b, page 295). MSHA has reviewed and agrees with OSHA's conclusions. These studies are summarized below, including detailed discussion and analysis of uncertainty in the studies and associated risk estimates.

OSHA found that the estimates from Mannetje *et al.* (2002b) and ToxaChemica Inc. probably understated the actual risk because silicosis is underreported as a cause of death since there is no nationwide system for collecting silicosis morbidity case data (OSHA, 2016a, 81 FR 16286, 16325). To help address this uncertainty, OSHA also included an exposure-response analysis of diatomaceous earth workers (Park *et al.,* 2002). This analysis better recognized the totality of respirable crystalline silica-related respiratory disease than the datasets of Mannetje *et al.* (2002b) and ToxaChemica International Inc. (2004). Information from the Park *et al.* (2002) study (described in the next subsection) was used to quantify the relationship between cristobalite exposure and mortality caused by NMRD, which includes silicosis, pneumoconiosis, emphysema, and chronic bronchitis. The category of NMRD captures much of the silicosis misclassification that results in underestimation of the disease. NMRD also includes risks from other lung diseases associated with respirable crystalline silica exposures. OSHA found the risk estimates derived from Park *et al.* (2002) were important to include in their range of estimates of the risk of death from respirable crystalline silica-related respiratory diseases, including silicosis (OSHA, 2013b, pages 297–298). OSHA concluded that the ToxaChemica International Inc. (2004) re-analysis of Mannetje *et al.*'s (2002b) silicosis mortality data and Park *et al.*'s (2002) study of NMRD mortality provided a credible range of estimates of mortality risk from silicosis and NMRD across many workplaces. The upper end of this range, based on the Park *et al.* (2002) study, is less likely to underestimate risk because of underreporting of silicosis mortality. However, risk estimates from studies focusing on cohorts of workers from different industries cannot be directly compared (OSHA 2016a, 81 FR 16286, 16397).

a. Silicosis Mortality: Mannetje et al. (2002b); ToxaChemica, International, Inc. (2004)

Mannetje *et al.* (2002b) relied upon the epidemiological studies contained within the Steenland *et al.* (2001a) pooled analysis of lung cancer mortality that also included extensive data on silicosis. The six cohorts included:

(1) U.S. diatomaceous earth workers (Checkoway *et al.,* 1997),

(2) Finnish granite workers (Koskela *et al.,* 1994),

(3) U.S. granite workers (Costello and Graham, 1988),

(4) U.S. industrial sand workers (Steenland and Sanderson, 2001),

(5) U.S. gold miners (Steenland and Brown, 1995b), and

(6) Australian gold miners (de Klerk and Musk, 1998).

These six cohorts contained 18,364 workers and 170 silicosis deaths, where silicosis mortality was defined as death from silicosis (ICD–9 502, n=150) or from unspecified pneumoconiosis (ICD–9 505, n=20). Table VI–3 provides information on each cohort, including size, time period studied, overall number of deaths, and number of deaths identified as silicosis for the pooled analysis conducted by Mannetje *et al.* (2002b). The authors stated this definition may have underestimated the number of silicosis deaths some of which may have been misclassified as other causes (*e.g.,* tuberculosis or COPD without mention of pneumoconiosis). Four cohorts were not included in the silicosis mortality study. The three Chinese studies did not use the ICD to code cause of death. In the South African gold miner study, silicosis was not generally recognized as an underlying cause of death. Thus, it did not appear on death certificates (OSHA, 2013b, page 292).

Table VI-3: Summary of Cohort Studies Used in the Pooled Analysis for Silicosis Mortality

Author	Cohort	Size of cohort	Time period of study	Number of deaths	Number of silicosis deaths
Checkoway *et al.*, 1997	U.S. diatomaceous earth	2,342	1942-1994	749	15 ("other" NMRD, including silicosis)
Koskela *et al.*, 1994	Finnish granite	1,026	1940-1993	418	14
Costello and Graham, 1988	U.S. granite	5,408	1950-1982	1,762	43
Steenland *et al.*, 2001b	U.S. industrial sand	4,027	1974-1996	860	15
Steenland and Brown, 1995b	U.S. gold miners	3,348	1940-1996	1,925	39
de Klerk and Musk, 1998	Australian surface and underground gold miners	2,213	1961-1993	1,351	44
	Total	18,364		7,065	170

Adapted from Mannetje *et al.* (2002b)
Source: OSHA, 2013b, page 293.

Mannetje *et al.* (2002a) described the exposure assessments developed for the pooled analysis. Exposure information from each of the 10 cohort studies varied and included dust measurements representing particle counts, mass of total dust, and respirable dust mass. Measurement methods also changed over time for each of the cohort studies. Generally, sampling was performed using impingers in earlier decades, and gravimetric techniques later. Exposure data based on analysis for respirable crystalline silica by XRD (the current method of choice) were available only from the study of U.S. industrial sand workers. To develop cumulative exposure estimates for all cohort members and to pool the cohort data, all exposure data were converted to units of μg/m³ (mg/m³) respirable crystalline silica. Cohort-specific conversion factors were generated based on the silica content of the dust to which workers were exposed. In some instances, results of side-by-side comparison sampling were available. Within each cohort, available job- or process-specific information on the silica composition or nature of the dust was used to reconstruct respirable crystalline silica exposures. Most of the studies did not have exposure measurements prior to the 1950s. Exposures occurring prior to that time were estimated either by assuming such exposures were the same as the earliest recorded for the cohort or by modeling that accounted for documented changes in dust control measures.

To evaluate the reasonableness of the exposure assessment for the lung cancer pooled study, Mannetje *et al.* (2002a) investigated the relationship between silicosis mortality and cumulative exposure. They performed a nested case-control analysis for silicosis or unspecified pneumoconiosis using conditional logistic regression. Since exposure to respirable crystalline silica is the sole cause of silicosis, any finding for which cumulative exposure was unrelated to silicosis mortality risk would suggest that serious misclassification of the exposures assigned to cohort members occurred. Cases and controls were matched for race, sex, age (within 5 years), and 100 controls were matched to each case. Each cohort was stratified into quartiles by cumulative exposure. Standardized rate ratios (SRRs) were calculated using the lowest-exposure quartile as the baseline. Odds ratios (ORs) were also calculated for the pooled data set overall, which was stratified into quintiles based on cumulative exposure. For the pooled data set, the relationship between the ORs for silicosis mortality and cumulative exposure, along with each of the 95 percent confidence intervals (95% CI), were as follows:

(1) 4,450 μg/m³-years (4.45 mg/m³-years), OR=3.1 (95% CI: 2.5–4.0);

(2) 9,080 μg/m³-years (9.08 mg/m³-years), OR=4.6 (95% CI: 3.6–5.9);

(3) 16,260 μg/m³-years (16.26 mg/m³-years), OR=4.5 (95% CI: 3.5–5.8); and

(4) 42,330 μg/m³-years (42.33 mg/m³-years), OR=4.8 (95% CI: 3.7–6.2).

In addition, in seven of the cohorts, there was a statistically significant trend between silicosis mortality and cumulative exposure. For two of the cohorts (U.S. granite workers and U.S. gold miners), the trend test was not statistically significant (p=0.10). An analysis could not be performed on the South African gold miner cohort because silicosis was never coded as an underlying cause of death, apparently due to coding practices in that country.

Based on this analysis, Mannetje *et al.* (2002a) concluded that the exposure-response relationship for the pooled data set was ''positive and reasonably monotonic.'' That is, the response increased with increasing exposure. The results also indicated that the exposure assessments provided reasonable estimates of cumulative exposures. In addition, despite some large differences in the range of cumulative exposures between cohorts, a clear positive exposure-response trend was evident in seven of the cohorts (OSHA, 2013b, page 271).

Furthermore, in their pooled analysis of silicosis mortality for six of the cohorts, Mannetje *et al.* (2002b) found a clear and consistently positive response with increasing decile of cumulative exposure, although there was an anomaly in the 9th decile. Overall, these data supported a monotonic exposure-response relationship for silicosis. Although some exposure misclassification almost certainly existed in the pooled data set, the authors concluded that exposure estimates did not appear to have been sufficiently misclassified to obscure an exposure-response relationship (OSHA, 2013b, page 271).

As part of an uncertainty analysis conducted for OSHA, Drs. Steenland and Bartell (ToxaChemica International, Inc., 2004) examined the quality of the original data set and analysis to identify and correct any data entry, programming, or reporting errors (ToxaChemica International, Inc., 2004). This quality assurance process revealed a small number of errors in exposure calculations for the originally reported results. Primarily, these errors resulted from rounding of job class exposures when converting the original data file for use with a different statistical program. Although the corrections affected some of the exposure-response models for individual cohorts, ToxaChemica International, Inc. (2004) reported that models based on the pooled dataset were not impacted by the correction of these errors (OSHA, 2013b, pages 271–272).

Silicosis mortality was evaluated using standard life table analysis in Mannetje *et al.* (2002b). Poisson regression, using 10 categories of cumulative exposure and adjusting for age, calendar time, and cohort, was conducted to derive silicosis mortality rate ratios using the lowest exposure group of 0–100 μg/m³-years (0–0.1 mg/m³-year) as the referent group. More detailed exploration of the exposure-response relationship using a variety of exposure metrics, including cumulative exposure, duration of exposure, average exposure (calculated as cumulative exposure/duration), and the log transformations of these variables, was conducted via nested case-control analyses (conditional logistic regression). Each case was matched to 100 controls selected from among those who had survived to at least the age of the case, with additional matching on cohort, race, sex, and date of birth within 5 years. The authors explored lags of 0, 5, 10, 15, and 20 years, noting that there is no *a priori* reason to apply an exposure lag, as silicosis can develop within a short period after exposure. However, a lag could potentially improve the model, as there is often a considerable delay in the development of silicosis following exposure. In addition to the parametric conditional logistic regression models, the authors performed some analyses using a cubic-spline model, with knots at 5, 25, 50, 75, and 95 percent of the distribution of exposure. Models with cohort-exposure interaction terms were fit to assess heterogeneity between cohorts (OSHA, 2013b, page 294).

The categorical analysis found a nearly monotonic increase in silicosis rates with cumulative exposure, from 4.7 per 100,000 person-years in the lowest exposure category (0–990 μg/m³-years [0–0.99 mg/m³-years]) to 299 per 100,000 person-years in the highest exposure category (>28,000 μg/m³-years [>28 mg/m³-years]). Nested case-control analyses showed a significant association between silicosis mortality and cumulative exposure, average exposure, and duration of exposure. The best-fitting conditional logistic regression model used log-transformed cumulative exposure with no exposure lag, with a model χ^2 of 73.2 versus χ^2 values ranging from 19.9 to 30.9 for average exposure, duration of exposure, and untransformed cumulative exposure (1 degree of freedom). No significant heterogeneity was found between individual cohorts for the model based on log-cumulative exposure. The cubic-spline model did not improve the model fit for the parametric logistic regression model using the log-cumulative exposure (OSHA, 2013b, page 294).

Mannetje *et al.* (2002b) developed estimates of silicosis mortality risk through age 65 for two levels of exposure (50 and 100 μg/m³ respirable crystalline silica), assuming a working life of occupational exposure from age 20 to 65. Risk estimates were calculated based on the silicosis mortality rate ratios derived from the categorical analysis described above. The period of time over which workers' exposures and risks were calculated (age 20 to 65) was divided into one-year intervals. The mortality rate used to calculate risk in any given interval was dependent on the worker's cumulative exposure at that time. The equation used to calculate risk is as follows:

$$\text{Risk} = 1 - \exp\left(-\sum_{i=20}^{65} \text{time}_i * \text{rate}_i\right)$$

Where time_i is equal to 1 year for every age *i*, and rate_i is the age-, calendar time-, and cohort adjusted silicosis mortality rate associated with the level of cumulative exposure acquired at age *i,* as presented in Mannetje *et al.* (2002b, Table 2, page 725). The calculated absolute risks equal the excess risks since there is no background rate of silicosis in the exposed population. Mannetje *et al.* (2002b) estimated the lifetime risk of death from silicosis, assuming 45 years of exposure to 100 μg/m³, to be 13 deaths per 1,000 workers; at an exposure of 50 μg/m³, the estimated lifetime risk was 6 per 1,000. Confidence intervals (CIs) were not reported (OSHA, 2013b, page 295).

In summary, OSHA's estimates of silicosis morbidity risks were based on studies of active and retired workers for which exposure histories could be constructed and chest X-ray films could be evaluated for signs of silicosis. MSHA agrees with OSHA's estimate of silicosis morbidity risks.

There is evidence in the record that chest X-ray films are relatively insensitive to detecting lung fibrosis (OSHA 2016a, 81 FR 16286, 16397). Hnizdo *et al.* (1993) found chest X-ray films to have low sensitivity for detecting lung fibrosis related to initial cases of silicosis, compared to pathological examination at autopsy. To address the low sensitivity of chest X-rays for detecting silicosis, Hnizdo *et al.* (1993) recommended that radiographs consistent with an ILO category of 0/1 or greater be considered indicative of silicosis among workers exposed to a high concentration of respirable crystalline silica-containing dust. In like manner, to maintain high specificity, chest X-rays classified as category 1/0 or 1/1 should be considered as a positive diagnosis of silicosis in miners who work in low dust (0.2 mg/m³) occupations. The studies on which OSHA relied in its risk assessment typically used an ILO category of 1/0 or greater to identify cases of silicosis. According to Hnizdo *et al.* (1993), they were unlikely to have included many false positives (*i.e.,* assumed diagnosis of silicosis in a miner without the disease), but may have included false negatives (*i.e.,* failure to identify cases of silicosis). Thus, in OSHA's risk assessment, the use of chest X-rays to ascertain silicosis cases in the morbidity studies may have underestimated risk given the X-rays' low sensitivity to detect disease. MSHA agrees with OSHA's assessment.

To estimate the risk of silicosis mortality at the then existing and then proposed exposure limits, OSHA used the categorical model described by Mannetje *et al.* (2002b) but did not rely upon the Poisson regression in their study. Instead, OSHA used rate ratios estimated from a nested case-control design implemented as part of a sensitivity analysis (ToxaChemica International, Inc., 2004). The case-control design was selected because it was expected to better control for age. In addition, the rate ratios derived from the case control study were derived from a Monte Carlo analysis to reflect exposure measurement uncertainty (See ToxaChemica International, Inc. (2004), Table 7, page 40). The rate ratio for each interval of cumulative exposure was multiplied by the annual silicosis rate assumed to be associated with the lowest exposure interval, 4.7 per 100,000 for exposures of 990 μg/m^3-years (0.99 mg/m^3-years), to estimate the silicosis rate for each interval of exposure. The lifetime silicosis mortality risk is the sum of the silicosis rate for each year of life through age 85 and assuming exposure from age 20 to 65. From this analysis, OSHA estimated the silicosis mortality risk for exposure to the then existing general industry exposure limit (100 μg/m^3) and then proposed exposure limit (50 μg/m^3) to be 11 (95% CI 5–37) and 7 (95% CI 3–21) deaths per 1,000 workers, respectively. For exposure to 250μg/m^3 (0.25 mg/m^3) and 500 μg/m^3 (0.5 mg/m^3), the range approximating the then existing construction/shipyard exposure limit, OSHA estimated the risk to range from 17 (95% CI 5–66) to 22 (95% CI 6–85) deaths per 1,000 workers (OSHA, 2013b, page 294–295).

In view of the aforementioned discussion, MSHA agrees with OSHA's analysis, and MSHA also selected the Mannetje *et al.* (2002b) study for estimating silicosis mortality risks and cases. MSHA used a life table analysis to estimate the lifetime excess silicosis mortality through age 80. To estimate the age-specific risk of silicosis mortality at the existing standards, the new PEL, and the action level, MSHA used the same categorical model that OSHA used in their PQRA (as described above from Mannetje *et al.,* 2002b; ToxaChemica International, Inc., 2004) to estimate lifetime risk following cumulative exposure of 45 years. MSHA used the 2018 all-cause mortality rates (NCHS, Underlying Cause of Death, 2018 on CDC WONDER Online Database, released in 2020b) as all-cause mortality rates. As stated previously, the general (unexposed) population is assumed to have silicosis mortality rates equal to zero.

In response to MSHA's question about the PRA in the proposed rule, the NVMA cited a 2021 study examining silica exposure in artificial stone workers, which this commenter asserted found higher prevalence of silicosis amongst those who did not use personal protective equipment (PPE) and amongst tobacco users (Requena-Mullor *et al.,* 2021) (Document ID 1441). This commenter continued that wearing respirators is a beneficial aid in protecting workers and that other technological advances in the mining industry have reduced exposures to respirable crystalline silica. However, this commenter did not elaborate on how the cited study or the technological advances within the industry relate to MSHA's risk analysis or whether the commenter believes the presented information indicate any weaknesses or shortcomings in MSHA's modeling. Further, the particular study this commenter cited did not find a statistically significant difference between tobacco users and non-tobacco users (Requena-Mullor *et al.,* 2021).

MSHA acknowledges that the relationship between exposure to respirable crystalline silica and silicosis may be confounded by several variables, including smoking. However, confounders are discussed in the FRA and were considered by the original authors of the studies MSHA selected for modeling. Park *et al.* (2002), which MSHA used to model NMRD mortality, fit a model that was stratified on smoking status. Mannetje *et al.* (2002b) did not account for smoking but noted that "no effect of smoking was detected in a study of Colorado miners." Moreover, the Mannetje *et al.* (2002b) model was used to determine how many of the NMRD deaths were attributable to silicosis as opposed to other forms of NMRD. The total estimate for NMRD deaths including silicosis is based on Park *et al.* (2002), which did account for smoking status. Buchanan *et al.* (2003), which MSHA used to estimate silicosis morbidity, originally included smoking status as a covariate, but the authors removed this variable from the final model because it did not improve the model fit by a statistically significant amount. Further, regarding the commenter's assertion that technological advancements in the mining industry may reduce exposure levels, these reductions are accounted for in the models, which use recent exposure data.

b. NMRD Mortality: Park et al. (2002)

In addition to causing silicosis, exposure to respirable crystalline silica causes increased risks of other NMRD. These include chronic obstructive pulmonary disease (COPD), which includes chronic bronchitis, emphysema, and combinations of the two, and is a cause of chronic airways obstruction. COPD is characterized by airflow limitation that is usually progressive and not fully reversible. OSHA reviewed several studies of NMRD morbidity and used a study by Park *et al.* (2002) to assess NMRD risk. Checkoway *et al.* (1997) originally studied a California diatomaceous earth cohort for which Park *et al.* (2002) then analyzed the effect of respirable crystalline silica exposures on the development of NMRD. The authors quantified the relationship between exposure to cristobalite and mortality from NMRD (OSHA, 2013b, page 295).

The California diatomaceous earth cohort consisted of 2,570 diatomaceous earth workers employed for 12 months or more from 1942 to 1994. As noted above, Park *et al.* (2002) was interested in the relationship between cristobalite exposure and mortality from chronic lung disease other than cancer (LDOC). LDOC included chronic diseases such as pneumoconiosis (which included silicosis), chronic bronchitis, and emphysema, but excluded pneumonia and other infectious diseases. The researchers selected LDOC as the health endpoint for three reasons. First, increased mortality from LDOC had been documented among respirable crystalline silica-exposed workers in several industry sectors, including gold mining, pottery, granite, and foundry industries. Second, the authors pointed to the likelihood that silicosis as a cause of death is often misclassified as emphysema or chronic bronchitis. Third, the number of deaths from the diatomaceous earth worker cohort that were attributed to silicosis was too small (10) for analysis. Industrial hygiene data for the cohort were available from the employer for total dust, respirable crystalline silica (mostly cristobalite), and asbestos. Smoking information was available for about 50 percent of the cohort and for 22 of the 67 LDOC deaths available for analysis, permitting Park *et al.* (2002) to partially adjust for smoking (OSHA, 2013b, pages 295–296).

Park *et al.* (2002) used the exposure assessment previously reported by Seixas *et al.* (1997) and used by Rice *et al.* (2001) to estimate cumulative respirable crystalline silica exposures for each worker in the cohort based on detailed work history files. The average respirable crystalline silica concentration for the cohort was 290 μg/m³ (0.29 mg/m³) over the period of employment (Seixas *et al.,* 1997). The total respirable dust concentration in the diatomaceous earth plant was 3,550 μg/m³ (3.55 mg/m³) before 1949 and declined by more than 10-fold after 1973, to 290 μg/m³ (0.29 mg/m³) (Seixas *et al.,* 1997). The concentration of respirable crystalline silica in the dust ranged from 1 to 25 percent and was dependent on the location within the worksite. It was lowest at the mine and greatest in the plant where the raw ore was calcined into final product. The average cumulative exposure values for total respirable dust and respirable crystalline silica were 7,310 μg/m³-year (7.31 mg/m³-year) and 2,160 μg/m³-year (2.16 mg/m³-year), respectively. The authors also estimated cumulative exposure to asbestos (OSHA, 2013b, page 296).

Using Poisson regression models and Cox proportional hazards models, the authors fit the same series of relative rate exposure-response models that were evaluated by Rice *et al.* (2001) for lung cancer (*i.e.,* log-linear, log-square root, log-quadratic, linear relative rate, a power function, and a shape function). In general form, the relative rate model was:

$$\text{Rate} = \exp(\alpha_0) \times f(E),$$

where $\exp(a_0)$ is the background rate and E is the cumulative respirable crystalline silica exposure. Park *et al.* (2002) also employed an additive excess rate model of the form:

$$\text{Rate} = \exp(\alpha_0) + \exp(\alpha_E),$$

Relative or excess rates were modeled using internal controls and adjusting for age, calendar time, ethnicity, and time since first entry into the cohort. In addition, relative rate models were evaluated using age- and calendar time-adjusted external standardization to U.S. population mortality rates for 1940 to 1994 (OSHA, 2013b, page 296).

There were no LDOC deaths recorded among workers having cumulative exposures above 32,000 μg/m³-years (32 mg/m³-years), causing the response to level off or decline in the highest exposure range. The authors believed the most likely explanation for this observation (which was also observed in their analysis of silicosis morbidity in this cohort) was some form of survivor selection, possibly smokers or others with compromised respiratory function leaving work involving extremely high dust concentrations. These authors suggested several alternative explanations. First, there may have been a greater depletion of susceptible populations in high dust areas. Second, there may have been greater misclassification of exposures in the earlier years where exposure data were lacking (and when exposures were presumably the highest) (OSHA, 2013b, pages 296–297).

Therefore, Park *et al.* (2002) performed exposure-response analyses that restricted the dataset to observations where cumulative exposures were below 10,000 μg/m³-years (10 mg/m³-years). This is a level more than four times higher than that resulting from 45 years of exposure to the former OSHA PEL for cristobalite (which was 50 μg/m³ (0.05 mg/m³) when cristobalite was the only polymorph present). These researchers also conducted analyses using the full dataset (OSHA, 2013b, page 297).

Model fit was assessed by evaluating the decrease in deviance resulting from addition of the exposure term, and cubic-spline models were used to test for smooth departures from each of the model forms described. Park *et al.* (2002) found that both lagged and unlagged models fit well, but unlagged models provided a better fit. In addition, they believed that unlagged models were biologically plausible in that recent exposure could contribute to LDOC mortality. The Cox proportional hazards models yielded results that were similar to those from the Poisson analysis. Consequently, only the results from the Poisson analysis were reported. In general, the use of external adjustments for age and calendar time yielded considerably improved fit over models using internal adjustments. The additive excess rate model also proved to be clearly inferior compared to the relative rate models. With one exception, the use of cumulative exposure as the exposure metric consistently provided better fits to the data than did intensity of exposure (*i.e.,* cumulative exposure divided by duration of exposure). As to the exception, when the highest-exposure cohort members were included in the analysis, the log-linear model produced a significantly improved fit with exposure intensity as the exposure metric, but a poor fit with cumulative exposure as the metric (OSHA, 2013b, page 297).

Among the models based on the restricted dataset [excluding observations with cumulative exposures greater than 10,000 μg/m³-years (10 mg/m³-years)], the best-fitting model with a single exposure term was the linear relative rate model using external adjustment. Most of the other single-term models using external adjustment fit almost as well. Of the models with more than one exposure term, the shape model provided no improvement in fit compared with the linear relative rate model. The log-quadratic model fit slightly better than the linear relative rate model, but Park *et al.* (2002) did not consider the gain in fit sufficient to justify an additional exposure term in the model (OSHA, 2013b, page 297).

Based on its superior fit to the cohort data, Park *et al.* (2002) selected the linear relative rate model with external adjustment and use of cumulative exposure as the basis for estimating LDOC mortality risks among exposed workers. Competing mortality was accounted for using U.S. death rates published by the National Center for Health Statistics (1996). The authors estimated the lifetime excess risk for white men exposed to respirable crystalline silica (mainly cristobalite) for 45 years at 50 μg/m³ (0.05 mg/m³) to be 54 deaths per 1,000 workers (95% CI: 17–150) using the restricted dataset, and 50 deaths per 1,000 using the full dataset. For exposure to 100 μg/m³ (0.1 mg/m³), they estimated 100 deaths per 1,000 using the restricted dataset, and 86 deaths per 1,000 using the full dataset. The CIs were not reported (OSHA, 2013b, page 297).

The estimates of Park *et al.* (2002) were about eight to nine times higher than those that were calculated for the pooled analysis of silicosis mortality (Mannetje *et al.,* 2002b). Also, these estimates are not directly comparable to those from Mannetje *et al.* (2002b) because the mortality endpoint for the Park *et al.* (2002) analysis was death from all non-cancer lung diseases beyond silicosis (including pneumoconiosis, emphysema, and chronic bronchitis). In the pooled analysis by Mannetje *et al.* (2002b), only deaths coded as silicosis or other pneumoconiosis were included (OSHA, 2013b, pages 297–298).

Less than 25 percent of the LDOC deaths in the Park *et al.* (2002) analysis were coded as silicosis or other pneumoconiosis (15 of 67). As noted by Park *et al.* (2002), it is likely that silicosis as a cause of death is often misclassified as emphysema or chronic bronchitis (although COPD is part of the spectrum of disease caused by respirable crystalline silica exposure and can occur in the absence of silicosis). Thus, the selection of deaths by Mannetje *et al.* (2002b) may have underestimated the true risk of silicosis mortality. The analysis by Park *et al.* (2002) would have more fairly captured the total respiratory mortality risk from all non-malignant causes, including silicosis and chronic obstructive pulmonary disease. Furthermore, Park *et al.* (2002) used untransformed cumulative exposure in a linear model compared to the log-transformed cumulative exposure metric used by Mannetje *et al.* (2002b). This would have caused the exposure-response relationship to flatten in the higher exposure ranges (OSHA, 2013b, page 298).

It is also possible that some of the difference between Mannetje *et al.'*s (2002b) and Park *et al.'*s (2002) risk estimates reflected factors specific to the nature of exposure among diatomaceous earth workers (*e.g.,* exposure to cristobalite vs. quartz). However, neither the cancer risk assessments nor assessments of silicosis morbidity supported the hypothesis that cristobalite is more hazardous than quartz (OSHA, 2013b, page 298).

Based on the available risk assessments for silicosis mortality, OSHA believed that the estimates from the pooled study by Mannetje *et al.'*s (2002b) likely underestimated mortality risk given that the study only counted deaths where silicosis was specifically identified on death certificates, which are prone to misclassification. In contrast, the risk estimates provided by Park *et al.* (2002) for the diatomaceous earth cohort would have captured some of this misclassification and included risks from other lung diseases (*e.g.,* emphysema, chronic bronchitis) that have been associated with respirable crystalline silica exposure. Therefore, OSHA believed that the Park *et al.* (2002) study provided a better basis for estimating the respirable crystalline silica-related risk of NMRD mortality, including that from silicosis. Based on Park *et al.'*s (2002) linear relative rate model [$RR = 1 + \beta x$, where $\beta = 0.5469$ (no standard error reported) and x = cumulative exposure], OSHA used a life table analysis to estimate the lifetime excess NMRD mortality through age 85. For this analysis, OSHA used all-cause and cause-specific background mortality rates for all males (National Center for Health Statistics, 2009). Background rates for NMRD mortality were based on rates for ICD–10 codes J40–J47 (chronic lower respiratory disease) and J60–J66 (pneumoconiosis). OSHA believed that these corresponded closely to the ICD–9 disease classes (ICD 490–519) used by the original researchers. According to CDC (2001), background rates for chronic lower respiratory diseases were increased by less than five percent because of the reclassification to ICD–10. From the life table analysis, OSHA estimated that the excess NMRD risk due to respirable crystalline silica exposure at the former general industry PEL (100 $\mu g/m^3$) and at OSHA's final PEL (50 $\mu g/m^3$) for 45 years are 83 and 43 deaths per 1,000, respectively. For exposure at the former construction/shipyard exposure limit, OSHA estimated that the excess NMRD risk ranged from 188 to 321 deaths per 1,000 (OSHA, 2013b, page 298).

Following its own independent review, MSHA agrees with and has followed the rationale presented by OSHA in its selection of the Park *et al.* (2002) model to estimate NMRD mortality risk in miners.

MSHA used a life table analysis to estimate the lifetime excess NMRD mortality through age 80. MSHA used the Park *et al.* (2002) model to estimate age-specific NMRD mortality risk as 1 + 0.5469 * cumulative exposure. MSHA used all-cause and cause-specific background mortality rates for all males for 2018 (National Center for Health Statistics, Underlying Cause of Death 2018 on CDC WONDER Online Database, released in 2020b). Background rates for NMRD mortality were based on rates for ICD–10 codes J40–J47 (chronic lower respiratory disease) and J60–J66 (pneumoconiosis).

A state mining association cited CDC data to state that the largest decrease in pneumoconiosis deaths over the 1999–2018 time period was in the coal mining industry, with a decrease of 69.6 percent, and the largest increase was in the OSHA construction sector (Bell and Mazurek, 2020) (Document ID 1368). This commenter also stated that, beyond the CDC data, there is little understanding of pneumoconiosis case attribution, such as what percentage of cases were specifically due to mining-related employment compared to non-mining activities that might lead to harmful exposure. The commenter's point that it is difficult to correctly attribute pneumoconiosis is precisely why MSHA's FRA has relied on peer-reviewed epidemiological studies, which control for confounders where necessary and quantify the precise exposure-response relationship. Regarding pneumoconiosis, the cited article was about declining pneumoconiosis *deaths* in particular. Other sources, including analysis by NIOSH, show that the prevalence of pneumoconiosis *illness* has risen substantially among miners since the 1990s (NIOSH, 2021d). This same trend in pneumoconiosis illness among coal miners was also mentioned by three other commenters—the ACLC, Appalachian Voices, and the UMWA (Document ID 1445; 1425; 1398). While it may be true that prevalence of pneumoconiosis deaths decreased among the entire U.S. population during this period, trends in pneumoconiosis deaths tend to lag trends in pneumoconiosis illness because people can live many years with the disease prior to death. The increasing prevalence of the illness among miners indicates that pneumoconiosis deaths also are expected to rise in the future. In addition, trends among the full U.S. population may not reflect trends among miners in particular, since the mining workforce has decreased in size since the 1990s. Thus, MSHA does not believe that pneumoconiosis illnesses or deaths among coal miners would decline in the future in the absence of this rule and, therefore, affirms that the final rule is needed to protect the health of all miners from various respirable crystalline silica-related diseases.

4. Lung Cancer Mortality

Since the publication of OSHA's final rule in 2016, NIOSH has published two documents concerning occupational carcinogens, *Chemical Carcinogen Policy* (2017b) and *Practices in Occupational Risk Assessment* (2019a). NIOSH will no longer set recommended exposure levels for occupational carcinogens. Instead, NIOSH intends to develop risk management limits for carcinogens (RML-Cas) to acknowledge that, for most carcinogens, there is no known safe level of exposure. An RML–CA is a reasonable starting place for controlling exposures. An RML–CA limit is based on a daily maximum 8-hour TWA concentration of a carcinogen above which a worker should not be exposed (NIOSH, 2017b, page vi). RML-Cas for occupational carcinogens are established at the estimated 95% lower confidence limit on the concentration (*e.g.,* dose) corresponding to 1 in 10,000 (10^{-4}) lifetime excess risk (when analytically possible to measure) (NIOSH, 2019a). NIOSH stated that in order to incrementally move toward a level of exposure to occupational chemical carcinogens that is closer to background, NIOSH will begin issuing recommendations for RML-Cas that would advise employers to take additional action to control chemical carcinogens when workplace exposures result in excess risks greater than 10^{-4} (NIOSH, 2017b, page vi).

MSHA used the Miller *et al.* (2007) and Miller and MacCalman (2010) studies to estimate lung cancer mortality risk in miners. In British coal miners, excess lung cancer mortality was studied through the end of 2005 in a cohort of 17,800 miners (Miller *et al.,* 2007; Miller and MacCalman, 2010). By that time, the cohort had accumulated

516,431 person-years of observation (an average of 29 years per miner), with 10,698 deaths from all causes. Overall lung cancer mortality was elevated (Standard Mortality Ratio (SMR) = 115.7, 95% CI: 104.8–127.7), and a positive exposure-response relationship with respirable crystalline silica exposure was determined from Cox regression after adjusting for smoking history. Three strengths of this study were: (1) the detailed time-exposure measurements of quartz and total mine dust, (2) detailed individual work histories, and (3) individual smoking histories. For lung cancer, analyses based on Cox regression provided strong evidence that, for these coal miners, although quartz exposures were associated with increased lung cancer risk, simultaneous exposures to coal dust did not cause increased lung cancer risk (OSHA 2016a, 81 FR 16286, 16308).

Miller *et al.* (2007) and Miller and MacCalman (2010) conducted a follow-up study of cohort mortality, begun in 1970. Their previous report on mortality presented a follow-up analysis on 18,166 coal miners from 10 British coal mines followed through the end of 1992 (Miller *et al.,* 1997). The 2 reports from 2007 and 2010 analyzed the mortality experience of 17,800 of these miners (18,166 minus 346 men whose vital status could not be determined) and extended the analysis through the end of 2005. Causes of deaths that were of particular interest included pneumoconiosis, other NMRD, lung cancer, stomach cancer, and tuberculosis. The researchers noted that no additional exposure measurements were included in the updated analysis, since all the mines had closed by the mid-1980s. However, some of these men might have had additional exposure at other mines or facilities not reported in this study (OSHA, 2013b, page 287).

This cohort mortality study used Cox proportional hazards regression methods which controlled for a variety of external and internal factors. The external controls included British administrative regional age-, time-, and cause-specific mortality rates from which to calculate SMRs. The internal controls included each miner's age, smoking status, and detailed dust and respirable crystalline silica (quartz) time-dependent exposure measurements. Cox regression analyses were done in stages, with the initial analyses used to establish what factors were required for baseline adjustment (OSHA, 2013b, page 287).

For the analysis using external mortality rates, the all-cause mortality SMR from 1959 through 2005 was 100.9 (95% CI: 99.0–102.8), based on all 10,698 deaths. However, these SMRs were not uniform over time. For the period from 1990–2005, the SMR was 109.6 (95% CI:106.5–112.8), while the ratios for previous periods were less than 100. This pattern of increasing SMRs in the recent past was also seen for cause-specific deaths from chronic bronchitis, SMR = 330.0 (95% CI:268.1–406.2); tuberculosis, SMR = 193.4 (95% CI: 86.9–430.5); cardiovascular disease, SMR = 106.6 (95% CI: 102.0–111.5); all cancers, SMR = 107.1 (95% CI:101.3–113.2); and lung cancer, SMR = 115.7 (95% CI: 104.8–127.7). The SMR for NMRD was 142.1 (95% CI: 132.9–152.0) in this recent period and remained highly statistically significant. In their previous analysis on mortality from lung cancer, reflecting follow-up through 1995, Miller *et al.* (1997) had not found any increase in the risk of lung cancer mortality (OSHA, 2013b, page 287).

OSHA reported that Miller and MacCalman (2010) used these analyses to estimate relative risks for a lifetime exposure of 5 gram-hours/m³ (ghm⁻³) to quartz (OSHA, 2013b, page 288). This is equivalent to approximately 55 μg/m³ (0.055 mg/m³) for 45 years, assuming 2,000 hours per year of exposure and/or 100 ghm⁻³ total dust. The authors estimated relative risks (see Miller and MacCalman (2010), Table 4, page 9) for various causes of death including pneumoconiosis, COPD, ischemic heart disease, lung cancer, and stomach cancer. Their results were based on models with single exposures to dust or respirable crystalline silica (quartz) or simultaneous exposures to both, with and without 15-year lag periods. Generally, the risk estimates were slightly greater using a 15-year lag period.

For the models using only quartz exposures with a 15-year lag, pneumoconiosis, RR = 1.21 (95% CI: 1.12–1.31); COPD, RR = 1.11 (95% CI: 1.05–1.16); and lung cancer, RR = 1.07 (95% CI: 1.01–1.13) showed statistically significant increased risks.

For lung cancer, analyses based on these Cox regression methods provided strong evidence that, for these coal miners, quartz exposures were associated with increased lung cancer risk, but simultaneous exposures to coal dust were not associated with increased lung cancer risk. The relative risk (RR) estimate for lung cancer deaths using coal dust with a 15-year lag in the single exposure model was 1.03 (95% CI: 0.96 to 1.10). In the model using both quartz and coal mine dust exposures, the RR based on coal dust decreased to 0.91, while that for quartz exposure remained statistically significant, increasing to a RR = 1.14 (95% CI: 1.04 to 1.25). According to Miller and MacCalman (2010), other analyses have shown that exposure to radon or diesel fumes was not associated with an increased cancer risk among British coal miners (OSHA, 2013b, page 288).

The RRs in the Miller and MacCalman (2010) report were used to estimate excess lung cancer risk for OSHA's purposes. Life table analyses were done as in the other studies above. Based on the RR of 1.14 (95% CI: 1.04–1.25) for a cumulative exposure of 5 ghm⁻³, the regression slope was recalculated as β = 0.0524 per 1,000 μg-years (per mg/m⁻³-years) and used in the life table program. Similarly, the 95-percent CI on the slope was 0.0157–0.08926. From this study, the lifetime (to age 85) risk estimates for 45 years of exposure to 50 μg/m³ (0.05 mg/m³) and 100 μg/m³ (0.100 mg/m³) respirable crystalline silica were 6 and 13 excess lung cancer deaths per 1,000 workers, respectively. These lung cancer risk estimates were less by about two- to four-fold than those estimated from the other cohort studies described above.

However, three factors might explain these differences. First, these estimates were adjusted for individual smoking histories so any smoking-related lung cancer risk (or smoking–respirable crystalline silica interaction) that might possibly be attributed to respirable crystalline silica exposure in the other studies was not reflected in the risk estimates derived from the study of these coal miners. Second, these coal miners had significantly increased risks of death from other lung diseases, which may have decreased the lung cancer-susceptible population. Of note, for example, were the higher increased SMRs for NMRD during the years 1959–2005 for this cohort (Miller and MacCalman, 2010, Table 2, Page 7). Third, the difference in risk seen in these coal miners may have been the result of differences in the toxicity of quartz present in the coal mines as compared to the work environments of the other cohorts. One Scottish mine (Miller *et al.,* 1998) in this 10-mine study had been cited as having presented ''unusually high exposures to [freshly fractured] quartz.'' However, this was also described as an atypical exposure among miners working in the 10 mines. Miller and MacCalman (2010) stated that increased quartz-related lung cancer risk in their cohort was not confined to that Scottish mine alone. They also stated, ''The general nature of some quartz exposures in later years . . . may have been different from earlier periods when coal extraction was largely manual . . .'' (OSHA, 2013b, page 288).

All these factors in this mortality analysis for the British coal miner cohort could have combined to yield an underestimation of lung cancer risk estimates. However, OSHA believed that these coal miner-derived estimates were credible because of the quality of several study factors relating to both study design and conduct. In terms of design, the cohort was based on union rolls with very good participation rates and good reporting. The study group also included over 17,000 miners, with an average of nearly 30 years of follow-up, and about 60 percent of the cohort had died. Just as important was the high quality and detail of the exposure measurements, both of total dust and quartz. However, one exposure factor that may have biased the estimates upward was the lack of exposure information available for the cohort after the mines closed in the mid-1980s. Since the mortality ratio for lung cancer was higher during the last study period, 1990–2005, this period contributed to the increased lung cancer risk. It is possible that any quartz exposure experienced by the cohort after the mines had closed could have accelerated either death or malignant tumor (lung cancer) growth. By not accounting for this exposure, if there was any, the risk estimates would have been biased upwards. Although the 15-year lag period for quartz exposure used in the analyses provided slightly higher risk estimates than use of no lag period, the better fit seen with the lag may have been artificial. This may have occurred because there appeared to have been no exposures during the recent period when risks were seen to have increased (OSHA, 2013b, page 289).

MSHA believes, as OSHA did, that this study of a large British coal mining cohort provides convincing evidence of the carcinogenicity of respirable crystalline silica. This large cohort study, with almost 30 years of follow-up, demonstrated a positive exposure-response after adjusting for smoking histories. Additionally, the authors state that there was no evidence that exposure to potential confounders such as radon and diesel exhaust were associated with excess lung cancer risk (Miller and MacCalman (2010, page 270). MSHA is relying on the British studies conducted by Miller *et al.* (2007) as well as Miller and MacCalman (2010) to estimate the lung cancer risk in all miners.

MSHA found these two studies suitable for use in the quantitative characterization of health risks to exposed miners for several reasons. First, their study populations were of sufficient size to provide adequate statistical power to detect low levels of risk. Second, sufficient quantitative exposure data were available over a sufficient span of time to characterize cumulative respirable crystalline silica exposures of cohort members. Third, the studies either adjusted for or otherwise adequately addressed confounders such as smoking and exposure to other carcinogens. Finally, these researchers developed quantitative assessments of exposure-response relationships using appropriate statistical models or otherwise provided sufficient information that permits MSHA to do so.

MSHA implemented the risk model in its life table analysis so that the use of background rates of lung cancer and assumptions regarding length of exposure and lifetime were consistent across models. Thus, MSHA was able to estimate lung cancer risks associated with exposure to specific levels of respirable crystalline silica of interest to the Agency. MSHA used the Miller *et al.* (2007) and Miller and MacCalman (2010) model to estimate age-specific cumulative lung cancer mortality risk as EXP(0.0524 * cumulative exposure), lagged 15 years.

MSHA's FRA uses risk estimates derived from 10 coal mines in the U.K. (Miller *et al.,* 2007; Miller and MacCalman, 2010). These researchers developed regression analyses for time-dependent estimates of individual exposures to respirable dust. Their analyses were based on the detailed individual exposure estimates of the PFR program. To estimate mortality risk for lung cancer from the pooled cohort analysis, MSHA used the same life table approach as OSHA. However, for this life table analysis, MSHA used 2018 mortality rates for U.S. males (*i.e.,* all-cause and background lung cancer). The 2018 lung cancer death rates were based on the ICD–10 classification of diseases codes, C34.0, C34.2, C34.1, C34.3, C34.8, and C34.9. Lifetime risk estimates reflected excess risk through age 80. To estimate lung cancer risks, MSHA used the log-linear relative risk model, exp $(0.0524 \times$ cumulative exposure), lagged 15 years. The coefficient for this model was 0.0524 (OSHA, 2013b, page 290).

MSHA's use of Miller and MacCalman (2010) to estimate lung-cancer mortality risk is in contrast to OSHA's use of Steenland *et al.* (2001a) to estimate lung-cancer mortality risk. There are several reasons for MSHA's use of Miller and MacCalman (2010). First, it covers coal mining-specific cohort large enough (with 45,000 miners) to provide adequate statistical power to detect low levels of risk, and it covers an extended follow-up period (1959–2006). Second, the study provided data on cumulative exposure of cohort members and adjusted for or addressed confounders such as smoking and exposure to other carcinogens. Finally, it developed quantitative assessments of exposure-response relationships using appropriate statistical models or otherwise provided sufficient information that permitted MSHA to do so.

NVMA criticized MSHA's reliance on the Miller and MacCalman (2010) study because, according to the commenter, it primarily focused on coal miners, does not consider technological advancements in the mining sector, and is ''insufficient for justifying the implementation of a rule of this magnitude on MNM mines'' (Document ID1441). Commenters from the Black Lung Clinics and UMWA were in support of MSHA's use of Miller and MacCalman (2010) in assessing lung cancer mortality (Document ID 1410; 1398).

MSHA does not agree that reliance on Miller and MacCalman (2010) refutes the risk of material impairment of health to MNM miners. MSHA considered several other studies on lung cancer mortality, which covered a variety of populations aside from coal miners, including gold miners, diatomaceous earth workers, granite workers, industrial sand employees, pottery workers, tin miners, and tungsten miners. As OSHA showed in its QRA, the estimates from Miller and MacCalman (2010) were lower by roughly two- to four-fold than the estimates from other cohort studies. In selecting Miller and MacCalman (2010), MSHA chose a study that found smaller risks than the other studies. The Miller and MacCalman (2010) study has many strengths, including the fact that it had very high participation rates, with over 17,000 miners and nearly 30 years of follow up. In addition to detailed exposure information, the study also used individual smoking histories to adjust its estimates for the effect of smoking. Further, exposure changes owing to technological advancements are accounted for by MSHA's models which use recent exposure data.

Urging MSHA to lower the PEL to 25 $\mu g/m^3$, the AIHA commented that the work by Steenland and Sanderson should not be discounted (Document ID 1351). The commenter said that a 2001 Steenland and Sanderson study showed a significant increase in mortality risk from lung cancer at average exposure levels greater than 65 $\mu g/m^3$, indicating that 50 μg/m³ would probably not be protective of workers' health.

MSHA clarifies that, although it departed from OSHA's risk assessment by using the exposure-response model from Miller and MacCalman (2010) to assess lung cancer mortality, Steenland and Sanderson's work was not discounted. MSHA relied on Steenland and Sanderson in the standalone Health Effects document and the FRA. Further, MSHA acknowledges that there remains a risk of material impairment of health at the revised PEL; however, a further reduction in the PEL is not achievable at all mines (see MSHA's Technological Feasibility analysis). MSHA concludes that the final PEL will provide a substantial reduction in the risk of material impairment of health to miners.

5. ESRD Mortality

Several epidemiological studies have found statistically significant associations between occupational exposure to respirable crystalline silica and renal disease, although others have failed to find a statistically significant association. These studies are discussed in the standalone Health Effects document (Section 14). Possible mechanisms suggested for respirable crystalline silica-induced renal disease included a direct toxic effect on the kidney, deposition of immune complexes (IgA) in the kidney following respirable crystalline silica-related pulmonary inflammation, and an autoimmune mechanism (Gregorini *et al.,* 1993; Calvert *et al.,* 1997; Parks *et al.,* 1999; Steenland, 2005b) (OSHA 2016a, 81 FR 16286, 16310).

MSHA, like OSHA, chose the Steenland *et al.* (2002a) study to include in the FRA. In a pooled cohort analysis, Steenland *et al.* (2002a) combined the industrial sand cohort from Steenland *et al.* (2001b), the gold mining cohort from Steenland and Brown (1995a), and the Vermont granite cohort studies by Costello and Graham (1988). All three were included in portions of OSHA's PQRA for other health endpoints: under lung cancer mortality in Steenland *et al.* (2001a) and under silicosis mortality in the related work of Mannetje *et al.* (2002b). In all, the combined cohort consisted of 13,382 workers with exposure information available for 12,783. The analysis demonstrated statistically significant exposure-response trends for acute and chronic renal disease mortality with quartiles of cumulative respirable crystalline silica exposure (OSHA 2016a, 81 FR 16286, 16310).

The average duration of exposure, cumulative exposure, and concentration of respirable crystalline silica for the pooled cohort were 13.6 years, 1,200 μg/m³-years (1.2 mg/m^{-3}-years), and 70 μg/m³ (0.07 mg/m³), respectively. Renal disease risk was most prevalent among workers with cumulative exposures of 500 μg/m³ or more (Steenland *et al.,* 2002a). SMRs (compared to the U.S. population) for renal disease (acute and chronic glomerulonephritis, nephrotic syndrome, acute and chronic renal failure, renal sclerosis, and nephritis/nephropathy) were statistically significant and elevated based on multiple cause of death data (SMR 1.28, 95% CI: 1.10–1.47, 194 deaths) and underlying cause of death data (SMR 1.41, 95% CI: 1.05–1.85, 51 observed deaths) (OSHA, 2013b, page 315).

A nested case-control analysis was also performed which allowed for more detailed examination of exposure-response. This analysis included 95 percent of the cohort for which there were adequate work history and quartz exposure data. This analysis included 50 cases for underlying cause mortality and 194 cases for multiple-cause mortality. Each case was matched by race, sex, and age within 5 years to 100 controls from the cohort. Exposure-response trends were examined in a categorical analysis where renal disease mortality of the cohort divided by exposure quartile was compared to U.S. rates (OSHA, 2013b, page 315).

In this analysis, statistically significant exposure-response trends for SMRs were observed for multiple-cause ($p<0.000001$) and underlying cause ($p=0.0007$) mortality (Steenland *et al.,* 2002a, Table 1, Page 7).

With the lowest exposure quartile group serving as a referent, the case-control analysis showed monotonic trends in mortality with increasing cumulative exposure. Conditional regression models using log-cumulative exposure fit the data better than cumulative exposure (with or without a 15-year lag) or average exposure. Odds ratios by quartile of cumulative exposure were 1.00, 1.24, 1.77, and 2.86 ($p=0.0002$) for multiple cause analyses and 1.00, 1.99, 1.96, and 3.93 for underlying cause analyses ($p=0.03$) (Steenland *et al.,* 2002a, Table 2, Page 7). For multiple-cause mortality, the exposure-response trend was statistically significant for cumulative exposure ($p=0.004$) and log-cumulative exposure ($p=0.0002$), whereas for underlying cause mortality, the trend was statistically significant only for log-cumulative exposure ($p=0.03$). The exposure-response trend was homogeneous across the three cohorts and interaction terms did not improve model fit (OSHA, 2013b, pages 216, 315).

Based on the exposure-response coefficient for the model with the log of cumulative exposure, Steenland (2005b) estimated lifetime excess risks of death (age 75) over a working life (age 20 to 65). At 100 μg/m³ (0.1 mg/m³) respirable crystalline silica, this risk was 5.1 percent (95% CI 3.3–7.3) for ESRD based on 23 cases (Steenland *et al.,* 2001b). It was 1.8 percent (95% CI 0.8–9.7) for kidney disease mortality (underlying), based on 51 deaths (Steenland *et al.,* 2002a) above a background risk of 0.3 percent (OSHA, 2013b, page 216).

MSHA notes that these studies added to the evidence that renal disease is associated with respirable crystalline silica exposure. Statistically significant increases in odds ratios and SMRs were seen primarily for cumulative exposures of >500 μg/m³-years (0.5 mg/m³-years). Steenland (2005b) noted that this could have occurred from working for 5 years at an exposure level of 100 μg/m³ (0.1 mg/m³) or 10 years at 50 μg/m³ (0.05 mg/m³).

OSHA had a large body of evidence, particularly from the three-cohort pooled analysis (Steenland *et al.,* 2002a), on which to conclude that respirable crystalline silica exposure increased the risk of renal disease mortality and morbidity. The pooled analysis by Steenland *et al.* (2002a) involved a large number of workers from three cohorts with well-documented, validated job-exposure matrices. These researchers found a positive, monotonic increase in renal disease risk with increasing exposure for underlying and multiple cause data. Thus, the exposure and work history data were unlikely to have been seriously misclassified. However, there are considerably less data available for renal disease than there are for silicosis mortality and lung cancer mortality. Nevertheless, OSHA concluded that the underlying data were sufficient to provide useful estimates of risk and included the Steenland *et al.* (2002a) analysis in its PQRA (OSHA, 2013b, pages 229, 316).

To estimate renal disease mortality risk from the pooled cohort analysis, OSHA implemented the same life table approach as was done for the assessments on lung cancer and NMRD. However, for this life table analysis, OSHA used 1998 all-cause and background renal mortality rates for U.S. males, rather than the 2006 rates used for lung cancer and NMRD. The 1998 rates were based on the ICD–9 classification of diseases, which was the same as used by Steenland *et al.* (2002a) to ascertain the cause of death of workers in their study. However, U.S.

cause-of-death data from 1999 to present are based on the ICD–10, in which there were considerable changes in the classification system for renal diseases. According to CDC (2001), the change in the classification from ICD–9 to ICD–10 increased death rates for nephritis, nephritic syndrome, and nephrosis by 23 percent, in large part due to reclassifying ESRD. The change from ICD–9 to ICD–10 did not materially affect background rates for those diseases grouped as lung cancer or NMRD. Consequently, OSHA conducted its analysis of excess renal disease mortality associated with respirable crystalline silica exposure using background mortality rates for 1998. As before, lifetime risk estimates reflected excess risk through age 85. To estimate renal mortality risks, OSHA used the log-linear model with log-cumulative exposure that provided the best fit to the pooled cohort data (Steenland *et al.,* 2002a). The coefficient for this model was 0.269 (SE=0.120) (OSHA, 2013b, page 316). Based on the life table analysis, OSHA estimated that exposure to the former general industry exposure limit of 100 µg/m³ and to the final exposure limit of 50 µg/m³ over a working life would result in a lifetime excess renal disease risk of 39 (95% CI: 2–200) and 32 (95% CI: 1.7–147) deaths per 1,000, respectively. OSHA also estimated lifetime risks associated with the former construction and shipyard exposure limits of 250 and 500 µg/m³. These lifetime excess risks ranged from 52 (95% CI 2.2–289) to 63 (95% CI 2.5–368) deaths per 1,000 workers (OSHA, 2013b, page 316).

MSHA acknowledges the uncertainty associated with the divergent findings in the renal disease literature; however, MSHA concludes that the evidence supporting causality regarding renal risk outweighs the evidence casting doubt on that conclusion.

Upon reviewing the PRA, the NSSGA commented that it is unclear whether renal disease is causally related to occupational respirable crystalline silica exposure (Document ID 1448, Attachment 3). The commenter cited a 2017 German Federal Institute for Occupational Safety and Health systematic review and meta-analysis on respirable crystalline silica and non-malignant renal disease, which concluded that ''while the studies of cohorts exposed to silica found elevated SMRs for renal disease, no clear evidence of a dose-response relationship emerged.'' As detailed above in *Section V. Health Effects Summary* and further discussed in MSHA's standalone Health Effects document, MSHA reviewed a wide variety of studies which suggest that occupational exposure to respirable crystalline silica increases the risk of renal disease, including the risk of non-malignant cases. The Steenland *et al.* (2002a) study, which was selected for modeling ESRD risk in the FRA, found a monotonic increase in renal disease risk with increasing exposures to respirable crystalline silica. MSHA believes that the Steenland *et al.* (2002a) study has several strengths, including (1) a large cohort with well-documented and validated job-exposure matrices and (2) low risk of bias from exposure misclassification. The FRA has selected studies for modeling risks based on a thorough evaluation of each study's methodology. The fact that other studies (which MSHA did not use for modeling) may have found significantly elevated mortality ratios but inconclusive exposure-response relationships does not render invalid the findings or methodological strengths of Steenland *et al.* (2002a). Thus, MSHA concludes that increasing exposure to respirable crystalline silica increases a miner's risk of renal disease and reaffirms its decision to model benefits stemming from reductions in ESRD mortality due to the final rule in the FRA.

To estimate renal disease mortality risk from the pooled cohort analysis, MSHA implemented the same life table approach as OSHA. However, MSHA's life table analysis used 2018 all-cause and 1998 background renal mortality rates for U.S. males. The 1998 renal death rates were based on the ICD–9 classification of diseases, 580–589. This is the same classification used by Steenland *et al.* (2002a) to ascertain the cause of death of workers in their study. Consequently, MSHA conducted its analysis of excess ESRD mortality risk associated with exposure to respirable crystalline silica using background ESRD mortality rates for 1998. The U.S. cause-of-death data from 2018 were used as well to estimate the rate of death due to all causes among the unexposed population. Lifetime excess risk estimates reflect the excess risk through age 80. To estimate ESRD excess mortality risks, MSHA used the log-linear model with log-cumulative exposure that provided the best fit to the pooled cohort data (Steenland *et al.,* 2002a), as EXP(0.269*ln(cumulative exposure)). The coefficient for this model was 0.269 (SE=0.120) (OSHA, 2013b, page 316). 6. Coal Workers' Pneumoconiosis (CWP) and Progressive Massive Fibrosis (PMF).

Exposure to respirable coal mine dust causes lung diseases including CWP, emphysema, silicosis, and chronic bronchitis, known collectively as ''black lung.'' These diseases are debilitating, incurable, and can result in disability and premature death. There are no specific treatments to cure CWP or COPD. These chronic effects may progress even after miners are no longer exposed to coal dust.

MSHA's 2014 Coal Dust Rule quantified benefits among coal miners related to reduced cases of CWP due to lower exposure limits for respirable coal mine dust. In the FRA, MSHA has not quantified the reduction in morbidity risk associated with CWP among coal miners. Nonetheless, MSHA believes that the final rule would reduce the excess risk of morbidity from this disease. Many coal miners work extended shifts, increasing their potential exposure to respirable crystalline silica; therefore, calculating exposures based on a full-shift 8-hour TWA would be more protective. Thus, the final rule is expected to provide additional reductions in CWP risk beyond those ascribed in the 2014 Coal Dust Rule. However, exposure-response relationships based on respirable crystalline silica exposure are not available for CWP, so the reductions in this disease due to reductions in silica exposure cannot be quantified.

In the FRA, PMF deaths are captured in part by silicosis mortality as defined by Mannetje *et al.* (2002b). Those PMF deaths not captured by the definition in Mannetje *et al.* are likely captured by the definition of NMRD mortality adopted from Park *et al.* (2002). Thus, the FRA fully characterizes the reduction in lifetime cases of PMF mortality including mortality due to complicated CWP and complicated silicosis. However, the FRA likely underestimates reduction in PMF morbidity. This is because the Buchanan *et al.* (2003) model, which was used to model silicosis morbidity, likely undercounts PMF due to exclusion of cases below the threshold of 2/1+ profusion of opacities on a chest X-ray. While the FRA quantifies reduction in lifetime mortality cases from CWP and PMF (which are included under NMRD), there are likely additional unquantified morbidity benefits from CWP and PMF that are not captured.

Finally, the Appalachian Voices expressed concern that the modeling conducted for the rule does not incorporate data that medical clinics in Appalachia have reported since 2010 (Document ID 1425). This commenter stated that, while not all cases can be attributed directly to silica exposure, reporting over the last 15 years has led medical experts to believe that silica is a significant driver of the increased prevalence of severe black lung disease in Central Appalachia, and that any rule designed to reduce silica exposure should consider data from clinics in Central Appalachia to ensure a more realistic accounting of current morbidity and set a high goal for future morbidity. This commenter urged MSHA to review data from black lung clinics in Central Appalachia.

MSHA notes that comprehensive longitudinal clinical outcome data, paired with exposure histories, are not available for U.S. miners. MSHA acknowledges that these data would be useful for the purpose of estimating risk reductions and acknowledges that the exposure-response models used in this FRA are not based on current disease incidence among U.S. miners. While clinic data help document pneumoconiosis as an important problem, these data alone are not sufficient to estimate the reduction in excess morbidity and mortality that are specifically attributable to the new PEL. Calculating future miners' reduction in excess cases from the current disease incidence reported by clinics would also require those clinic patients' exposure and work histories, which are not available. Moreover, the data from medical clinics in Appalachia represent only a portion of miners whose respirable crystalline silica exposures may have exceeded the existing standard and who may have worked during a time when the coal mining industry was larger. The methodology of the FRA is to use peer-reviewed exposure-response models to estimate avoided excess deaths and illnesses that are specifically attributable to reducing respirable crystalline silica exposure from, at most, the existing standard to the new PEL of 50 μg/m^3. MSHA has not quantified reductions in simple or complicated CWP morbidity, as an exposure-response model for respirable crystalline silica and CWP is not available, and this final rule does not regulate levels of coal dust. Nonetheless, miners will likely see reductions in CWP risk, including risk of severe forms of CWP such as PMF, due to the final rule, since respirable crystalline silica exposure may play a role in development of CWP, and because concentrations of mixed coal dust may decrease due to this rule. These benefits associated with reductions in CWP mortality and morbidity are not quantified in the FRA.

D. Overview of Results

Table VI–4 summarizes the FRA's main results: once all miners and retirees have only been exposed under the new PEL, the final rule is expected to result in at least 1,067 avoided deaths and 3,746 avoided cases of silicosis morbidity among the working and future retired miner population. This is a change from the PRA, which predicted at least 799 avoided deaths and 2,809 avoided cases of silicosis morbidity in the working miner population. The increased avoided deaths and cases in the FRA are the result of changes to MSHA's risk analysis methodology; specifically, the inclusion of future retired miners. This methodological change is discussed in detail in the standalone FRA. The expected reductions in death and illness in the FRA are based on actual exposure conditions, peer-reviewed exposure-response models, and the assumption that miners have 45 years of employment under the new PEL (from the beginning of age 21 through the end of age 65) and 15 years of retirement (up through the end of age 80). These estimates of the avoided lifetime excess mortality and morbidity represent the final calculations based on the five selected models and the observed exposure data. The first group of miners that will experience the avoided lifetime deaths and illnesses shown in Table VI–4 is the population living 60 years after the start of implementation of the final rule. In other words, this group will only contain miners exclusively exposed under the final rule for the duration of their working lives. To calculate benefits associated with the rulemaking, the economic analysis monetizes avoided deaths and illnesses while accounting for the fact that, during the first 60 years following the start of implementation of the final rule, miners will have fewer avoided lifetime deaths and illnesses because they will have been exposed under both the existing standards and the new PEL.

Table VI-4: Lifetime Excess Cases of Death and Illness Avoided Due to Implementation of New Exposure Limit

	Avoided Cases of Death (Mortality) or Illness (Morbidity) by Sector		
Health Outcome	**MNM**	**Coal**	**Total**
Morbidity			
Silicosis (excluding deaths)	3,421	325	3,746
Total	***3,421***	***325***	***3,746***
Mortality			
Silicosis	233	15	248
Lung cancer	75	7	82
NMRD (excluding silicosis deaths)	489	47	536
ESRD	185	15	200
Total	***982***	***85***	***1,067***

Notes:
Due to rounding, some totals do not exactly equal the sum of the corresponding individual entries.

Table VI–5 summarizes miners' expected percentage reductions in lifetime excess risk of developing or dying from certain diseases due to their reduced respirable crystalline silica exposure expected to result from implementation of the final rule. The lifetime excess risk reflects the probability of developing or dying from diseases over a maximum lifetime of 45 years of exposure during employment and 15 years of retirement.[25] The excess

[25] In the model, not every miner lives through age 80, and deaths occur at the expected rate given the all-cause mortality rates and given miners' elevated mortality risk due to their exposure to respirable crystalline silica. Excess risks stop accruing after

risk reduction compares (a) miners' excess health risks associated with respirable crystalline silica exposure at the limits included in MSHA's existing standards to (b) miners' excess health risks associated with exposure at this standard's new PEL. MSHA expects full-scale implementation to reduce lifetime excess mortality risk by 9.5 percent and to reduce lifetime excess silicosis morbidity risk by 41.9 percent. Excess mortality risk includes the excess risk of death due to silicosis, NMRD, lung cancer, and ESRD.

Table VI-5: Lifetime Excess Risk Reduction Due to Implementation of New Exposure Limit

	Percentage Reduction in Lifetime Excess Risk of Death (Mortality) or Illness (Morbidity) by Sector		
Health Outcome	**MNM**	**Coal**	**Total**
Morbidity			
Silicosis (excluding deaths)	47.2%	19.2%	41.9%
Total	47.2%	19.2%	41.9%
Mortality			
Silicosis	21.2%	4.9%	17.6%
NMRD (excluding silicosis deaths)	20.8%	5.8%	17.0%
Lung cancer	23.0%	6.3%	19.0%
ESRD	4.2%	0.9%	3.2%
Total	12.0%	2.8%	9.5%

Notes:
Due to rounding, some totals do not exactly equal the sum of the corresponding individual entries.

Table VI–6 presents MSHA's estimates of lifetime excess risk per 1,000 miners at exposure levels equal to the existing standards, the new PEL, and the action level. These estimates are adjusted for FTE ratios and thus utilize cumulative exposures that more closely reflect the average hours worked per year.[26] For an MNM miner who is presently exposed at the existing PEL of 100 μg/m³ (and given the weighted average FTE ratio of 0.87), implementing the new PEL will lower the miner's lifetime excess risk of death by 58.8 percent for silicosis, 45.7 percent for NMRD (not including silicosis), 52.7 percent for lung cancer, and 19.9 percent for ESRD. The MNM miner's risk of acquiring a non-fatal case of silicosis will decrease by 80.4 percent.

For a coal miner who is currently exposed at the existing standard of 85.7 μg/m³ (and given the weighted average FTE ratio of 0.99), implementing the new PEL will lower the miner's lifetime excess risk of death by 42.6 percent for silicosis mortality, 40.2 percent for NMRD mortality (not including silicosis), 43.4 percent for lung cancer mortality, and 15.8 percent for ESRD mortality. The coal miner's lifetime excess risk of acquiring non-fatal silicosis will decrease by 73.8 percent. While even greater reductions would be achieved at exposures equal to the action level (25 μg/m³), some residual risks do remain at exposures of 25 μg/m³. Notably, at the action level, ESRD risk is still 20.7 per 1,000 MNM miners and 21.6 per 1,000 coal miners. At the action level, risk of non-fatal silicosis is 16.3 per 1,000 MNM miners and 16.9 per 1,000 coal miners.

BILLING CODE 4520–43–P

death, and the life table methodology accounts for these deaths. For example, only roughly half of an original cohort of 21-year-old miners are expected to be alive at the start of age 80.

[26] The FTE ratios used in these calculations are a weighted average of the FTE ratio for production employees and the FTE ratio for contract miners.

Table VI-6: Lifetime Excess Risk (per 1,000 Miners) for Selected Health Endpoints at Respirable Crystalline Silica Exposure Levels Equal to the Existing Standards, New PEL, and Action Level

Health Outcome (Study)	MNM			Coal		
	100 µg/m³	50 µg/m³	25 µg/m³	85.7 µg/m³	50 µg/m³	25 µg/m³
Silicosis Morbidity (Buchanan *et al.*, 2003)	206.7	43.6	18.7	189.9	54.2	21.0
Silicosis Morbidity (Net of Silicosis Mortality)[1]	192.4	37.7	16.3	175.9	46.1	16.9
Silicosis Mortality (Mannetje *et al.*, 2002)	14.3	5.9	2.5	14.1	8.1	4.1
NMRD Mortality (Park *et al.*, 2002)	54.8	27.9	14.1	53.2	31.5	15.9
NMRD Mortality (Net of Silicosis Mortality)[2]	40.5	22.0	11.6	39.1	23.4	11.9
Lung Cancer Mortality (Miller and MacCalman, 2010)	5.5	2.6	1.3	5.3	3.0	1.5
ESRD Mortality (Steenland *et al.*, 2002a)	32.6	26.1	20.7	32.3	27.2	21.6

Notes:

1. The lifetime excess silicosis morbidity risk (net of silicosis mortality) is the difference between (a) the lifetime excess silicosis risk computed from the Buchanan *et al.* model and (b) the lifetime excess risk of silicosis mortality computed from the Mannetje *et al.* model.
2. NMRD (net) mortality risk is the difference between projected total NMRD mortality risk and projected silicosis mortality risk.
3. Values may not sum to total due to rounding.
4. Lifetime excess risk values are based on annual exposure durations that are scaled by a weighted average FTE ratio for contract miners and miners (excluding contract miners). For MNM miners, this ratio is 0.87. For coal miners, this ratio is 0.99.

BILLING CODE 4520–43–C

Supporting the need for the proposed rule overall, the National Black Lung Association (NBLA) cited a 2023 investigation (Berkes and Hicks, 2023), which the commenter said reported 21,000 excessive respirable crystalline silica dust exposures from 1986 to 2016 (Document ID 1402). In its above review of exposure data, MSHA also found exposures that exceeded the new PEL. On the other hand, questioning the necessity of the proposed rule for the coal industry, the Pennsylvania Coal Alliance asserted that only 1.2 percent of the samples MSHA relied on for its analysis showed an exceedance of 100 µg/m³ (Document ID 1378).

While coal exposure data since 2016 may indicate a recent trend of less frequent noncompliance, 6.9 percent of samples for coal miners showed an exceedance of the new PEL. As Table VI–6 demonstrates, reducing a coal miner's exposure from 85.7 µg/m³ to 50 µg/m³ is expected to reduce his total silicosis morbidity risk by 71 percent (from 189.9 to 54.2 per 1,000), reduce his silicosis mortality risk by 43 percent (from 14.1 to 8.1 per 1,000), reduce his total NMRD mortality by 41 percent (from 53.2 to 31.5 per 1,000), reduce his lung cancer mortality risk by 43 percent (from 5.3 to 3.0 per 1,000), and reduce his ESRD mortality by 16 percent (from 32.3 to 27.2 per 1,000). Additionally, for a typical coal miner exposed between 50 µg/m³ and 85.7 µg/m³, the new PEL is expected to reduce his silicosis morbidity risk by 46 percent (from 79.5 to 54.3 per 1,000), reduce his lung cancer mortality risks by 22 percent (from 3.6 to 3.0 per 1,000), reduce his silicosis mortality risk by 15 percent (from 9.4 to 8.1 per 1,000), reduce his NMRD mortality risk by 20 percent (from 37.9 to 31.5 per 1,000), and reduce his ESRD mortality risk by 6 percent (from 28.9 to 27.2 per 1,000). The benefits calculated in the main analysis of the FRA represent only those benefits of reducing exposures from, at most, the existing standard to the new PEL of 50 µg/m³. Even when assuming compliance with the existing standard, the results of the FRA affirm the need for the rule for all mining industries.

E. Healthy Worker Bias

MSHA accounted for ''healthy worker survivor bias'' in estimating the risks for coal and MNM miners. The healthy worker survivor bias causes epidemiological studies to underestimate excess risks associated with occupational exposures. As with most worker populations, miners are composed of heterogeneous groups that possess varying levels of background health. Over the course of miners' careers, illness tends to remove the most at-risk workers from the workforce prematurely, thus causing the highest cumulative exposures to be experienced by the healthiest workers who are most resistant to developing disease. Failing to account for this imbalance of cumulative exposure across workers negatively biases risk estimates, thereby underestimating true risks in the population. Keil *et al.* (2018) analyzed a type of healthy worker bias referred to as the healthy worker survivor bias in the context of OSHA's 2016 life table estimates for risk associated with respirable crystalline silica exposure. After analyzing data from 65,999 workers pooled across multiple countries and industries, Keil *et al.* found that the ''healthy worker survivor bias results in a 28% underestimate of risk for lung cancer and a 50% underestimate for other causes of death,'' with risk being defined as ''cumulative incidence of mortality [at age 80].''

Given that MSHA has calculated risks using the same underlying epidemiological studies OSHA used in 2016, the healthy worker survivor bias is likely impacting the estimates in Table V–6 of lifetime excess risk and lifetime excess cases avoided. Accordingly, as part of a sensitivity analysis, MSHA re-estimated risks for MNM and coal miners to account for the healthy worker survivor bias. MSHA adjusted for this effect by increasing the risk estimates of lung cancer risk by 28 percent and increasing the risk of each other disease by 50 percent. This produced larger estimates of lifetime excess risk reductions and lifetime excess cases avoided, which are presented in FRA Table 23 through FRA Table 26 of the FRA document. As these tables show, when adjusting for the healthy worker survivor bias, the new PEL will decrease lifetime silicosis morbidity risk by 23.9 cases per 1,000 MNM miners (compared to the unadjusted estimate of 15.9 cases per 1,000 MNM miners, see FRA Table 15 of the FRA document) and 5.8 cases per 1,000 coal miners (compared to 3.8 cases per 1,000 coal miners, see FRA Table 16 of the FRA document). Still accounting for the healthy worker survivor bias, the new PEL will decrease total morbidity by 5,131 lifetime cases among MNM miners (compared to 3,421 cases, see FRA Table 17 of the FRA document) and by 487 lifetime cases among coal miners (compared to 325 cases, see FRA Table 18 of the FRA document). Among the current MNM and coal mining populations, implementation of the new PEL during their full lives will have avoided 1,457 deaths and 126 deaths, respectively, over their lifetimes (compared to unadjusted estimates of 982 deaths and 85 deaths, respectively).

MSHA believes adjusted estimates for the healthy worker survivor bias are more reliable than unadjusted estimates. However, given that the literature does not support specific scaling factors for each of the health endpoints analyzed, these adjustments for the healthy worker survivor bias have not been incorporated into the final lifetime excess risk estimates that served as the basis for monetizing benefits. Because the monetized benefits do not account for the healthy worker bias, MSHA believes the reductions in lifetime excess risks and lifetime excess cases, as well as the monetized benefits, likely underestimate the true reductions and benefits attributable to the final rule.

The ACLC provided comments that the agency's proposed rule would do little to alter the status quo (Document ID 1445). Specifically, this commenter cited the findings of the PRA that thousands of miners would continue to get sick and die from overexposure to silica dust under the new proposed rule (Document ID 1445). Recommending that the Agency should focus on entirely preventing any disability or disease from inhaling silica dust, the commenter urged MSHA to strengthen the proposed rule such that the vast majority of miner lives will be saved over the coming decades (Document ID 1445). MSHA acknowledges that reducing respirable crystalline silica concentrations to 25 μg/m^3 would further reduce morbidity and mortality amongst miners. However, MSHA determined that a PEL of 25 μg/m^3 would not be achievable for all mines.

Also, upon reviewing these results, many commenters, including the ACLC, the American Thoracic Society, the American Lung Association, and the American College of Chest Physicians (hereafter referred to as ''The American Thoracic Society *et al.*''), Appalachian Voices, USW, and the AOEC discussed how silica-related diseases are becoming more prevalent and/or severe in miners (Document ID 1445; 1421; 1425; 1447; 1373; 1391; 1439; 1372; 1353; 1375). They expressed concern that recently there has been an increase in cases of black lung disease, pneumoconiosis, and other related illnesses. The American Thoracic Society *et al.* stated that the increase in the number of cases is due to increasing silica exposures in mining processes, citing studies supporting this point (Cohen *et al.,* 2016, 2022) (Document ID 1421). Appalachian Voices added that research has found that black lung disease is occurring at its highest level in decades, is affecting more younger miners now than in the past, and is more frequently presenting in its more severe form, PMF (Document ID 1425). The ACLC echoed this point, stating that, in the 1990s, the worst forms of black lung disease (*i.e.,* PMF) had almost been eradicated in the United States (Document ID 1445). This commenter expressed concern that the prevalence of black lung disease has grown in the past decade, and clinics in eastern Kentucky and southwest Virginia have diagnosed hundreds of cases of PMF. The commenter cited a new analysis of data from NIOSH and black lung clinics that, according to the commenter, reveals more than 4,000 cases of the most advanced form of black lung since 2010, as well as more than 1,500 advanced black lung diagnoses in just the last 5 years (Document ID 1445). The UMWA described surveillance findings from the National Academies of Sciences, Engineering, and Medicine (NASEM) that severe pneumoconiosis where respirable crystalline silica is likely an important contributor is presenting in relatively young miners, sometimes in their late 30s and early 40s (Document ID1398). The ACLC and UMWA expressed concern that the risk estimates presented in the PRA heavily underestimated the avoided cases because it severely underestimated current disease incidence (Document ID 1445; 1398).

There are a number of reasons why current incidence of disease would be higher than estimates in the FRA:

• For all diseases except silicosis, the FRA does not present the total number of cases that are expected in the future. The FRA only presents the number of *excess* cases that miners experience due to their occupational exposure to respirable crystalline silica. For example, the FRA presents an estimated 1,794 excess ESRD deaths over the next 60 years under the baseline scenario among coal miners. This estimate would rise from 1,794 to 2,407 when including all ESRD deaths and not just the *excess* ESRD deaths attributable to respirable crystalline silica exposure.[22] For silicosis and PMF, the number of excess cases equals the number of total cases, since MSHA assumes non-miners have no background risk of silicosis or PMF.

• There is a lag between the time when exposure occurred and new diagnoses. Many of the new cases of silicosis and PMF that are currently being diagnosed in coal miners are for individuals who likely worked during a time when the coal mining industry was substantially larger than (*e.g.,* roughly double) its current size. The number of miners who are being diagnosed today belong to larger cohorts than those currently entering the mining workforce. Consequently, the number of disease cases and deaths amongst retired miners 60 years in the future would be expected to be lower than that amongst currently retired miners because the latter group is larger in size.

• Additionally, as the FRA explains, the Baseline scenario involves reducing all noncompliant exposures to the existing standard (100 μg/m³ for MNM or 85.7 μg/m³ for coal). This is done to avoid attributing benefits to this rule which should instead be attributed to a previous rule. Consistent with this approach, MSHA also has not estimated the cost to become compliant with existing standards. Capping noncompliant exposures at 100 μg/m³ for MNM or 85.7 μg/m³ for coal increases the discrepancy between the present-day incidence and expected future cases under the baseline scenario. For coal miners, estimates of avoided cases assume that, in the absence of this rule, miners would be exposed to the same levels of respirable crystalline silica that have been observed in the coal compliance data from 2016 through 2021. This more recent period was selected to account for the fact that MSHA's 2014 RCMD Standard likely reduced concentrations of respirable crystalline silica. Coal miners who are being diagnosed with silicosis and PMF today likely suffered from higher exposures than those represented by more recent compliance data, which would lead to higher incidence of silicosis and PMF than the QRA projects for future miners.

• For PMF morbidity, not all cases of this disease are quantified in the FRA. The term ''PMF'' is used to refer to complicated CWP (caused by coal dust exposure) and to refer to complicated silicosis (caused by respirable crystalline silica exposure). The FRA only captures silicosis profusion 2/1+ morbidity (which may overlap partially with some definitions of PMF) but does not quantify benefits associated with reducing CWP morbidity.

F. Uncertainty Analysis

MSHA conducted extensive uncertainty analyses to assess the impact on risk estimates of factors including treatment of data in excess of the new PEL, sampling error, and use of average rather than median point estimates for risk. The impact of excluding insufficient mass (weight) samples was also examined. As discussed below, some sources of uncertainty suggest that miners' risks may be lower than what MSHA modeled, and other sources suggest that risks may be higher. MSHA's estimates represent central values, which are based on the most reliable data and assumptions. Moreover, the overall weight-of-evidence indicates that increased exposures to respirable crystalline silica cause increased risk of mortality and morbidity, from which it follows that reduced exposures would lead to reduced risks.

1. Sampling Error in Exposure Data

To quantify the impact of sampling uncertainty on the risk estimates, 1,000 bootstrap resamples of the original exposure data were generated (sampling with replacement). The resamples were stratified by commodity to preserve the relative sampling frequencies of coal, metal, non-metal, sand and gravel, crushed limestone, and stone observations in the original dataset. Risk calculations were repeated on each of the 1,000 bootstrap samples, thereby generating empirical distributions for all risk estimates. From these empirical distributions, 95 percent confidence intervals were calculated. These confidence intervals characterize the uncertainty in the risk estimates arising from sampling error in the exposure data. All lifetime excess risk estimates had narrow confidence intervals, indicating that the estimates of lifetime excess morbidity and mortality risks have a high degree of precision.

In regard to use of average, rather than median, point estimates of risk, the estimates acquired from average exposures are similar to the estimates from median exposures, with 95 percent confidence intervals having similar widths. However, the 95 percent confidence intervals are not always overlapping, and average exposures tended to yield higher estimates of reduced morbidity and mortality. Among MNM miners, MSHA expects the new PEL to reduce lifetime excess cases of silicosis morbidity by 3,394–3,703 when using average exposures to model risks (see FRA Table 41 of the FRA document), compared to 3,271–3,576 fewer cases when using median exposures to model risks (see FRA Table 37 of the FRA document). Among coal miners, this reduction in excess cases of silicosis morbidity is expected to be 328–372 when using average exposures (see FRA Table 42 of the FRA document), compared to 305–354 when using median exposures (see FRA Table 38 of the FRA document). The new PEL is estimated to prevent 981–1,056 MNM miner deaths and 87–97 coal miner deaths when using average exposures to model risks (see FRA Tables 41 and 42 of the FRA document), compared to 945–1,020 fewer MNM miner deaths and 80–92 fewer coal miner deaths using median exposures to model risks (see FRA Tables 37 and 38 of the FRA document).

2. Alternate Treatment of Exposure Samples in Excess of the New Exposure Limit

To estimate excess risks and excess cases under the new PEL, MSHA assumed that no exposures will exceed the new limit, which effectively reduced any exposures exceeding 50 μg/m³ to 50 μg/m³. However, if mines implement controls with the goal of reducing exposures to 50 μg/m³ on every shift, then some exposure currently in excess of 50 μg/m³ will likely decrease below the new PEL. For this reason, the estimation method of capping all exposure data at 50 μg/m³ represents a ''lowball'' estimate of risk reductions due to the new PEL. In this section, MSHA presents estimates using an alternate ''highball'' method wherein exposures exceeding 50 μg/m³ are set equal to the median exposure value for the 25–50 μg/m³ exposure group. Because this highball method attributes larger reductions in exposure to the new PEL, it estimates higher lifetime excess risk reductions and more avoided lifetime excess cases.

As with lifetime excess risks, the highball method also yields larger reductions in lifetime excess cases. Using the highball method, MNM miners are expected to experience 4,148 fewer cases of non-fatal silicosis and coal miners are expected to experience 446 fewer cases of non-fatal silicosis over their lifetimes. MNM miners would experience 1,519 fewer deaths and coal miners would experience 164 fewer deaths over their lifetimes. Compared to the lowball method—which estimates that the new PEL would avoid a total of 3,746 lifetime cases of non-fatal silicosis and 1,067 lifetime excess deaths (among both MNM and coal miners)—the highball method estimates totals of 4,594 avoided lifetime cases of non-fatal silicosis and 1,683 avoided lifetime excess deaths.

3. Samples With Insufficient Mass

The MSHA Laboratory does not analyze samples for respirable crystalline silica that do not meet a minimum threshold for total respirable dust mass. The MNM exposure data gathered by enforcement from January 1, 2005, through December 31, 2019, contain samples that were analyzed using the P–2 method. As discussed, the P–2 method specifies that filters are only analyzed for quartz if they achieve a net mass (weight) gain of 0.100 mg or more. If cristobalite is requested, a mass gain of 0.050 mg or more is required for a filter to be analyzed (MSHA, 2022c). During the 15-year sample period for MNM exposure data, 40,618 MNM samples were not analyzed because the filter failed to meet the P–2 minimum net mass gain requirements.

Similarly, the coal exposure data gathered by enforcement from August 1, 2016, through July 31, 2021, contains samples that were analyzed using the P–7 method. For samples taken in underground mines, the P–7 method requires a minimum sample mass of 0.100 mg [27] of dust for the sample to be analyzed for quartz. For samples taken in surface coal mines, the P–7 method typically requires a minimum sample mass of 0.200 mg of dust for the sample to be analyzed for quartz. During the five-year sample period for coal exposure data, 32,401 valid full-shift coal samples were not analyzed because the P–7 method's minimum mass requirement was not met.

MNM and Coal samples that did not meet the MSHA Laboratory's minimum mass criteria were excluded from the risk analysis because their concentrations of respirable crystalline silica are not known. The unanalyzed samples all had very low total respirable dust mass, making it unlikely that many would have exceeded the existing standards or the new PEL. Nonetheless, excluding these unanalyzed samples from the exposure datasets may introduce bias, potentially causing the Agency to overestimate the proportion of high-intensity exposure values.

As a sensitivity analysis, MSHA used imputation techniques to estimate the respirable crystalline silica mass for each sample based on the sample weight and the median percent silica content for each commodity and occupation. All the unanalyzed samples with imputed concentrations were estimated to be <25 μg/m³, and thus including these unanalyzed samples in the analysis leads to lower estimates of estimated lifetime excess cases for both MNM and coal miners.

When including the imputed values for the unanalyzed samples, the new PEL would result in 2,327 fewer cases of non-fatal silicosis among MNM miners and 171 fewer cases among coal miners, over their lifetimes. The new PEL would also result in 666 fewer deaths (due to all 4 diseases) among MNM miners and 46 fewer deaths among coal miners, over their lifetimes. This yields a total reduction in lifetime excess morbidity of 2,498 miner deaths and a total reduction in lifetime excess mortality of 712 miner deaths. While these estimates are lower than those presented in Table VI–4 (of 3,746 avoided lifetime cases of non-fatal silicosis and 1,067 avoided lifetime excess deaths), MSHA nonetheless believes that—even including these unanalyzed samples—the new PEL would still reduce the risk of material impairment of health or functional capacity in miners exposed to respirable crystalline silica. Moreover, the possible positive bias that may arise when excluding these samples would be offset by other negative biases discussed herein (*e.g.,* the healthy worker survivor bias and the assumption that full compliance with the new PEL would not produce any reductions in exposure below 50 μg/m³).

It should be noted that the imputation method has some limitations. For example, the method assumes that, if the insufficient mass samples had been analyzed, every sample would have possessed a percentage of quartz, by mass, equal to the median percentage for that sample's associated commodity and occupation. (See Section 17.1 of the standalone FRA document for a full discussion of the imputation method.) However, within a given occupation, this percentage varies substantially and is positively correlated with exposure concentration. Suppressing the variation in this percentage quartz, by mass, produces less variation in the resulting imputed concentrations. Consequently, the imputation method may underestimate the number of unanalyzed samples that would truly exceed 50 μg/m³.

VII. Feasibility

A. Technological Feasibility

This section, technological feasibility, presents MSHA's conclusions on the technological feasibility of the final rule for mine operators. The section considers whether currently available technologies, used alone or in combination with each other, can be used by mine operators to comply with the final rule and notes and responds to public comments received regarding technological feasibility. In the proposed rule, MSHA preliminarily determined that it is technologically feasible for mine operators to achieve the proposed requirements. In the proposal, MSHA requested public comments on these preliminary conclusions and any other aspects of the proposed rule. After receiving public comments, the Agency has reviewed them and has determined that it is technologically feasible for mine operators to conduct air sampling and analysis and to achieve the final rule's PEL using commercially available samplers. MSHA has also determined that these technologically feasible samplers are widely available, and a number of commercial laboratories provide the service of analyzing dust containing respirable crystalline silica. In addition, MSHA has determined that technologically feasible engineering controls are readily available, can control crystalline silica-containing dust particles at the source, provide reliable and consistent protection to all miners who would otherwise be exposed to respirable dust, can be monitored, and are achievable. MSHA has also determined that administrative controls, used to supplement engineering controls, can further reduce and maintain exposures at or below the final rule's PEL. Moreover, MSHA has determined the final rule's respiratory protection practices for respirator use are technologically feasible for mine operators to implement. For MNM operators, MSHA has determined that the final rule's medical surveillance requirements are technologically feasible. This section focuses on technological feasibility; public comments specifically related to technological feasibility are addressed here, other comments are addressed in *Section VIII.B. Section-by-Section Analysis* of this preamble.

MSHA is required to set standards to assure, based on the best available evidence, that no miner will suffer material impairment of health or functional capacity from exposure to toxic materials or harmful physical agents over his working life. 30 U.S.C. 811(a)(6)(A). The Mine Act also instructs MSHA to set health standards to attain ''the highest degree of health and safety protection for the miner'' while considering ''the latest available scientific data in the field, the feasibility of the standards, and experience gained under this and other health and safety laws.'' 30 U.S.C. 811(a)(6)(A). But the health and safety of the miner is always the paramount consideration: ''[T]he Mine Act evinces a clear bias in favor of miner health and safety,'' and ''[t]he duty to use the best evidence and to consider feasibility are appropriately viewed through this lens and cannot be wielded as counterweight to MSHA's overarching role to protect the life and health of workers in the mining industry.'' *Nat'l Min. Ass'n* v. *Sec'y, U.S. Dep't of Lab.,* 812 F.3d 843, 866 (11th Cir. 2016); 30 U.S.C. 801(a).

The D.C. Circuit clarified the Agency's obligation to demonstrate the technological feasibility of reducing occupational exposure to a hazardous substance. MSHA ''must only

[27] Often the threshold for analyzing Coal samples is ≥0.1 mg. There are, however, some exceptions based on Sample Type and Occupation Code. For samples with Sample Type 4 or 8, if the sample's Occupation Code is not 307, 368, 382, 383, 384, or 386, then the threshold is ≥0.2 mg.

demonstrate a 'reasonable possibility' that a 'typical firm' can meet the permissible exposure limits in 'most of its operations.'' *Kennecott Greens Creek Min. Co.* v. *Mine Safety & Health Admin.,* 476 F.3d 946, 958 (D.C. Cir. 2007) (quoting *American Iron & Steel Inst.* v. *OSHA,* 939 F.2d 975, 980 (D.C. Cir. 1991)). Additionally, MSHA has authority to promulgate technology-forcing rules. ''When a statute is technology-forcing, the agency 'can impose a standard which only the most technologically advanced plants in an industry have been able to achieve—even if only in some of their operations some of the time.' '' *Id.* at 957 (quoting *United Steelworkers of Am.* v. *Marshall,* 647 F.2d 1189, 1264 (D.C. Cir. 1980)).

This section presents technological feasibility findings that guided MSHA's selection of the final rule's requirements, including the PEL. MSHA's technological feasibility findings are organized into two main sections covering: (1) the technological feasibility of part 60: PEL and action level; engineering and administrative controls; sampling provisions, including methods of sampling, and sampler and sample analysis requirements; and medical surveillance requirements for MNM mines; and (2) the technological feasibility of the revision to previous respiratory protection standards. Based on the analyses presented in the two sections, MSHA concludes that the Agency's final rule is technologically feasible. MSHA's feasibility determinations in this rulemaking are supported by its findings that the majority of the industry is already using technology that will allow it to effectively comply with the final rule.

As noted above, MSHA has determined that part 60 is technologically feasible. Many mine operators already maintain respirable crystalline silica exposures at or below the final rule's PEL of 50 μg/m^3, and at mines where there are elevated exposures, operators are able to reduce exposures to at or below the PEL by properly maintaining existing engineering controls and/or by implementing new engineering and administrative controls that are currently available. In addition, mine operators can satisfy the exposure monitoring requirements of part 60 with existing, validated, and widely used sampling technologies and analytical methods.

Second, the analysis shows that the final rule's update to MSHA's prior respiratory protection requirements is also technologically feasible. The mining industry's existing respiratory protection practices for selecting, fitting, using, and maintaining respiratory protection include program elements that are similar to those of *ASTM F3387–19,* ''*Standard Practice for Respiratory Protection*''*,* which MSHA is incorporating by reference. Existing respiratory protection programs must be in writing and developed by a person with relevant experience and capabilities.

1. Technological Feasibility of the PEL

a. Methodology

The technological feasibility analysis for the PEL relies primarily on information from three key sources:

- MSHA's Standardized Information System (MSIS) respirable crystalline silica exposure data, which includes 57,769 MNM and 63,127 coal mine compliance samples collected by MSHA inspectors; these samples were of sufficient mass gain to be analyzed for respirable crystalline silica by MSHA's analytical laboratory.[28]
- The NIOSH series on reducing respirable dust in mines, including: ''Dust Control Handbook for Industrial Minerals Mining and Processing, Second Edition'' (NIOSH, 2019b) and ''Best Practices for Dust Control in Coal Mining, Second Edition'' (NIOSH, 2021a).[29] With cooperation from the MNM and coal mining industries, NIOSH has extensively researched and documented engineering and administrative controls for respirable crystalline silica in mines.
- MSHA's knowledge of the mining industry. MSHA has over four decades of experience inspecting surface mines at least twice per year and underground mines at least four times per year and in assisting mine operators and miners with technological issues, such as control of respirable dust (including respirable crystalline silica) exposure. MSHA provides compliance assistance, including informational programs, training, publications, onsite evaluations, and investigations that document conditions in mines and help mines operate in a safe and healthy manner.[30]

Additionally, MSHA consulted other published reports, scientific journal articles, and information from equipment manufacturers and mining industry suppliers.[31]

MSHA did not identify any comments specific to the technological feasibility analysis methodology. This final rule retains the methodology supporting the technological feasibility analysis of the PEL in the proposed rule.

b. The Technological Feasibility Analysis Process

Mining Commodity Categories and Activity Groups

As described in the Preliminary Regulatory Impact Analysis (PRIA), MSHA categorized mine types into six MNM ''commodity categories'' (using the method of Watts *et al.,* 2012) based on similarities in exposure characteristics. MNM mine categories include metal, nonmetal, stone, crushed limestone, and sand and gravel. All coal mines are categorized together as one commodity category.

Within each commodity, MSHA further separated mining operations into the four activity groups widely used by the industry: (1) development and production miners (drillers, stone cutters); (2) ore/mineral processing miners (crushing/screening equipment operators and kiln, mill, and concentrator workers in mine facilities); (3) miners engaged in load/haul/dump activities (conveyor, loader, and large haulage vehicle operators, such as dump truck drivers); and (4) miners in all other occupations (mobile and utility workers, such as surveyors, mechanics, cleanup crews, laborers, and operators of compact tractors and utility trucks).

Before determining the feasibility of reducing miners' exposure to respirable crystalline silica, MSHA gathered and analyzed information to understand current miner exposures by creating an ''exposure profile,'' identified the existing (*i.e.,* baseline) conditions and the exposure levels associated with

[28] These respirable crystalline silica exposure data consist of 15 years of MNM mine samples (January 1, 2005, through December 31, 2019) and five years of coal mine samples (August 1, 2016, through July 31, 2021). These MSHA compliance samples represent the conditions identified by MSHA inspectors as having the greatest potential for respirable crystalline silica exposure during the periodic inspection when sampling occurred. While MSHA's laboratory also analyzes mine operators' respirable coal mine dust samples containing respirable crystalline silica, those samples are not included in the data used for this analysis.

[29] Together, these two recent reports provide more than 500 pages of detailed descriptions, discussion, and illustrations of dust control technologies currently used in mines.

[30] MSHA also analyzes RCMD samples collected by mine operators, including those containing respirable crystalline silica, in addition to the compliance samples collected by MSHA inspectors (mentioned in the first bullet of this series).

[31] Project personnel reviewed 104,365 samples collected and analyzed by MSHA for respirable crystalline silica, plus another 103,745 samples collected but not analyzed due to insufficient respirable dust collected in the sample. They examined over 200 published reports, proceedings, case studies, analytical methods, and journal articles, in addition to inspecting more than 200 web page, product brochures, user manuals, service/maintenance manuals and descriptive literature for dust control products, mining equipment, and related services.

those conditions, and determined whether mines will need additional control methods, and if so, whether those methods were available. MSHA's exposure datasets for MNM and coal mining industries are available as part of the rulemaking record under Docket ID MSHA–2023–0001–1290.

Exposure Profiles

MSHA classified all valid respirable crystalline silica samples in the Agency's MSIS data,[32] grouping the data by commodity category, followed by activity group.[33] MSHA created an exposure profile to better examine the sample data for each commodity category. These profiles include basic summary statistics, such as sample count, mean, median, and maximum values, presented as ISO 8-hour TWA values. They also show the sample distribution within the following exposure ranges: ≤25 μg/m³, >25 μg/m³ to ≤50 μg/m³, >50 μg/m³ to ≤100 μg/m³ (equivalent to 85.7 μg/m³ in coal mines for a sample calculated as an 8-hour TWA), >100 μg/m³ to ≤250 μg/m³, >250 μg/m³ to ≤500 μg/m³, and >500 μg/m³.[34]

In Table VII–1, the respirable crystalline silica exposure data for MNM miners are summarized by commodity and for the MNM industry as a whole, while Table VII–2 presents the exposure profile as the percentage of samples in each exposure range. Overall, approximately 82 percent of the 57,769 MNM compliance samples were at or below the PEL (50 μg/m³). The exposure profile shows variability between the commodity categories: approximately 73 percent of metal miner exposures at or below the PEL (50 μg/m³) (the lowest among all MNM mines), compared with approximately 90 percent of the crushed limestone miner exposures (the highest among all MNM mines).

Table VII–3 and Table VII–4 present the corresponding respirable crystalline silica exposure information for coal miners by location (underground or surface). Overall, approximately 93 percent of the 63,127 samples obtained by MSHA inspectors for coal miners were at or below the PEL (50 μg/m³). There was little variation between samples for underground miners and surface miners (with approximately 93 and 92 percent of the samples at or below 50 μg/m³, respectively). Exposure values from the coal industry are expressed as ISO 8-hour TWAs, compatible with the final rule's (see notes, Table VII–3).

BILLING CODE 4520–43–P

[32] MSHA removed duplicate samples, samples missing critical information, and those identified as invalid by the mine inspector, for example because of a ''fault'' (failure) of the air sampling pump during the sampling period.

[33] MSHA MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220812); MSHA MSIS respirable crystalline silica data for the Coal Industry, August 1, 2016, through July 31, 2021 (version 20220617). All samples were collected by mine inspectors and were of sufficient mass to be analyzed for respirable crystalline silica by MSHA's laboratory.

[34] MSHA selected these ranges based on the PELs under consideration, then multiples of 100 μg/m³ to show how data are distributed in the higher ranges. Table VII–4 also presents additional exposure ranges corresponding to the 85.7 μg/m³ concentration for coal samples.

Table VII-1: Summary of Respirable Crystalline Silica Exposures in the MNM Industry from 2005 to 2019, by Commodity Category

Commodity	Activity Group	Number of Samples	ISO Concentration, µg/m³		
			Mean	Median	Max
Metal	Overall: metal (all activity groups)	3,499	49.1	25.0	3,588
Nonmetal	Overall: nonmetal (all activity groups)	5,165	26.4	11.0	2,124
Stone	Overall: stone (all activity groups)	15,415	36.6	17.0	1,548
Crushed limestone	Overall: crushed limestone (all activity groups)	15,184	21.7	10.0	4,289
Sand and gravel	Overall: sand and gravel (all activity groups)	18,506	38.7	20.0	3,676
Overall: MNM	Overall: MNM	57,769	33.2	15.0	4,289

Notes:

Summary of personal samples presented as ISO 8-hour TWA concentrations. The permissible exposure limit (PEL) for all mines is 50 µg/m³ as an 8-hour time-weighted average (8-hour TWA) sample collected according to the ISO standard 7708:1995: *Air Quality—Particle Size Fraction Definitions for Health-Related Sampling*.

1. The compliance samples summarized in this table were collected by MSHA inspectors as 8-hour TWAs using ISO-compliant sampling equipment with an air flow rate of 1.7 L/min, with results comparable to the PEL.
2. When the mass of respirable crystalline silica collected was too small to be reliably detected by the laboratory, a mass of 2.5 µg for quartz and 5 µg for cristobalite (1/2 the respective limits of detection for these two forms of crystalline silica) were assumed and used to calculate sample results.
3. The procedure to calculate the ISO 8-hour TWA concentration (µg/m³) is:

$$\text{8-hour TWA} = \frac{quartz\ mass}{(480\ minutes)\ x\ (air\ flow\ rate)}\ x\ 1000\ \frac{L}{m^3}$$

where: quartz mass is in micrograms (µg); normalized sampling time is 8 hours (480 minutes); flow rate = 1.7 L/min; 1000 Liters (L) per cubic meter (m³)

4. Source: MSHA MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220812). All samples were of sufficient mass gain to be analyzed for respirable crystalline silica.

Table VII-2: Percentage Distribution of Respirable Crystalline Silica Exposures in the MNM Industry from 2005 to 2019, by Commodity Category

Commodity	Activity Group	Number of Samples	Percentage of Samples in ISO Concentration Ranges, µg/m³						Total %
			≤ 25	> 25 to ≤ 50	> 50 to ≤ 100	> 100 to ≤ 250	> 250 to ≤ 500	> 500	
Metal	Overall: metal (all activity groups)	3,499	51.6%	21.3%	16.3%	8.3%	1.9%	0.6%	100%
Nonmetal	Overall: nonmetal (all activity groups)	5,165	70.5%	15.1%	9.9%	3.8%	0.6%	0.1%	100%
Stone	Overall: stone (all activity groups)	15,415	60.3%	18.7%	13.6%	6.0%	1.1%	0.3%	100%
Crushed limestone	Overall: crushed limestone (all activity groups)	15,184	77.8%	12.5%	6.9%	2.3%	0.4%	0.2%	100%
Sand and gravel	Overall: sand and gravel (all activity groups)	18,506	58.6%	20.8%	13.2%	5.7%	1.2%	0.4%	100%
Overall: MNM	Overall: MNM	57,769	64.7%	17.6%	11.6%	4.8%	1.0%	0.3%	100%

Notes:

1. Personal samples were collected using ISO-compliant sampling equipment and calculated as an 8-hour time-weighted average (8-hour TWA). Samples were collected using an air flow rate of 1.7 L/min and reported as 8-hour TWAs. See notes in Summary Table VII-1 for additional details.
2. Source: MSHA MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220812). All samples were of sufficient mass to be analyzed for respirable crystalline silica.

Table VII-3: Summary of Respirable Crystalline Silica Exposures in the Coal Mining Industry from 2016 to 2021, by Location

Location	Activity Group	Number of Samples	ISO Concentration (8-hour TWA, µg/m³)		
			Mean	Median	Max
Underground	Overall: underground (all activity groups)	53,095	22.1	16.0	778.6
Surface	Overall: surface (all activity groups)	10,032	20.5	11.1	747.8
Overall: coal	Overall: coal	63,127	21.9	16.0	778.6

Notes: Summary of personal samples presented as ISO 8-hour TWA concentrations. The permissible exposure limit (PEL) for all mines is 50 µg/m³ as an 8-hour time-weighted average (8-hour TWA) sample collected according to the ISO standard 7708:1995: *Air Quality—Particle Size Fraction Definitions for Health-Related Sampling*.

1. The compliance samples summarized in this table were collected by MSHA inspectors for the entire duration of each miner's work shift using sampling equipment with an air flow rate of 2 L/min, with results reported as MRE TWA concentrations. For this rulemaking analysis, MSHA recalculated the samples as ISO-equivalent 8-hour TWA concentrations, comparable to the PEL (since samples were not collected using an ISO-compliant sampling method). The procedure to calculate an ISO-equivalent concentration from an MRE TWA sample concentration involves normalizing the sample concentration to an 8-hour TWA and applying the empirically derived conversion factor of 0.857 recommended by NIOSH (1995a) using the following equation:

ISO 8-hour TWA concentration = $(MRE\ TWA\ in\ \mu g/m^3)\ x\ \frac{(original\ sampling\ time)}{(480\ minutes)}\ x\ 0.857$

where: both concentrations (ISO 8-hour TWA and MRE TWA) are concentrations presented as µg/m³; sampling time in minutes.

2. When the mass of respirable crystalline silica collected was too small to be reliably detected by the laboratory, a mass of 1.5 µg (1/2 the limit of detection) was assumed and used to calculate sample results.

3. Source: MSHA MSIS respirable crystalline silica data for the Coal Industry, August 1, 2016, through July 31, 2021 (version 20220617). All samples were of sufficient mass gain to be analyzed for respirable crystalline silica.

Table VII-4: Percentage Distribution of Respirable Crystalline Silica Exposures as ISO 8-hour TWA in the Coal Industry from 2016 to 2021, by Location

Location	Activity Group	Number of Samples	Percentage of Samples in ISO Concentration Ranges, 8-hour TWA, μg/m³							Total %
			≤ 25	> 25 to ≤ 50	> 50 to ≤ 85.7	> 85.7 to ≤ 100	> 100 to ≤ 250	> 250 to ≤ 500	> 500	
Underground	*Overall: underground (all activity groups)*	53,095	72.7%	20.6%	5.1%	0.6%	1.0%	0.1%	0.0%	100%
Surface	*Overall: surface (all activity groups)*	10,032	79.5%	12.4%	4.6%	0.8%	2.3%	0.4%	0.1%	100%
Overall: coal	Overall: coal	63,127	73.8%	19.3%	5.0%	0.6%	1.2%	0.1%	0.0%	100%

Notes:

1. Personal samples presented in terms of ISO concentrations, normalized to 8-hour time-weighted averages (TWAs). The samples were originally collected for the entire duration of each miner's work shift, using an air flow rate of 2 L/min. See notes in Summary Table VII-3 for additional details.
2. Source: MSHA MSIS respirable crystalline silica data for the coal industry, August 1, 2016, through July 31, 2021 (version 20220617). All samples were of sufficient mass to be analyzed for respirable crystalline silica.

Existing Dust Controls in Mines (Baseline Conditions)

MNM and coal mines are controlling dust containing respirable crystalline silica in various ways. As shown in Tables VII–1 through VII–4, respirable crystalline silica exposures exceeded the PEL of 50 μg/m³ in about 18 percent of all MNM samples collected. About seven percent of all coal samples exceeded the PEL. Overall, metal mines and sand and gravel mines had higher exposure levels than other commodity mines.

Despite the extensive dust control methods available, dust control measures have been implemented in some commodity categories to a greater degree than in others. This is partly because some commodity categories tend to have larger mines. MSHA has found that the larger the amount (tonnage) of material a mine moves (including overburden and other waste rock), the faster the mine tends to operate its equipment (*i.e.,* closer to the equipment capacity), creating more air turbulence and therefore generating more airborne respirable crystalline silica. The amount of material moved also influences the number of miners employed at a mine, and therefore, the number of miners can be indirectly correlated to the amount of dust generated. MSHA has observed that in large mines, dusty conditions typically prompt more control efforts, usually in the form of added engineering controls.

MSHA has also found that metal mines, which are typically large operations with higher numbers of miners, tend to have available engineering controls for dust management. On the other hand, sand and gravel mines, which generally employ fewer miners and handle modest amounts of material, have very limited, if any, dust control measures. This is because most of the mined material is a commodity that only requires washing and screening into various sizes of product stockpiles, generating little waste material. Nonmetal, stone, and crushed limestone mines occupy the middle range in terms of employment, existing engineering controls, and maintenance practices.

Over the years, staff from multiple MSHA program areas have worked alongside miners and mine operators to improve safety and health by inspecting, evaluating, and researching mine conditions, equipment, and operations. These key programs, each of which has an onsite presence, include (but are not limited to) Mine Safety and Health Enforcement; Directorate of Educational Policy and Development, which includes the National Mine Health and Safety Academy and the Educational Field and Small Mine Services; and the Directorate of Technical Support, which comprises the Approval and Certification Center and the Pittsburgh Safety and Health Technology Center (including its Health Field Division, Analytical and Laboratory Services Division, National Air and Dust Laboratory, Ventilation Division, and other specialized divisions). Table VII–5 reflects the collective observations of these MSHA programs, presented in terms of existing dust control (baseline conditions) and the classes of additional control measures that will provide those mines with the greatest benefit to reduce exposures below the PEL and action level.

Table VII–5 shows MSHA's assessment of existing dust controls in mines (baseline conditions) and additional controls needed to meet the PEL for each commodity category, including the need for frequent scheduled maintenance. By conducting frequent scheduled maintenance, mine operators can reduce the concentration of respirable crystalline silica. Table VII–5 shows that metal mines have adopted extensive dust controls, while sand and gravel mines tend to have minimal engineering controls, if any.

Table VII-5: Baseline Conditions and Class of Additional Controls Needed, by Commodity

	Baseline (existing) Conditions		Additional Controls Needed to Achieve the PEL		
Commodity category	**Extent of engineering controls adopted**	**Dust control equipment maintenance practices**	**Extent of engineering controls needed**	**Extent of maintenance and repair needed**	**Extent of administrative controls needed**
Metal	Extensive	Minimal	Minimal	Extensive	Moderate
Nonmetal	Moderate	Moderate	Moderate	Moderate	Moderate
Stone	Moderate	Moderate	Moderate	Moderate	Moderate
Crushed limestone	Moderate	Moderate	Moderate	Moderate	Moderate
Sand and gravel	Minimal	Moderate	Moderate	Moderate	Extensive
Coal	Moderate	Moderate	Moderate	Moderate	Moderate

Notes:

1. Extensive, moderate and minimal are relative terms.
2. "Extensive" indicates that the baseline (existing) condition is widely (i.e., predominantly) present among mines within the commodity group as a whole, or that the additional control class is found to be widely needed (e.g., these mines' engineering controls routinely show evidence of needing more attentive maintenance and/or repair to function as intended).
3. "Moderate" indicates an intermediate level of baseline availability or need.
4. "Minimal" means little or no baseline availability or need as an additional control (for that commodity).

Source: MSHA's experience from multiple program areas.

BILLING CODE 4520–43–C

Based on MSHA's experience, NIOSH research, and effective respirable dust controls currently available and in use in the mining industry, MSHA finds that the baseline conditions include various combinations of existing engineering controls selected and installed by individual mines to address respirable crystalline silica generated during mining operations.

Respirable Crystalline Silica Exposure Controls Available to Mines

Under the final rule, the mine operator must install, use, and maintain engineering controls, supplemented by administrative controls, when necessary, to keep each miner's exposure at or below the PEL. Engineering controls reduce or prevent miners' exposure to hazards.[35] Administrative controls establish work practices that reduce the duration, frequency, or intensity of miners' exposures (under the final rule, the rotation of miners is not considered an acceptable administrative control to comply with the PEL).

MSHA data and experience show that mine operators already have numerous engineering and administrative control options to control miners' exposures to respirable crystalline silica. These control options are widely recognized and used throughout the mining industry. NIOSH has extensively researched and documented engineering and administrative controls for respirable crystalline silica in mines. As noted previously, NIOSH has published a series on reducing respirable dust in mines (NIOSH, 2019b, 2021a).

(1) Engineering Controls

Examples of existing engineering controls used at mines and commercially available engineering controls that MSHA considered include:

- Wetting or water sprays that prevent, capture, or redirect dust;
- Ventilation systems that capture dust at its source and transport it to a dust collection device (*e.g.,* filter or bag house), dilute dust already in the air, or "scrub" (cleanse) dust from the air in the work area;
- Process enclosures that restrict dust from migrating outside of the enclosed area, sometimes used with an attached ventilation system to improve effectiveness (*e.g.,* crushing equipment and associated dump hopper enclosure, with curtains and mechanical ventilation to keep dust inside);

[35] Control measures that reduce respirable crystalline silica can also reduce exposures to other hazardous particulates, such as RCMD, metals, asbestos, and diesel exhaust. Operator enclosures and process enclosures also reduce hazardous levels of noise by creating a barrier between the operator and the noise source.

• Operator enclosures, such as mobile equipment cabs or control booths, which provide an environment with clean air for an equipment operator to work safely;

• Protective features on mining process equipment to help prevent process failures and associated dust releases (*e.g.,* skirtboards on conveyors, which protect the conveyor system from damage and prevent material on the conveyor from falling off, which generates airborne dust);

• Preventive maintenance conducted on engineering controls and mining equipment that can influence dust levels at a mine, to keep them functioning optimally; and

• Instrumentation and other equipment to assist mine operators and miners in evaluating engineering control effectiveness and recognizing control failures or other conditions that need corrective action.[36]

(2) Administrative Controls

Administrative controls include practices that change the way tasks are performed to reduce a miner's exposure. Administrative controls can be very effective and can even prevent exposure entirely. MSHA has determined that various administrative controls are readily available to provide supplementary support to engineering controls. Examples of administrative controls include housekeeping procedures; proper work positions of miners; walking around the outside of a dusty process area rather than walking through it; cleaning of spills; and measures to prevent or minimize contamination of clothing to help decrease miners' exposure to respirable crystalline silica. However, these control methods depend on human behavior and intervention and are less reliable than properly designed, installed, and maintained engineering controls. Therefore, administrative controls will be permitted only as supplementary measures, with engineering controls required as the primary means of protection. Nevertheless, administrative controls play an important role in reducing miners' exposure to respirable crystalline silica.[37]

(3) Combinations of Controls

Various control options can also be used in combinations. NIOSH has documented in detail most control methods and has confirmed that they are currently used in mines, both individually and in combination with each other (2019b, 2021a).

Maintenance

MSHA finds that a strong preventive maintenance program plays an important role in achieving consistently lower respirable crystalline silica exposure levels. MSHA has observed that when engineering controls are installed and maintained in working condition, respirable dust exposures tend to be below the existing exposure limits. When engineering controls are not maintained, dust control efficiency declines and exposure levels rise. When engineering controls fail due to a lack of proper maintenance, a marked rise in exposures can occur, resulting in noncompliance with MSHA's existing exposure limits. Some examples of the impact that proper maintenance can have on respirable dust levels include:

• Water spray maintenance: An experiment using water spray bars that could be turned on or off showed that dust reduction was less effective each time additional spray nozzles were deactivated. A 10 percent decrease occurred when three of 21 sprays were shut off, but a 50 percent decrease occurred when 12 out of the 21 sprays were shut off. Decreased total water spray volume and gaps in the spray pattern (due to deactivated nozzles) were both partially responsible for the decreased dust control (Seaman *et al.,* 2020).

• Water added to drill bailing air: When introduced into the drill hole (with the bailing air through a hollow drill bit), water mixes with and moistens the drill dust ejected from the hole and can reduce respirable dust by more than 90% (NIOSH, 2019b, 2021a). NIOSH reports that this same control measure, and others, are similarly effective for MNM and surface coal mine drills preparing the blasting holes used to expose the material below (whether ore or coal).

• Ventilation system maintenance: The amount of air cleaned by an air scrubber is decreased by up to one-third (33 percent) after one continuous mining machine cut. Cleaning the scrubber screens restores scrubber efficacy, but this maintenance must be performed after every cut. Spare scrubber screens make frequent cleaning practical without slowing production (NIOSH, 2021a).

• Operator enclosure maintenance: Tests with mining equipment showed that maintenance activities such as repairing weather stripping and replacing clogged and missing cab ventilation system filters (intake, recirculation, final filters) increased miner protection by up to 95 percent (NIOSH, 2019b, 2021a).

• Filter selection during maintenance: Airflow is as important as filtration and pressurization in operator enclosures; during maintenance, filter selection can influence all three factors. Performing serial end-shift testing of enclosed cabs (on a face drill and a roof/rock bolter) at an underground crushed limestone mine, NIOSH compared installed HEPA filters and an alternative (MERV 16 filters). The latter provided an equal level of filtration and better overall miner protection by allowing greater airflow and cab pressurization. As an added advantage, NIOSH showed that these filters cost less and required less-frequent replacement, reducing maintenance expenses in this mining environment (Cecala *et al.,* 2016; NIOSH, 2019b, 2021a).[38 39]

• Proper design and installation—foundation for effective maintenance: A new replacement equipment operator enclosure (control booth) installed adjacent to the primary crusher at a granite stone quarry initially provided 50 to 96 percent respirable dust reduction, even with inadequate pressurization. The protection it offered miners tripled after the booth's second pressurization/filtration unit was activated (Organiscak *et al.,* 2016).

MSHA has observed that when engineering controls are properly maintained, exposure levels decrease or stay low. Metal mines, which typically have substantial controls already installed, primarily need reliable preventive maintenance programs to achieve the PEL. It is also important to repair equipment damage that contributes to dust exposure (for example, damage to conveyor skirtboards that protect the conveyor system from damage and prevent spillage which generates airborne dust). Maintenance and repair programs must

[36] These instruments include dust monitors; water, air, and differential air pressure gauges; pitot tubes and air velocity meters; and video camera (NIOSH recommends software that pairs video with a dust monitor to track conditions that could lead to elevated exposures if not corrected). These instruments are discussed in NIOSH's best practices guides and dust control handbooks.

[37] Paragraph 60.11(b) prohibits the use of rotation of miners as an administrative control used for compliance with this part.

[38] NIOSH believes this study, like many of its other mining studies on operator enclosures and surface drill dust controls, is relevant to both MNM mining and coal mining. NIOSH reports on this study, conducted at an underground limestone mine, in detail in both its Dust Control Handbook for Industrial Minerals Mining and Processing (second edition) (2019b) and its Best Practices for Dust Control in Coal Mining (second edition) (2021a).

[39] Acronyms: High efficiency particulate air (HEPA). Minimum efficiency reporting value (MERV).

ensure that dust control equipment is functioning properly.

Some commenters described conditions where they found engineering controls were not feasible. The NSSGA, the NVMA, and US Silica (a MNM mine operator) cited examples such as water sprays that freeze in winter or are not practical where the product must be kept dry so mine workers can bag it; and enclosures and ventilation systems that are sometimes impractical for portable operations at some locations and limited (so made less effective) by the physical constraints of others (Document ID 1448; 1441;1455). The MNM mine operator commenter indicated that at their worksite, these physical conditions cause engineering controls to be ineffective more than does lack of effort (Document ID 1455).

In MSHA's considerable experience providing technical support to mines, there is always a way to eliminate overexposures to respirable dust (including respirable crystalline silica) by using the information contained in NIOSH best practice guides for mines. MSHA has found that the number of control options and level of detail in the guides make compliance achievable through engineering controls alone. By adding administrative controls (or procedural practices) mines routinely achieve consistent compliance. MSHA agrees with commenters that exposed water sprays are not effective in freezing weather, however, the Agency has found that one or more other options is available for every circumstance. For example, enclosing the process equipment is one alternative to using water sprays for dust control. Rather than suppressing dust, as water spray does, enclosing the dusty process equipment limits the amount of dust that escapes from the process enclosure, in turn limiting the amount of dust in the equipment operator's breathing zone. A process equipment enclosure can be constructed with baffles to help calm the air inside the enclosure, so dust settles more quickly inside the enclosure. As another option, a ventilation dust collection system can be paired with a process equipment enclosure to make both even more effective. Yet another example is to enclose the equipment operators (*e.g.,* in a booth or mobile cab). Furthermore, MSHA observes that a number of surface mines operate intermittently; many of them are closed in seasons with harsh weather. Typically, those mines can use water sprays effectively when they are operating. MSHA notes that ventilation systems are effective in every season; a large variety of system components and designs provide a ventilation system that can be constructed for almost every situation. As noted in the proposed rule, some mines might need to work harder than others (layering different engineering controls and adding administrative controls) to achieve compliance.

The Brick Industry Association (BIA) noted that their industry usually operates with the minimum number of personnel even under optimal staffing conditions and explained that it can be difficult to avoid rotating workers to achieve efficient workflow (Document ID 1422). This commenter also stated that it could be difficult to maintain productive operations if management is not able to either rotate workers to minimize exposure levels or allow personnel to wear respirators for day-to-day tasks.

As MSHA stated in the proposed rule and, and included in this final rule, miner rotation is not considered an acceptable administrative control for minimizing miner exposure levels or complying with any provision of part 60. MSHA understands that mine operators may assign a variety of work tasks for business reasons unrelated to compliance with the PEL. However, MSHA will not consider as compliance a mine operator's implementation of a varied task schedule for particular miners for purposes of avoiding conflict with the PEL, as engineering and administrative controls can feasibly reduce exposure levels below the PEL.

This final rule prioritizes engineering controls for reducing miner exposures, because they (1) control crystalline silica-containing dust particles at the source; (2) provide reliable, predictable, effective, and consistent protection to miners who would otherwise be exposed to dust from that source; and (3) can be monitored. MSHA maintains that as described earlier in this section, a combination of engineering controls and administrative controls can reduce miner exposures to levels below the PEL and that equipment maintenance will help minimize exposures. Some examples of engineering controls include wet dust suppression methods; enclosure; ventilation—permanent or portable trunks; pre-cleaning—by washing or HEPA vacuuming; and controlling dust sources. Examples of administrative controls include proper miner positioning and improved housekeeping. For a detailed discussion on rotation of miners, see *Section VIII.B.4. Section 60.11—Methods of Compliance.*

MSHA finds that the technological feasibility analysis process was effective and controlling exposure levels to the PEL or lower using engineering controls is both feasible and practical. The final rule, as did the proposed rule, emphasizes engineering controls, supplemented with administrative controls, to control miner exposure.

c. Feasibility Determination of Control Technologies

MSHA's final PEL is 50 μg/m³ for MNM and coal mines. As NIOSH (2019b, 2021a) has documented, the mining industry has a wide range of options for controlling dust exposure that are already in various configurations in mines. NIOSH has carefully evaluated most of the dust controls used in the mining industry and found that many of the controls may be used in combination with other control options. NIOSH has documented protective factors and exposure reductions of 30 to 90 percent or higher for many engineering and administrative controls.

Effective maintenance will also help mine operators comply with the final rule. MSHA finds that maintaining (including adjusting) or repairing existing equipment will help achieve exposures at or below 50 μg/m³. For example, NIOSH (2019b) found that performing maintenance on an operator enclosure can restore enclosure pressurization and reduce the respirable dust exposure of a miner by 90 to 98.9 percent (*e.g.,* by maintaining weather stripping, reseating or replacing leaking or clogged filters, and upgrading filtration). When an equipment operator remains inside a well-maintained enclosure for a portion of a shift (for example 75 percent of an 8-hour shift), the cab can reduce the exposure of the equipment operator proportionally, to a level of 50 μg/m³ (or lower). This point is demonstrated by the following example involving a bulk loading equipment operator in a poorly maintained booth, exposed to respirable crystalline silica near the existing exposure limit (in the MNM sectors, 100 μg/m³, as ISO 8-hour TWA value; in the coal sector, 85.7 μg/m³ ISO, calculated as an 8-hour TWA). During the 25 percent of their shift (two hours of an eight-hour shift) that the miner works in the poorly maintained enclosure, their exposure will be 100 μg/m³, while for the other six hours (operating mobile equipment with a fully refurbished protective cab), the exposure level will be 90 percent lower, or 10 μg/m³, resulting in an 8-hour TWA exposure of 33 μg/m³ for that miner's shift.[40] Greater

[40] Calculating the exposure for the shift: 8-hour TWA = [(10 μg/m³ × 6 hours) + (100 μg/m³ × 2 hours)]/8 hours = 33 μg/m³.

exposure reductions could also be achieved by repairing or replacing the poorly maintained enclosure, or modifying the miner's schedule so that the miner works seven hours, rather than six, inside the well-maintained enclosure.

Other engineering controls (*e.g.,* process enclosure, water dust suppression, dust suppression hopper, ventilation systems) could reduce dust concentrations in the area surrounding the poorly maintained enclosure, which reduces the exposure of the equipment operator inside. As a hypothetical example, if the poorly maintained enclosure was an open-air control booth (windows do not close) at a truck loading station, adding a dust suppression hopper (which reduces respirable dust exposure by 39 to 88 percent during bulk loading) (NIOSH, 2019b), will lead to lower exposure during the two hours the miner is inside the open-air booth. The calculated respirable crystalline silica 8-hour TWA exposure of that miner could be reduced from 33 μg/m³ (with improved equipment operator enclosure alone) to 23 μg/m³ (improved equipment operator enclosure plus dust suppression hopper).[41] As an added benefit, any helper or utility worker in the truck loading area will also experience reduced exposure.

A similar hypothetical example is a coal miner helper who spends 90 minutes (1.5 hours) per 8-hour shift assisting a drilling rig operator (in a protective operator's cab) drilling blast holes. The combination of controls used to control drilling dust (including water added to the bailing air, which can reduce airborne respirable dust emissions by up to 96 percent) can keep the helper's respirable crystalline silica exposure in the range of 35 μg/m³ (ISO) as an 8-hour TWA. If, however, the drill's on-board water tank runs dry due to poor maintenance, the respirable crystalline silica concentration near the drill will rise by 95 percent, meaning that the concentration is 20 times greater than the usual level (NIOSH, 2021a). If the drill operator idles the drill and calls for water resupply, the helper will not experience an elevated exposure. The hypothetical helper's exposure level rises higher the longer the drill is operated. If the drill is operated dry for another 30 minutes until water resupply arrives, the helper will experience a respirable crystalline silica exposure of 77 μg/m³ (ISO) as an 8-hour TWA. If dry drilling continued for 1.5 hours, the helper would have an exposure of 160 μg/m³ ISO as an 8-hour TWA.[42] After water is delivered, drill respirable dust emissions will return to their normal level once water is again introduced into the drill bailing air.

Based on these examples and the wide range of effective exposure control options available to the mining industry, MSHA finds that control technologies capable of reducing miners' respirable crystalline silica exposures are available, proven, effective, and transferable between mining commodities; however, they must be well-designed and consistently used and maintained. MSHA also finds that methods of maintaining engineering controls are known, available, and effective.

Feasibility Findings for the PEL

Based on the exposure profiles in Table VII–1 and Table VII–2 for MNM mines, and in Table VII–3 and Table VII–4 for coal mines, and the examples in the previous section that demonstrate the beneficial effect of combined controls, MSHA finds that the PEL of 50 μg/m³ is technologically feasible for all mines.

Table VII–6 summarizes the technological feasibility of control technologies available to the mining industry, by commodity. MSHA finds that control technologies are technologically feasible for all six commodities and their respective activity groups. Under baseline conditions, mines in each commodity category have already achieved respirable crystalline silica exposures at or below 50 μg/m³ for most of the miners represented by MSHA's 57,769 samples for MNM miners and 63,127 samples for coal miners.

BILLING CODE 4520–43–P

[41] Calculating the exposure with both the well-maintained operator enclosure (6 hours) and dust suppression hopper, assuming only the minimum documented respirable dust concentration reduction (39 percent): [(10 μg/m³ × 6 hours) + (100 μg/m³ × (1 − 0.39) × 2 hours)]/8 hours = 23 μg/m³.

[42] The 8-hour TWA exposure level of the helper, including the 30-minute period of elevated exposure, is calculated as: [(35 μg/m³ × 7.5 hours) + (35 μg/m³ × 20 × 0.5 hours)]/8 hours = 77 μg/m³. Drill bits designed for use with water may need to be replaced sooner if used dry.

Table VII-6: Summary of Technological Feasibility of Control Technologies in the Mining Industry, by Commodity, Indicating Activity Groups Affected by Respirable Crystalline Silica Exposures

Commodity category	% samples ≤ 50 μg/m³	Total number of affected activity groups[1]	Number of activity groups for which the PEL is achievable with engineering and administrative controls[2, 3]	Number of activity groups for which the PEL is NOT achievable with engineering and administrative controls	Feasibility finding, by commodity category
Metal	73	4	4	0	Feasible
Nonmetal	86	4	4	0	Feasible
Stone	79	4	4	0	Feasible
Crushed limestone	90	4	4	0	Feasible
Sand and Gravel	79	4	4	0	Feasible
Coal (under-ground and surface)[4]	93	7	7	0	Feasible
Overall	--	27	100%	0%	Feasible

Notes:

1. Activity groups include 1) production and development miners; 2) ore/mineral processing miners; 3) miners engaged in load/haul/dump activities; and 4) miners in all other occupations.
2. Engineering controls include wetting and water sprays, ventilation systems, enclosure of dusty processes, and operator enclosures (equipment cabs and control booths). For the purposes of this table, effective maintenance is also an engineering control.
3. Administrative controls encompass both mine operator policies and miner work practices, such as written operating procedures, miner training, keeping operator enclosure door and windows closed to exclude dust; or walking around, rather than through a dusty area.
4. Coal mines include three activity groups underground and four surface activity groups.

BILLING CODE 4520–43–C

Feasibility Findings for the Action Level

MSHA finds that mine operators can achieve exposure levels below the action level of 25 μg/m³ for most miners by implementing additional engineering controls and more flexible and innovative administrative controls, in addition to the existing control methods already discussed in this technological feasibility analysis. The exposure profiles in Tables VII–1 and VII–2 for MNM mines, and Tables VII–3 and VII–4 for coal mines, indicate that mine operators have already achieved the action level for at least half of the miners MSHA has sampled in each commodity category. However, to reliably maintain exposures below the action level for all miners, operators will need to upgrade equipment and facility designs, particularly in mines with higher respirable crystalline silica concentrations, which may be due to an elevated silica content in materials.

One control option is increased automation, such as expanding the use of existing autonomous or remote-controlled drilling rigs, roof bolters, stone cutting equipment, and packaging/bagging equipment. This type of automation can reduce exposures by increasing the distance between the equipment operator and the dust source. Other options include completely enclosing most processes and ventilating the enclosures with dust extraction equipment or controlling the speed of mining equipment (*e.g.,* longwall shearers, conveyors, dump truck emptying) and process equipment (*e.g.,* crushers, mills) to reduce turbulence that increases dust concentrations in air. Additionally, where compatible with the material, exposure levels can be reduced by increased wetting to constantly maintain the material, equipment, and mine facility surfaces damp through added water sprays and frequent housekeeping (*i.e.,* hosing down surfaces as often as necessary). In addition, vacuuming minimizes the amount of dust that becomes airborne and prevent dust that does settle on a surface from being resuspended in air.

Mines that only occasionally work with higher-silica-content materials may not be equipped with the controls required to achieve the action level of 25 μg/m³, or they may not currently have procedures to ensure miners are protected when they do work with these materials. Examples of these activities include cutting roof or floor rock with a continuous mining machine in underground coal mines; packaging operations that involve materials from an unfamiliar supplier, including another mine; and rebuilding or repairing kilns. To address these activities, under the final rule, mine operators will have to add engineering controls to address any foreseeable respirable crystalline silica overexposures. Examples of additional controls include pre-testing batches of new raw materials; improving hazard communication when batches of incoming raw materials contain higher concentrations of crystalline silica, and augmenting enclosure and ventilation (*e.g.,* adding ventilation to all crushing and screening equipment, increasing mine facility ventilation to 30 air changes per hour, and fully enclosing and ventilating all conveyor transfer locations). NIOSH (2019b, 2021a) describes all of the dust control methods outlined in this section, which are already used in mines, although to a less rigorous extent than will be necessary to reliably and consistently achieve exposure levels of 25 μg/m³ or lower for all miners.

MSHA finds that the action level of 25 μg/m³ is technologically feasible for most mines. This finding is based on the exposure profiles, presented in Tables VII–1 and VII–2 for MNM mines, and Tables VII–3 and VII–4 for coal mines, which show that within each commodity category, the exposure levels are at or below 25 μg/m³ for at least half of the miners sampled. MSHA's finding is also based on the extensive control options documented by NIOSH, which can be used in combinations to achieve additional reductions in respirable crystalline silica exposure. Although most mines will need to adopt and rigorously implement a number of the control options mentioned in this section, the technology exists to achieve this level, is already in use in mines, and is available for most mines.

MSHA received numerous comments related to exposure control methods. Several commenters recommended that the standard incorporate by reference certain materials to assist mine operators with compliance. The International Society of Environmental Enclosure Engineers (ISEEE) discussed ISO 23875 (Document ID 1377).[43] The commenter explained that this ISO standard is a widely adopted international standard for cab air quality, as a practical and cost-effective engineering control that would help mine operators meet the final rule's requirements since the desired outcome in all ISO 23875 cabs is compliance with air quality regulations at the 25 μg/m³ level. The commenter added that increased awareness of the standard and compliant cabs would lead to the development of a standardized cab design that could be mass-produced and therefore reduce costs. Another commenter, the APHA, stated that guides prepared by NIOSH for coal mines and metal and non-metal mines contain helpful illustrations of technologically feasible engineering controls that reduce exposure to respirable dust (Document ID 1416).

MSHA has reviewed the comments and suggested material. The Agency agrees that ISO 23875 is a useful tool that promotes feasible dust control equipment manufacture and maintenance practices. Although MSHA has not incorporated it into the final rule, the Agency will keep this standard in mind during future initiatives. MSHA acknowledges that many other organizations and agencies, including NIOSH with its detailed and carefully illustrated best practice guides for the mining industries, have published extensive information that may be helpful to mine operators seeking methods to protect miners. The Agency encourages mine operators to use these tools to identify proper and adequate engineering controls, choose those that will be useful in their mines, and ensure that the controls are correctly installed, implemented, and maintained.

MSHA received several comments regarding the description and use of feasible engineering controls. The NVMA requested that MSHA supply a definition for what is ''feasible'' (Document ID 1441).

Within MSHA's standard development process, the term ''feasible'' generally means ''capable of being done.'' In the case of respirable crystalline silica exposure controls, these controls exist already and are not technology-forcing. Based on its extensive experience inspecting and providing compliance assistance and technical support in mines, MSHA has observed that U.S. mines are already using an extensive array of engineering controls. As documented by NIOSH in its best practices guides and other resources for the mining industry, the numerous readily available engineering controls provide evidence that it is technologically feasible for mine operators to reduce miner respirable crystalline silica exposure to levels at or below the PEL and, in some cases, below the action level (NIOSH, 2019b, 2021a).

These engineering controls, including examples and data, were discussed in more detail previously in this Technological Feasibility section (see *Section VII.A.1.b. The Technological Feasibility Analysis Process*). That section explains that engineering controls reduce or prevent miners' exposure to hazards, while administrative controls establish work practices that reduce the duration, frequency, or intensity of miners' exposures. The different functional types of engineering controls (wetting or water sprays, ventilation systems, process enclosures, equipment operator enclosures, the associated preventive maintenance that keeps the control equipment operating effectively, and instrumentation to monitor function and identify need for corrective actions) work alone or in combination with the same or other controls to provide additional protections. To further ensure that mine operators can achieve the PEL under diverse mining conditions, the final rule allows operators who seek an added measure of protection for miners to supplement engineering controls with administrative controls (*e.g.,* housekeeping procedures; proper work positions of miners; walking around the outside of a dusty process area rather than walking through it; cleaning of spills; and measures to prevent or minimize contamination of clothing to help decrease miners' exposure). This strategy allows a mine operator to select the set of engineering controls that will be most effective given the mining conditions and the mine environment. MSHA acknowledges that some mines will need to work harder than others; however, with the wide array of control options, MSHA is confident that the PEL is technologically feasible. As stated earlier with respect to a feasibility finding: ''MSHA does not need to show that every technology can be used in every mine. The agency must only demonstrate a 'reasonable possibility' that a 'typical firm' can meet the permissible exposure limits in 'most of its operations.' '' *Kennecott Greens Creek Min. Co.* v. *Mine Safety & Health Admin.,* 476 F.3d 946, 958 (D.C. Cir. 2007) (quoting *Am. Iron & Steel Inst.* v. *Occupational Safety & Health Admin.,* 939 F.2d 975, 980 (D.C. Cir. 1991)).

Some commenters, including the UMWA, American Federation of Labor and Congress of Industrial Organizations (AFL–CIO), Black Lung Clinics, and AIHA echoed the availability of effective engineering controls in the mining industry

[43] ISO 23875:2021 (*Mining—Air quality control systems for operator enclosures—Performance requirements and testing methods*) and Amendments.

(Document ID 1398; 1449; 1410; 1351). Two labor organizations stated that mine operators should already be utilizing engineering and administrative controls in accordance with the law and their existing ventilation plans (Document ID 1398; 1449). The Black Lung Clinics, AIHA, and UMWA expressed support for engineering and administrative controls as means to keep miners' exposures to respirable crystalline silica below the proposed PEL (Document ID 1410; 1351; 1398). Agreeing with MSHA that technologically feasible engineering controls are available, the AIHA stated that these methods can control crystalline silica-containing dust particles at the source and provide reliable and consistent protection to all miners who would otherwise be exposed to respirable dust (Document ID 1351).

MSHA concurs with these comments. MSHA's experience is consistent with these comments. Based on MSHA's experience, consideration of the OSHA silica rule (2016), and documentation from NIOSH as discussed in this section of the preamble, MSHA determines that engineering controls exist for mining operations to reduce miners' exposure to the level of the PEL (50 μg/m³). The Agency finds that engineering controls: (1) control crystalline silica-containing dust particles at the source; (2) provide reliable, predictable, effective, and consistent protection to miners who would otherwise be exposed to dust from that source; and (3) can be monitored. The technological feasibility analysis of the PEL in the proposed rule remains in effect for this final rule.

MSHA received several comments on the technological feasibility of the action level (25 μg/m³). Commenters including the Arizona Mining Association and American Iron Steel Institute (AISI) stated that the action level would not be achievable with current technology (Document ID 1368; 1426). The AIHA opposing the proposed action level, stated that the action level should be removed and the PEL should instead be set at the proposed action level of 25 μg/m³ (Document ID 1351).

After careful consideration of the comments, MSHA has determined a full-shift 8-hour TWA action level of 25 μg/m³ is feasible, and the final rule is the same as the proposal. MSHA acknowledges that its FRA finds that there will be a greater reduction of risk for morbidity and mortality at the action level than the final PEL of 50 μg/m³.[44] Additionally, MSHA's exposure profile (*Section VII.A.1.b,* Tables VII–1 through VII–4) indicates, based on MSHA compliance samples, that operators at most mines are already achieving exposure levels less than 25 μg/m³ for most miners. Tables VII–1 and VII–3 (in this section) show that the overall median MNM miner exposure is 15 μg/m³ and the overall median coal miner exposure is 16 μg/m³.[45] Although these medians indicate that mine operators have already achieved exposure levels below 25 μg/m³ for more than half of all miners sampled by MSHA, the Agency acknowledges that, for some mines, consistently achieving a PEL of 25 μg/m³ for all the miners it employs could present a substantial challenge (*i.e.,* a PEL of 25 μg/m³ is technically feasible, but the actions required might not be practical for many mines).[46] MSHA finds, however, that the concentration of 25 μg/m³ is an appropriate and necessary action level, which most mine operators can (and may already have) achieve for many miners. The action level is consistent with MSHA's statutory purpose under the Mine Act—to provide the highest level of health protection for the miner. MSHA establishes the action level and sets a sampling frequency for concentrations above the action level to require mine operators to be proactive and act before miners are overexposed. Under the final rule, where some miners have exposures at or above the action level (25 μg/m³), but not exceeding the PEL, mine operators are not required to install additional controls, but instead (in accordance with § 60.12(a)(3)) must sample those miners quarterly to confirm exposures remain below the PEL. Alternatively, the mine operator may choose to take actions to further reduce exposures below 25 μg/m³ and, where successful, discontinue sampling (after meeting the sampling requirements under § 60.12(a)(4)).

Comments on the analytical limit of detection and reliability relative to the action level relate to analytical methodology and are addressed in *Section VII.2.b. Analytical Methods and Feasibility of Measuring Below the PEL and Action Level.*

Section VIII.B.2.a. Action Level also addresses these and other comments related to the action level (25 μg/m³).

The action level is an important provision of this final rule, necessary to protect miners' health. According to NIOSH research, wherever exposure measurements are above one-half the PEL, the employer cannot be reasonably confident that the employee is not exposed to levels above the PEL on days when no measurements are taken (NIOSH, 1975). Thus, an action level (in this case set at one-half of the PEL) allows mine operators to take action before overexposures occur. The action level of 25 μg/m³ remains unchanged in the final rule and the methodology supporting the technological feasibility analysis for the action level in the proposed rule remains in effect for this final rule.

MSHA finds that the PEL of 50 μg/m³ is technologically feasible. This determination is based on MSHA's sound methodology and process for analyzing technological feasibility and control technology currently used in mines (described in this section and *Section VII.A.1.b.*), including the MSHA exposure profiles in Tables VII–1 through VII–4, which show that using the exposure control measures already in place, most mine operators are already achieving the PEL for most miners.

2. Technological Feasibility of Sampling and Analytical Methods

a. Sampling Methods

MSHA's final rule requires mine operators in both MNM and coal mines to conduct sampling for respirable crystalline silica using respirable particle size-selective samplers that conform to the ''*International Organization for Standardization (ISO) 7708:1995: Air Quality—Particle Size Fraction Definitions for Health-Related Sampling*'' standard. The ISO convention defines respirable particulates as having a 4 micrometer (μm) aerodynamic diameter median cut-point (*i.e.,* 4 μm-sized particles are collected with 50 percent efficiency), which approximates the size distribution of particles that when inhaled can reach the alveolar region of the lungs. For this reason, the ISO

[44] Some residual risks remain even at exposures of 25 μg/m³ of respirable crystalline silica. For example, at 25 μg/m³, end stage renal disease (ESRD) risk is 20.7 per 1,000 MNM miners and 21.6 per 1,000 coal miners.

[45] The median exposure level is the midpoint concentration of all samples; in other words, half (50%) of all the miner exposure samples are below the median, and the remaining half are above. Tables VII–2 (MNM mines) and VII–4 (coal mines) show the percent of MSHA compliance exposure samples that are less than 25 μg/m³.

[46] For example, MSHA preliminarily reviewed control measures the could reliably maintain exposures throughout mines to levels of 25 μg/m³ or lower and determined these likely would include, as a minimum, installing multiple layers of engineering controls at every point throughout the entire mine site by: concurrently enclosing and installing ventilation along the full length of every conveyor, fully enclosing all process equipment, doubling or quadrupling all ventilation system airflow, rebuilding ventilation systems to capture dust at its source, installing HEPA filters at air exhaust points, converting to automated processes, and maintaining all worksurfaces damp at all times.

convention is widely considered biologically relevant for respirable particulates and provides appropriate criteria for equipment used to sample respirable crystalline silica.

MSHA received supportive comments from Badger Mining Corporation (BMC), National Mining Association (NMA), and SKC Inc., regarding the requirement for samplers to conform to ISO 7708:1995 (Document ID 1417; 1428; 1366). BMC reported having no objection to MSHA's sampling device provisions proposed here (Document ID 1417). NMA encouraged MSHA to clarify that any sampling technology that meets the characteristics for respirable-particle-size-selective samplers that conform to the ISO 7708:1995 standard is acceptable for air sampling under the rule (Document ID 1428). NMA, BMC, and SKC, Inc. each mentioned currently available sampling equipment that meets the ISO criteria (Document ID 1428; 1417; 1366), and the manufacturer SKC, Inc. pointed out that, for respirable crystalline silica sampling, mine operators can use any respirable dust sampling device that conforms to ISO 7708:1995 (and where appropriate, meets MSHA permissibility requirements) (Document ID 1366). In the Section-by-Section analysis of this preamble, MSHA clarifies that mine operators are allowed to use any type of sampling device for respirable crystalline silica sampling, as long as the device is designed to meet the characteristics for respirable-particle-size-selective samplers that conform to the ISO 7708:1995 standard and, where appropriate, meet MSHA permissibility requirements.[47] [48]

The American Exploration & Mining Association (AEMA), NMA, and Portland Cement Association expressed concern that sufficient samplers (and sampling pumps) might not be available by the proposed compliance date (Document ID 1424; 1428; 1407).

As discussed in more detail in *Section VIII.B. Section-by-Section Analysis,* MSHA has extended the compliance dates for the final rule (24 months from publication of the final rule for MNM and 12 months from publication for coal) in response to concerns about the availability of sampling equipment, among other things. MSHA believes that this will resolve compliance date concerns but if concerns are not resolved by the time operators must comply, MSHA may exercise enforcement discretion as necessary.

MSHA received comments both for and against the proposed requirement of sampling within 180 days after the effective date of the final rule to complete the baseline sampling requirements, with most commenters stating, for a variety of reasons, that it was not enough time and recommending a longer period ranging from 1 year to 3 years. The Metallurgical Coal Producers Association (MCPA) and MSHA Safety Services, Inc. stated that providing only 180 days to complete baseline sampling is not sufficient because of the limitation of available resources for conducting sampling (Document ID 1406; 1392). The Portland Cement Association, SSC, and the NMA stated that this requirement may not be feasible for many operators because of competition for outsourced resources such as rental equipment, media, professional services, and laboratory sample analysis (Document ID 1407; 1432;1428). Concerned that mine operators will be competing to obtain these resources, the Portland Cement Association and National Lime Association (NLA) stated that small mines are likely to have the greatest difficulty in finding these resources in a short period of time (Document ID 1407; 1408). The NSSGA, NLA, BMC, and the Arizona Mining Association each expressed concerns about performing other tasks within the proposed timeframe for compliance, including establishing contracts with accredited laboratories and other service providers necessary for sampling, performing sampling for all miners who may reasonably be expected to be exposed to respirable crystalline silica, and designing and implementing new engineering controls (Document ID 1448; 1408; 1417; 1368). The NSSGA also urged MSHA to factor in the increased demand that might result from the state of California's effort to promulgate an Emergency Temporary Standard on silica (Document ID 1448). The MCPA and the Portland Cement Association recommended a phased timeline similar to the OSHA silica rule (which gave employers one year before the commencement of most requirements and two years before the commencement of sample analysis methods) and the MSHA 2014 RCMD Standard (which gave operators 18 months after the rule became effective) for completing sampling (Document ID 1406; 1407).

Other commenters considered the rule feasible and practical. The AFL–CIO stated that technologically feasible air sampling and analysis exist to achieve the proposed PEL using commercially available samplers (Document ID 1449). This commenter noted that these technologically feasible samplers are widely available, and a number of commercial laboratories provide the service of analyzing dust containing respirable crystalline silica. One individual supported the proposed requirement that baseline sampling be conducted within 180 days of the rule's effective date (Document ID 1367).

Samplers used in both MNM and coal mines can be used to perform the sampling, and because other commercially available (already on the market) samplers also conform to the ISO standard, MSHA finds that sampling in accordance with the ISO standard is technologically feasible and the technological feasibility analysis supporting the sampling methods provisions in the proposed rule remain in effect for this final rule.

b. Analytical Methods and Feasibility of Measuring Below the PEL and Action Level

After a respirable dust sample is collected and submitted to a laboratory, it must be analyzed to quantify the mass of respirable crystalline silica present. The laboratory method must be sensitive enough to detect and quantify respirable crystalline silica at levels below the applicable concentration. The analytical limit of detection (LOD) and/or limit of quantification (LOQ), together with the sample volume, determine the airborne concentration LOD and/or LOQ for a given air sample. MSHA's final PEL for respirable crystalline silica is 50 $\mu g/m^3$ as a full shift, 8-hour TWA for both MNM and coal mines. Several analytical methods are available for measuring respirable crystalline silica at levels well below the PEL of 50 $\mu g/m^3$ and action level of 25 $\mu g/m^3$.

MSHA uses two main analytical methods (1) *P–2: X-Ray Diffraction Determination Of Quartz And Cristobalite In Respirable Metal/Nonmetal Mine Dust* (analysis by X-ray diffraction, XRD) for MNM mines and (2) *P–7: Determination Of Quartz In Respirable Coal Mine Dust By Fourier Transform Infrared Spectroscopy*

[47] To comply with the final rule requirement for using respirable particulate samplers that meet the ISO 7708:1995 criteria, those coal mine operators that currently use coal mine dust personal sampler units (CMDPSU) will need to adjust their samplers to the flow rate specified by the sampler manufacturer for complying with the ISO standard. This means that mine operators who wish to use sampling devices that include a Dorr-Oliver cyclone can adjust the associated sampling pumps so they operate at a flow rate of 1.7 L/min to meet the ISO criteria. MSHA reminds mine operators that they must continue to ensure any sampling equipment used in underground coal mines is approved under Title 30 Part 74—Coal Mine Dust Sampling Devices.

[48] Mine operators must continue to ensure sampling equipment used in underground coal mines is approved under Title 30 Part 74—Coal Mine Dust Sampling Devices.

(analysis by infrared spectroscopy, FTIR or IR) for coal mines.[49] The MSHA P–2 and P–7 methods reliably analyze compliance samples collected by MSHA inspectors. The exposure profile portion of this technological feasibility analysis included 15 years of MNM compliance samples and 5 years of coal industry compliance samples MSHA analyzed with these methods. These methods can measure respirable crystalline silica exposures at levels below the PEL and action level.

For an analytical method to have acceptable sensitivity for determining exposures at the PEL of 50 μg/m³ and action level of 25 μg/m³, the LOQ must be at or below the amount of analyte (*e.g.,* quartz) that will be collected in an air sample where the concentration of analyte is equivalent to the PEL or action level. To determine the minimum airborne concentration that can be quantified, the LOQ mass is divided by the sample air volume, which is determined by the sampling flow rate and duration. Table VII–7 presents minimum quantifiable quartz concentrations that can be measured using particle size-selective samplers under various sampling parameters and established analytical method reporting limits.

BILLING CODE 4520–43–P

Table VII-7: Minimum Quantifiable Quartz Concentrations, Determined by Reporting Limit or LOQ and Sampling Volume

Sampling Parameters (examples)	Reporting Limit or LOQ = 5 μg	Reporting Limit or LOQ = 9.76 μg	Reporting Limit or LOQ = 12 μg
Airflow rate: 1.7 L/min Sampling minutes: 480 Sample air volume: 816 L	6.1 μg/m³	12.0 μg/m³	14.7 μg/m³
Airflow rate: 2.5 L/min Sampling minutes: 480 Sample air volume: 1,200 L	4.2 μg/m³	8.1 μg/m³	10 μg/m³
Airflow rate: 2.75 L/min Sampling minutes: 480 Sample air volume: 1,320 L	3.8 μg/m³	7.4 μg/m³	9.1 μg/m³
Airflow rate: 4.2 L/min Sampling minutes: 480 Sample air volume: 2,016 L	2.5 μg/m³	4.8 μg/m³	6.0 μg/m³

Notes:

1. An analytical method LOQ may be referred to as a reporting limit (RL) or reliable quantitation limit (RQL).
2. RL and LOQ values are limits reported by (1) commercial laboratories (5 μg) (EMSL Analytical, Inc., 2022; RJ Lee Group, 2021; SGS Galson, 2016), (2) OSHA ID-142 (9.76 μg), and (3) MSHA P-2 and P-7 (12 μg).
3. The minimum quantifiable concentration may change based on the laboratory's analytical method and instrumentation.
4. Airflow rates are typical of sampler manufacturer recommendations for complying with ISO 7708:1995.
5. Sample air volume (in liters) calculation: (sampling minutes) x (air flow rate as L/min)
6. Minimum quantifiable concentration (μg/m³) calculation: (LOQ) / (L air volume) x 1000 L/m³

BILLING CODE 4520–43–C

Two commenters mentioned the need for sampling devices with real-time or near real-time sample analysis capabilities for respirable crystalline silica (Document ID 1428; 1449). One of these commenters, the NMA, noted that personal dust monitoring devices with real-time analysis did not appear in the proposed respirable crystalline silica rule, noting that this equipment was included in MSHA's 2014 Coal Dust Rule (Document ID 1428). The commenter recommended that MSHA adopt new technology from the domestic or international mining community to better protect miners. Also interested in new technology, the AFL–CIO stated that, to more appropriately characterize exposures, MSHA should incorporate continuous and rapid quartz monitoring systems into the rule (Document ID 1449).

MSHA agrees with these commenters that new technology, such as real-time dust monitors and NIOSH's rapid field-based quartz monitoring (RQM) system with end-of-shift reporting[50] can help mine operators, for example by identifying overexposure conditions while the operator evaluates and implements controls to reduce exposure. MSHA is not, however, including instruments such as those mentioned by the commenters in the

[49] Other similar XRD methods include NIOSH–7500 and OSHA ID–142. XRD methods distinguish between the different polymorphs—quartz, cristobalite and tridymite. Other IR methods include NIOSH 7602 and 7603. IR methods, while efficient, are prone to interferences and should only be used with a well-characterized sample matrix (*e.g.,* coal dust).

[50] NIOSH Information Circular 9533, ''Direct-on-filter Analysis for Respirable Crystalline Silica Using a Portable FTIR Instrument'' provides detailed guidance on how to implement a field-based end-of-shift respirable crystalline silica monitoring program.

final rule because the Agency has reviewed the information on these instruments and decided that analysis of samples using accredited laboratories is the most accurate and reliable method of determining respirable crystalline silica exposures for compliance purposes. The final rule is the same as the proposal. Nevertheless, MSHA recommends that operators stay aware of and evaluate advances in technologies to identify control options that facilitate compliance, improve mine operator and miner awareness, and improve miner health.

A commenter, AISI, expressed concern that the action level was too close to the limit of accurate detection of respirable crystalline silica (Document ID 1426) and one commenter, SSC, stated that there is little confidence in the reliability of sampling results below 50 μg/m³ (Document ID 1432).

MSHA agrees that limits of detection and reliability are important considerations, and, in this context, the agency carefully reviewed currently available sampling equipment and analytical methods as part of the final rule and in Table VII–7. In Table VII–7, MSHA demonstrates how exposure levels well below the PEL and action level can be reliably quantified using particle size-selective samplers under various sampling parameters and established analytical method reporting limits. The minimum quantifiable quartz concentrations shown in Table VII–7 are all less than 25 μg/m³ and all but one are 12 μg/m³ or less, therefore well below the action level (25 μg/m³).

MSHA finds that current analytical methods are sufficiently sensitive to meet the PEL and action level in the final rule. This finding is based on information presented in this section showing the availability and sensitivity of MSHA, NIOSH, and OSHA analytical methods capable of measuring respirable crystalline silica concentrations below 50 μg/m³ and 25 μg/m³.

c. Laboratory Capacity

MSHA's final rule requires, for sample analysis, that mine operators use laboratories that meet *ISO 17025, General Requirements for the Competence of Testing and Calibration Laboratories* (ISO 17025). The majority of U.S. industrial hygiene laboratories that perform respirable crystalline silica analysis are accredited to ISO 17025 by the American Industrial Hygiene Association (AIHA) Laboratory Accreditation Program (LAP). The AIHA LAP lists 30 accredited commercial laboratories nationwide that, as of November 2023, performed respirable crystalline silica analysis using an MSHA, NIOSH, or OSHA method.

MSHA received comments in support of the requirement for sample analysis by the AIHA and the American Association for Laboratory Accreditation (A2LA) (Document ID 1351; 1388). Both commenters agreed that MSHA should rely on laboratories accredited to the ISO 17025 standards. The A2LA explained that relying on accredited laboratories' impartiality, expertise, and accuracy will permit MSHA to focus time and resources on policy, enforcement actions and other Agency responsibilities (Document ID 1388).

MSHA interviewed three AIHA LAP accredited laboratories (one small-capacity laboratory,[51] one medium-capacity laboratory,[52] and one large-capacity laboratory [53]) to estimate their sample-processing capacity. Insights from these interviews suggest that laboratories have the ability to provide demand capacity during the phase-in of the final rule. Collectively, these three laboratories could process approximately 33,240 samples by XRD (suitable for MNM mines) and 1,752 samples by FTIR or IR (suitable for coal mines) within a 6-month period. Extrapolating this across all laboratories that can analyze respirable crystalline silica samples, MSHA estimates that analysis will be available for 664,800 samples for MNM mines and 35,000 samples for coal mines over any one-year period. Separately, in its FRIA (and summarized in Table VII–8), MSHA estimates the numbers of miners for whom the various types of sampling is required under the final rule, in the first and each subsequent year after the final rule goes into effect.[54] As shown in Table VII–8, MSHA anticipates that within the first 12 months after the final rule effective date, mines will seek analysis for a total of 41,599 respirable crystalline silica samples (all for coal mines). In the subsequent 12-month period, mines will require analysis for 216,183 samples (primarily for MNM mines). The number of analyses will begin declining in Year 3, as mine operators reduce some miner exposures below the action level. Comparing these figures with the demand capacity estimates noted above, MSHA finds that there is sufficient processing capacity to meet the sampling analysis schedule in the final rule.

BILLING CODE 4520–43–P

[51] The small capacity laboratory has a maximum respirable crystalline silica sample analysis capacity of 300 samples per month (280 additional samples per month above the current number of samples analyzed), a level which the laboratory could sustain for two months.

[52] The medium capacity laboratory has a maximum respirable crystalline silica sample analysis capacity of 2,025 samples per month. Surge from the mining industry is considered to replace, rather than be in addition to the current number of samples analyzed.

[53] The large capacity laboratory has a maximum respirable crystalline silica sample analysis capacity of 4,500 samples per month (3,700 additional samples per month above the current number of samples analyzed).

[54] The estimated sample counts are based on MSHA's existing mine population data and its exposure profile, developed using 15 years of MNM compliance sampling exposure data and 5 years of data from the coal industry, stratified by exposure level (less than the action level, from the action level to the final rule PEL, and above the final rule PEL). That process was described in the proposed rule and is summarized in *Section VII.A Technological Feasibility* (see Subsections *VII.A.1.a Methodology* and *VII.A.1.b The Technological Feasibility Analysis Process*). From these data, MSHA estimated for its FRIA how many first- and second-time samples will represent miners likely to have exposure below the action level and require no further sampling. Based on its knowledge and experience of the mining industry, MSHA further estimated how rapidly mine operators will be able to reduce the exposures of the remaining miners to levels below the anticipated PEL or action level, and calculated how many quarterly, corrective actions, and post-evaluation samples that the mines will collect (and require analysis for) over time.

Table VII-8: Summary of the Estimated Number of Samples Taken by Type and Year

	Year 1		Year 2		Year 3	
All mines, Total, all samples	***41,599***		***216,183***		***143,881***	
Sector	**Coal**	**MNM**	**Coal**	**MNM**	**Coal**	**MNM**
Sector Subtotal, all samples	*41,599*	-	*19,475*	*196,708*	*19,025*	*124,855*
First-time and second-time samples	29,796	-	596	124,288	596	2,486
Above-action-level samples	5,423	-	10,556	36,442	10,170	66,764
Corrective actions samples	1,991	-	3,934	23,414	3,871	43,041
Post-evaluation samples	4,390	-	4,390	12,564	4,390	12,564

Notes:

1. MNM mines begin collecting samples in Year 2, due to extended MNM compliance date.
2. Component values may not sum to totals due to rounding.

Source: Summarized from MSHA's FRIA, Table 4-5. *Estimated Number of Samples Taken by Type and Year* (dated 11/27/2023).

BILLING CODE 4520–43–C

First- and Second-Time Sampling

MSHA's final rule requires mine operators to commence sampling, by the compliance date in the final rule, for each miner who is or may reasonably be expected to be exposed to respirable crystalline silica.[55] This requirement simplifies the initial sampling requirement described in the proposed rule, which called for a baseline sample followed by a confirmatory sample (or other data, as described below) if samples revealed concentrations below the action level. The final rule eliminates the option of using objective data or historical sample data (mine operator and MSHA sample data from the prior 12 months); all exposure samples used to comply with the rule must be collected and analyzed in accordance with the final rule. The changes to the proposed rule increase the number of samples that mine operators will collect and send to laboratories for analysis. The increased sampling will require an initial increase in analytical laboratory capacity of approximately 41,599 FTIR sample analyses in the first year (between the final rule's effective date and the coal mine compliance date), with 29,796 of these for first-time and second-time sampling. In the following year, MSHA estimates that MNM mine operators will require 196,708 XRD sample analyses (in the second year due to the extended MNM mine compliance date) of which approximately 124,288 will be first-time and second-time samples.[56]

All mine operators covered by the rule must initiate sampling by the compliance dates, potentially creating a peak demand for analysis around those dates. MSHA finds, however, that the final rule is feasible for mine operators to secure the services of analytical laboratories. First, the extended MNM compliance date permits more time to accommodate and prepare for any increase in demand. MSHA expects many mine operators will avoid last-minute sampling and begin the sampling process earlier than required; thus, the sampling and associated analysis will be spread over many months, meaning that any eventual peak period for laboratory analysis will be longer and less intense (*i.e.,* fewer analyses per month required) than it might be otherwise. Additionally, MSHA expects that the extended lead time will be sufficient for laboratories to increase their analytical capacity. For example, laboratories may acquire additional instrumentation, train additional analysts, or add a second or third operating shift. This is particularly

[55] Where several miners perform similar activities on the same shift, only a representative fraction of miners (minimum of two miners) would need to be sampled, including those expected to have the highest exposures.

[56] Also in the second year, MSHA anticipates that the coal mining industry will require 19,475 analysis by FTIR method; relatively few (596) of these will be for first- and second-time samples.

likely given that demand will be based on a regulatory requirement. MSHA has determined that the final rule is technologically feasible for mine operators to secure laboratories' analytical services.

Above-Action-Level, Corrective Actions, and Post-Evaluation Sampling

Under § 60.12(a), (b), and (d), mine operators may be required to conduct additional sampling. First, when the most recent sampling indicates that miner exposures are at or above the action level (25 μg/m³) but at or below the PEL (50 μg/m³), the mine operator is required to sample within 3 months of that sampling and continue to sample within 3 months of the previous sampling until two consecutive samplings indicate that miner exposures are below the action level. Second, where the most recent sampling indicates that miner exposures are above the PEL, the mine operator is required to sample after corrective actions are taken to reduce overexposures and continue conducting corrective actions sampling until sampling results indicate miner exposures are at or below the PEL. Third, if the mine operator determines, as a result of the periodic evaluation, that miners may be exposed to respirable crystalline silica at or above the action level, the mine operator is required to perform sampling to assess miners who are or may reasonably be expected to be exposed at or above the action level.

In its standalone Final Regulatory Impact Analysis (FRIA) document (referred to as the standalone FRIA document throughout the preamble), Table 4–5 ''Estimated Number of Samples Taken by Type and Year,'' MSHA estimates that, starting in the first 12-month period after the rule's effective date, coal mine operators will secure laboratory services for analysis of 5,423 above-action-level samples (those samples required when the previous sample is at or above the action level, but at or below the PEL), 1,991 corrective actions samples, and 4,390 post-evaluation samples, in addition to the 29,796 first-time and second-time samples mentioned in the previous subsection. MSHA assumes that coal industry analytical needs will be reduced in subsequent years as mine operators reduce miner exposures to levels below the PEL or action level. In the second 12-month period, in addition to 596 first-time and second time samples, coal mine operators will secure laboratory services for analysis for 10,556 above-action-level, 3,934 corrective actions, and 4,390 post-evaluation samples.

Similarly, starting in the second 12-month period (due to the extended MNM compliance date), MSHA estimates that MNM mine operators will secure laboratory analysis for 36,442 above-action-level, 23,414 corrective actions, and 12,564 post-evaluation samples (plus the 124,288 first-time and second-time samples discussed previously). MSHA estimates that the MNM industry's need for analysis will be lower in the following years as mine operators reduce miner exposures to levels below the PEL or action level. In the third 12-month period after the rule goes into effect, MNM mines are projected to need analysis for 2,486 first-time and second-time, 66,764 above-action-level, 43,041 corrective actions, and 12,564 post-evaluation samples.[57] Together, mine operators will require fewer sample (at least 10,000 fewer) analyses in each subsequent year than in the first 12-month period (coal sector) and second 12-month period (MNM mines), which are considered the ''worst case'' or highest demand periods for analysis under this rule.

MSHA estimated that the total number of analyses (699,800) that laboratories will be able to perform per year is nearly three times the maximum total estimated number of samples analyses required (216,183).[58] The maximum number of sample analyses required will occur in the second year after the rule goes into effect.[59] Based on MSHA's evaluation, the Agency finds that above-action-level, corrective actions, and post-evaluation sampling are technologically feasible for mine operators both in the early years after the rule becomes effective, and in subsequent years.[60]

The AEMA and NMA expressed concern that laboratory capacity might not be available by the proposed compliance date (Document ID 1424; 1428). As discussed in more detail in *Section VIII.B. Section-by-Section Analysis,* MSHA has extended the compliance dates in the final rule for MNM and coal (24 months and 12 months from publication of the final rule, respectively) in response to concerns about the availability of laboratory capacity, among other things. MSHA believes that this will resolve compliance date concerns but if concerns are not resolved by the time operators must comply, MSHA may exercise enforcement discretion as necessary.

As part of the proposed rule, MSHA examined the capacity of laboratories that meet the ISO 17025 standard to conduct respirable crystalline sample analyses. MSHA made the preliminary determination that there would be sufficient processing capacity to meet the sampling analysis schedule envisioned by the proposed rule, and that the proposed rule is technologically feasible for laboratories to conduct baseline sampling analyses (88 FR 44923). MSHA also preliminarily determined that the availability of samplers needed to conduct the required baseline sampling is technologically feasible (88 FR 44921). This preliminary determination, however, only examined whether sampler technology exists to conduct the respirable crystalline silica sampling as required under the proposal, not the availability of that technology to meet the demands that the final rule will impose.

MSHA agrees with commenters that the sampling requirements of the final rule will create an initial rush for sampling devices and related equipment and services. MSHA understands that there are more sampling devices (as well as related services and supplies) currently available in the market now than prior to OSHA's proposed silica rule. Nevertheless, based on OSHA's successful promulgation of that Agency's 2016 respirable crystalline silica final rule that included new silica sampling requirements (with similar

[57] As noted in *Section VII.A.2.c* (First- and second-time sampling) coal mines will have completed most of their first- and second-time sampling during the *first* year after the rule's effective date and MNM mines will complete most of it in the *second* year after the rule goes into effect. MSHA expects only a relatively modest amount of this sampling to continue in subsequent years (coal mining industry requiring 596 analyses per year and MNM mining industry 2,486 analyses per year) due to a steady background level of new activities starting or new mines opening.

[58] Excess capacity calculated as: (estimated annual demand capacity of 30 AIHA LAP accredited laboratories for sample analysis) divided by (maximum number of XRD and FTIR samples for which mines will seek analysis) = 699,800/216,183 = 3.2 times more analysis available on a yearly basis than the number of sample analyses labs will complete in the peak year.

[59] The maximum number of samples (the peak) will occur in the second 12-month period (second year) after rule's effective date, which is the period when MNM mines will conduct most of their first-time and second-time sampling as well as initiate above-action-level, corrective actions, and post-evaluation sampling. Concurrently, coal mines will continue conducting first-time and second-time, above-action-level, corrective actions, and post-evaluation sampling at somewhat lower rates. See Table 4–5 of the standalone FRIA document (estimates presented here are as of 11/26/2023).

[60] Surplus analyses calculated: estimated annual surge capacity of 30 AIHA LAP accredited laboratories for sample analysis) minus (maximum number of XRD and FTIR samples for which mines will seek analysis) = 699,800 − 216,183 = 483,617 surplus analyses.

ISO compliant sampling equipment and analytical method provisions for both general industry and the construction industry), MSHA expects that there will be another additional increase in demand (for equipment, services, and supplies) caused by this final rule. MSHA expects that the sampling device market will respond to the Agency's rule. MSHA does not expect that mines will experience a shortage of sampling resources due to a California emergency temporary standard (ETS) to address silicosis among engineered stone fabrication facility workers (*e.g.,* kitchen countertop shop employees who often use powered hand tools to grind/shape engineered stone, which has a quartz content greater than most natural stone).[61] Any increased demand of sampling equipment, services, or silica analysis for the mining industry will be related to MSHA's rule.

Resource limitations may be an issue for MNM mine operators since there are far more MNM mines in the U.S. compared to coal mines (in 2021, there were 11,231 MNM mines compared to 931 coal mines). As such, the expected demand for sampling devices, supplies, and services to meet the sampling requirements of this final rule is expected to be greater for MNM mines compared to coal mines.

MSHA carefully considered the above information about availability of laboratory capacity and sampling devices, including the likely increase in demand for such services and devices. MSHA acknowledges commenters' concerns about the need for more time to conduct sampling and implement necessary engineering controls. Accordingly, MSHA has adjusted the requirements in the final rule to allow MNM mine operators a total of 24 months after the publication date of the final rule to comply. This will provide sufficient time for MNM mine operators to comply with the requirements of part 60. Actions the operator may take in preparation for compliance with part 60 may include, for example, purchasing sampling equipment, securing sampling services, making arrangements with laboratories, and performing sampling. MSHA has changed the requirements in the final rule to allow coal mine operators a total of 12 months after publication of the final rule to come into compliance. MSHA expects that the extended time for compliance will provide coal mine operators with time to purchase additional sampling equipment and acquire necessary laboratory services. MSHA also notes that the AIHA, an accrediting body for commercial laboratories that analyze respirable crystalline silica, concurred with MSHA's findings that technologically feasible samplers are widely available, and a number of commercial laboratories provide the service of analyzing dust containing respirable crystalline silica (Document ID 1351). Additional discussion of the compliance dates can be found in *Section VIII.A.1.c. Compliance Dates.*

3. Technological Feasibility of Respiratory Protection (Within Part 60)

Under MSHA's final rule, respiratory protection will not be allowed for compliance. As discussed elsewhere, MSHA has determined that the PEL is feasible for all mines and all mines must comply with it. However, when exposures are above the PEL, mine operators must take immediate corrective actions, provide miners with respirators, and ensure that they are worn until exposures are below the PEL. There is a sufficient supply of respirators for mine operators to obtain and maintain for temporary use. Therefore, MSHA has determined that the requirements in the final rule for respirator use are technologically feasible. This finding is supported by the Agency's knowledge of and experience with the mining industry, evidence presented by NIOSH (2019b, 2021a), and Tables VII–1 through VII–4 (exposure profiles for MNM and coal mines). These tables indicate that the PEL (50 μg/m^3) has already been achieved for approximately 82 percent of the MNM miners and approximately 93 percent of the coal miners sampled by MSHA. MSHA believes that this data supports the Agency's approach to respirator use in the final rule.

Section 60.14(b) requires that any miner unable to wear a respirator must receive a temporary job transfer to an area or to an occupation at the same mine where respiratory protection is not required. The paragraph also requires that a miner transferred under this requirement continue to receive compensation at no less than the regular rate of pay in the occupation held by that miner immediately prior to the transfer. MNM mine operators must already comply with the job transfer provisions under the existing standard in § 57.5060(d)(7) that requires mine operators to transfer miners unable to wear a respirator to work in an existing position in an area of the mine where respiratory protection is not required. Section 60.14(b) is similar to these existing requirements. MSHA finds that mine operators will have a similar experience implementing the job transfer provisions of § 60.14(b). As discussed in *Section VIII.B.7.b. Section 60.14(b)—Miners unable to wear respirators,* MSHA concludes that temporary transfer of miners unable to wear respirators to a separate area or occupation to ensure their health and safety is feasible. As noted elsewhere in the preamble, any respirator use will be temporary to protect miners from overexposures during activities such as the implementation or development engineering controls. Therefore, MSHA finds that the requirement in § 60.14(b) is technologically feasible.

For miners who need to wear respiratory protection on a temporary basis, section 60.14(c)(1) requires the mine operator to provide NIOSH-approved atmosphere-supplying respirators or NIOSH-approved air-purifying respirators equipped with high-efficiency particulate filters in one of the following NIOSH classifications under 42 CFR part 84: 100 series or High Efficiency (HE). As discussed below in the Section-by-Section analysis, MSHA finds that particulate respirators meeting these criteria will offer the best filtration efficiency (99.97 percent) and protection for miners exposed to respirable crystalline silica and are widely available and used by most industries. This finding is based on the characteristics of the 100 series as compared to the other two most common series (95 and 99). The 95- and 99-series particulate respirators do not offer as high a degree of protection as the 100-series (95 percent and 99 percent efficiency, respectively), and are less likely to provide the expected level of protection due to concerns about poor fit and vulnerability to mishandling such as folding or crushing. The NIOSH-approved 100-series particulate respirators also have broad commercial availability.[62] NIOSH publishes a list of approved respirator models along with manufacturer/supplier information. In November 2022, the NIOSH-approved list contained 221 records on atmosphere-supplying respirator models, 160 records on elastomeric respirators with P–100 classification, and 23 records on filtering facepiece respirators with P–100 classification (NIOSH, 2022a list P–100 elastomeric, P–100 filtering facepiece, and atmosphere-supplying respirator

[61] The California ETS went into effect on December 29, 2023. The ETS includes revisions to protect workers engaged in high-exposure tasks (cutting, grinding, etc.) involving artificial stone and natural stone containing more than 10% crystalline silica.

[62] Class 100 particulate respirators (currently the most widely used respirator filter specification in the U.S.) are available from numerous sources including respirator manufacturers, online safety supply companies, mine equipment suppliers, and local retail hardware stores.

models).[63] Based on this information regarding the level of protection and the market availability, MSHA finds that § 60.14(c)(1) is technologically feasible.

Section 60.14(c)(2) incorporates the *ASTM F3387–19* ''*Standard Practice for Respiratory Protection*'' to ensure that the most current and protective respiratory protection practices are implemented by mine operators who temporarily use respiratory protection to control miners' exposures to respirable crystalline silica. The Agency is also incorporating this respiratory protection consensus standard under §§ 56.5005, 57.5005, and 72.710. This update is also addressed in the next section (see Technological feasibility of updated respiratory protection standards). Based on the information contained in that section, MSHA finds that § 60.14(c)(2) is technologically feasible.

4. Technological Feasibility of Updated Respiratory Protection Standards (Amendments to 30 CFR Parts 56, 57, and 72)

a. Incorporation by Reference

This section discusses the update to MSHA's existing respiratory protection standards in 30 CFR 56.5005, 57.5005, and 72.710 which deal with other airborne contaminants and do not include respirable crystalline silica. Respiratory protection requirements for respirable crystalline silica are in final § 60.14 and are substantially similar to MSHA existing standards. Respirators are used by mine operators to protect miners against respiratory hazards, including particulates, gases, and vapors. Under existing standards, for MNM and coal mine operators, respirators must not be used in place of engineering controls to control airborne contaminants. If respirable coal mine dust samples exceed the standard, coal mine operators must make approved respiratory equipment available to affected miners while taking immediate corrective actions to lower the concentration of respirable dust to at or below the respirable dust standard. Metal and nonmetal mine operators must provide miners with respirators and miners must use respirators while engineering control measures are being developed or when necessary by the nature of work involved (for example, while establishing controls or occasional entry into hazardous atmospheres to perform maintenance or investigation).

Where respirators are used, they must seal and isolate the miner's respiratory system from the contaminated environment. The risk that a miner will experience an adverse health effect from a contaminant when relying on respiratory protection is a function of the toxicity or hazardous nature of the air contaminants present, the concentrations of the contaminants in the air, the duration of exposure, and the degree of protection provided by the respirator. When respirators fail to provide the expected protection, there is an increased risk of adverse health effects. Therefore, it is critical that respirators perform as they are designed.

Accordingly, MSHA is incorporating by reference ASTM F3387–19 by amending §§ 56.5005, 57.5005, and 72.710 to replace the Agency's existing respiratory protection standard in those sections. Final §§ 56.5005, 57.5005, and 72.710 requires mine operators to develop a written respiratory protection program meeting the requirements in accordance with ASTM F3387–19. These requirements allow for achieving expected protection levels from respirator use. This revision to MSHA's existing standards will better protect miners who temporarily wear respiratory protection.

The *American National Standards Practices for Respiratory Protection ANSI Z88.2—1969* was previously incorporated by reference in §§ 56.5005, 57.5005, and 72.710.[64] Since MSHA adopted these standards, respirator technology and knowledge on respirator protection have advanced and as a result, changes in respiratory protection standard practices have occurred. ASTM F3387–19 is the most recent respirator practices consensus standard and provides more comprehensive and detailed guidance. MSHA finds, based on observations during enforcement inspections and compliance assistance visits to mines, that mines using respiratory protection have also already implemented current respiratory protection recommendations and standards such as ANSI/ASSE Z88.2—2015 ''*Practices for Respiratory Protection*'' standard, its similar ASTM replacement (the F3387–19 standard), or OSHA 29 CFR 1910.134—*Respiratory protection.* ASTM F3387–19 standard practices are substantially similar to the standard practices included in ANSI/ASSE Z88.2—2015 or OSHA's respiratory protection standards.

b. Availability of Respirators

The updated respiratory protection standard reflects current practice at many mines that use respiratory protection and does not require the use of new technology. Thus, MSHA finds that the update is technologically feasible for affected mines of all sizes.

c. Respiratory Protection Practices

By amending existing standards to incorporate the updated respiratory protection consensus standard (ASTM F3387–19), MSHA intends that mine operators will develop effective respiratory protection practices that meet the updated consensus standard and that will better protect miners from respiratory hazards.

MSHA presumes that most mines with respiratory protection programs, and particularly those MNM mines that have operations under both MSHA and OSHA jurisdiction, are already following either the ANSI/ASSE Z88.2—2015 standard, the ASTM F3387–19 standard, or OSHA 29 CFR 1910.134. As several commenters noted, consistency between OSHA and MSHA requirements is beneficial for organizations regulated by both agencies, as it permits them to more easily comply with a single, consistent set of requirements. Mine operators with operations under OSHA jurisdiction would, by this logic, choose to comply with 29 CFR 1910.134 across all operations rather than develop separate programs for MSHA-regulated facilities. The respiratory protection program elements under ASTM F3387–19 are largely similar to those in the previous standard.

MSHA expects that some operators may need to adjust their current respiratory protection practices and standard operating procedures to reflect ASTM F3387–19 standard practices. Examples of adjustments include formalizing annual respirator training and fit testing; updating the training qualifications of respirator trainers, managers, supervisors, and others responsible for the respiratory protection program; reviewing the information exchanged with the physician or other licensed health care professional (PLHCP) conducting medical evaluations; and formalizing internal and external respiratory protection program reviews or audits.

Overall, MSHA finds that the amendments to parts 56, 57, and 72 are technologically feasible because the requirements of ASTM F3378–19 have already been implemented at many mines.

MSHA received several comments on the Agency's decision to limit respirator

[63] The NIOSH list of approved models does not guarantee that each model is currently manufactured. However, the list does not include obsolete models, and the more popular models are widely available, including in bulk quantities.

[64] ASTM 3387–19 is the revised version of ANSI/ASSE Z88.2—2015. In 2017, the Z88 respirator standards were transferred from ANSI/ASSE to ASTM International (source: F3387–19, Appendix XI).

use to temporary and non-routine use. Many commenters opposed this limitation in the proposal, including AIHA, Miners Clinic of Colorado, ACLC, and Black Lung Clinics (Document ID 1351; 1418; 1445; 1410), while others requested more information to help them properly interpret the requirement, including SSC, AMI Silica LLC, NSSGA, and AFL–CIO (Document ID 1432; 1440; 1448; 1449). The AFL–CIO requested that MSHA clarify temporary and non-routine to specify circumstances and time limitations (Document ID 1449). Appalachian Voices stated that mine construction and coal production should be excluded from the temporary and non-routine use of respirators (Document ID 1425).

The Construction Industry Safety Coalition (CISC) suggested that coal miners should be prohibited from working in overexposures while using respirators, stating that the working conditions, especially in underground coal mines, make it very difficult for miners to communicate and work safely while wearing respirators (Document ID 1430). Many commenters suggested that MSHA utilize the full hierarchy of controls to recognize respirators as an acceptable solution when combined with other efforts to lower exposure levels, including Arizona Mining Association, AEMA, NMA, NVMA, NSSGA, US Silica, SSC, BMC, Illinois Association of Aggregate Producers (IAAP) (Document ID 1368; 1424; 1428; 1441; 1448; 1455; 1432; 1417; 1456). Advocating expanded use of respiratory protection, but differing in their approach, a few commenters, including SSC, NSSGA, US Silica, and IAAP, wrote that respirators are the only feasible means of protection for certain tasks, including housekeeping, dust collector maintenance and repair, and bagging operations (Document ID 1432; 1448; 1455; 1456). The AEMA stated that MSHA should allow the use of respirators, including PAPRs, whenever miners are working in exposures above the PEL (Document 1424). Another commenter stated that miners should always use respirators, to ensure complete protection from respirable crystalline silica exposures. MSHA finds that engineering controls, supplemented by administrative controls, are technologically feasible and provide reliable, consistent protection for miners engaged in the identified tasks; MSHA declines to expand the allowable use of respiratory protection. MSHA emphasizes that both in the existing standards for MNM mines and in § 60.14, respiratory protection use is required to be temporary. The Agency emphasizes that it will continue to enforce ''temporary'' use of respirators as meaning that respirators are used for only a short period of time.

MSHA clarifies that the final rule does not permit the use of respirators in lieu of feasible engineering and administrative controls. If anything, MSHA has provided greater protection for miners by requiring (as opposed to making available) usage of respirators for all miners when exposed to respirable crystalline silica above the PEL.

5. Technological Feasibility of Medical Surveillance (Within Part 60)

Under the final rule, MNM mine operators will be required to provide periodic medical examinations performed by a physician or other licensed health care professional (PLHCP) or specialist, at no cost to the miner. 30 CFR 60.15. The medical surveillance standards extend to MNM miners similar protections to those available to coal miners under existing standards in 30 CFR 72.100. The requirements in § 60.15 are consistent with the Mine Act's mandate to provide maximum health protection for miners, which includes making medical examinations and other tests available to miners at no cost. 30 U.S.C. 811(a)(7).

Under the final rule, all MNM miners who are employed or have already worked in the mining industry must be provided the opportunity for an initial voluntary examination starting during an initial 12-month period that begins no later than the compliance date or during a 12-month period that begins whenever a new mine commences operations. Subsequent medical examinations must be available at least every 5 years during a 6-month period that begins no less than 3.5 years and not more than 4.5 years from the end of the previous 6-month period. MNM miners who begin work in the mining industry for the first time must receive an initial examination within 60 days of beginning employment. After their initial examination, these new miners must be provided a follow-up examination within 3 years. If the 3-year follow-up examination indicates any medical concerns associated with chest X-ray findings or decreased lung function, these miners must have another follow-up examination in 2 years. After this 2-year follow-up examination, or if the 3-year follow-up examination indicates no medical concerns associated with chest X-ray findings or decreased lung function, these miners will be eligible for voluntary periodic 5-year examinations, transferring them into the larger cohort of miners already employed in the mining industry.

The final rule requires that medical examinations include a review of the miner's medical and work history, a physical examination with special emphasis on the respiratory system, a chest X-ray, and a pulmonary function test. The medical and work history covers a miner's present and past work exposures, illnesses, and any symptoms indicating respirable crystalline silica-related diseases and compromised lung function. The required chest X-ray must be classified by a NIOSH-certified B Reader, in accordance with the Guidelines for the Use of the International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses. The ILO recently made additional standard digital radiographic images available and has published guidelines on the classification of digital radiographic images (ILO, 2022). These guidelines provide standard practices for detecting changes of pneumoconiosis, including silicosis, in chest X-rays. The required pulmonary function test must be conducted by either a spirometry technician with a current certificate from a NIOSH-approved Spirometry Program Sponsor, or, as discussed in *Section VIII.B.8.a. 60.15(a)—Medical surveillance* of this preamble, a pulmonary function technologist with a current credential from the National Board for Respiratory Care.

MSHA has determined that it is technologically feasible for MNM mine operators to provide periodic examinations as described in the previous paragraph. Under the rule, a PLHCP, as defined, does not have to be an occupational medicine physician or a physician to conduct the initial and periodic examinations required by the rule, but can be any health care professional who is state-licensed to provide or be delegated the responsibility to provide those services. The procedures required (*i.e.,* medical history, physical examination, chest X-ray, pulmonary function test) for initial and periodic medical examination are commonly conducted in the general population by a wide range of practitioners with varying medical backgrounds. Because the medical examinations consist of procedures conducted in the general population and because MSHA will be giving MNM mine operators flexibility in selecting a PLHCP or specialist able to offer these services, MSHA determined that operators will not experience difficulty in finding PLHCPs or specialists who are licensed to provide these services.

Overall, MSHA finds that the medical surveillance provisions are technologically feasible and in the final rule maintains the proposed medical surveillance provisions, with some modifications.

MSHA received several comments on the feasibility of proposed § 60.15(a). The AIHA, the American Association of Nurse Practitioners (AANP), and CertainTeed, LLC supported MSHA's proposal to require MNM mine operators to provide MNM miners with medical examinations performed by a PLHCP or specialist (Document ID 1351; 1400; 1423). The Arizona Mining Association and the BIA expressed concerns with this requirement and asserted that many MNM mines may experience issues with access to a PLHCP or specialist qualified to perform the examinations (Document ID 1368; 1422). The APHA, the AOEC, and the ACOEM advocated for medical surveillance to be performed by physicians who are board-certified in occupational medicine or pulmonary medicine (Document ID 1416; 1373; 1405). The Hon. Rep. Robert C. ''Bobby'' Scott and an individual recommended that MNM miners should be able to choose their own health care provider (Document ID 1439; 1412). The AIHA and Black Lung Clinics stated that MSHA should require MNM miners to use NIOSH-approved facilities (Document ID 1351; 1410) while the AEMA and the NMA (Document ID 1424; 1428) expressed concerns about the limited availability of these facilities. The NMA, the Portland Cement Association, and the AEMA noted that there are only a limited number of B Readers available (Document ID 1428; 1407; 1424).

MSHA reviewed these comments and made one change to § 60.15(a) in the final rule. Under the proposed rule, a pulmonary function test must be administered by a spirometry technician with a current certificate from a NIOSH-approved Spirometry Program Sponsor. In the final rule, paragraph 60.15(a)(2)(iv) retains that language but adds pulmonary function technologists with current credentials from the National Board for Respiratory Care as individuals who may administer pulmonary function tests. This addition to the final rule text should further expand the pool of individuals eligible to administer pulmonary function tests.

MSHA determined that MNM mine operators should not experience any significant issues identifying a PLHCP or specialist to conduct medical examinations and emphasizes the final rule allows flexibility by not mandating that the medical examinations be conducted by full-time health care professionals employed by mine operators. As stated in the proposal, a PLHCP is an individual whose legally permitted scope of practice (*i.e.,* license, registration, or certification) allows that individual to independently provide or be delegated the responsibility to provide some or all of the required health services (*i.e.,* chest X-rays, pulmonary function test, symptom assessment, and occupational history). Specialist is defined in § 60.2 as an American Board-Certified Specialist in Pulmonary Disease or an American Board-Certified Specialist in Occupational Medicine. MSHA also clarifies that if medical examinations are integrated within health care plans, mine operators must ensure that the examinations are conducted in accordance with the requirements in § 60.15. MSHA determined that the requirements for testing and interpretation of results are technologically feasible.

The Agency has reviewed the comments related to availability of B Readers. MSHA has determined that, based on technological improvements that remove the need for geographic proximity between patients and technicians such as B Readers, as well as widespread availability of tests such as X-rays, getting X-ray tests and the results classified by B Readers is technologically feasible. With respect to chest X-ray classification, the availability of digital X-ray technology permits electronic submission to remotely located B Readers for interpretation. After consulting NIOSH, MSHA determined there are B Readers with remote reading capabilities available to meet the demands of the final rule. Therefore, MSHA finds that the limited number of B Readers in certain geographic locations will not be an obstacle for MNM operators. MSHA further concludes that any increase in demand for these services can be addressed by providers. Further discussion regarding NIOSH-approved facilities and B Readers can be found in *Section VIII.B.8.a. Section 60.15(a)—Medical Surveillance* of this preamble.

MSHA's experience with the coal mine medical surveillance program has shown the Agency that PLHCPs who have the required NIOSH or other certifications have the training to effectively examine miners and identify the occurrence or progression of silica-related diseases, even if they may not operate within NIOSH-approved facilities. MSHA's updated research continues to support OSHA's conclusion in its 2016 silica final rule that the number of B Readers in the United States is adequate to classify chest X-rays (OSHA 2016a, 81 FR 16286, 16821). Further, an increased demand for B Readers as a result of this final rule will lead to additional training for many health care providers. In addition, digital X-rays can be easily transmitted electronically to B Readers anywhere in the United States. The final rule ensures that medical examinations are comprehensive and tailored to discern and mitigate potential health risks associated with miners' occupational exposures to respirable crystalline silica. The final rule will ensure that the medical examinations are both robust and flexible enough to accommodate advancements and variations in medical evaluation techniques. Further discussion regarding NIOSH-approved facilities and B Readers can be found in *Section VIII.B.8.a. Section 60.15(a)—Medical Surveillance* of this preamble.

The final rule does not require that examinations conducted under this section occur in NIOSH-approved facilities. There are only 168 NIOSH-approved health clinics nationwide. NIOSH manages the Coal Workers' Health Surveillance Program and the program's facilities are concentrated in geographies where coal mining is prevalent (*e.g.,* Appalachia, the Illinois Basin, and Powder River Basin). The NIOSH-approved facilities are not uniformly distributed across the U.S. and there are many areas that have MNM mines but do not have NIOSH-approved facilities (*e.g.,* the states California, Idaho, Nevada, and Washington). Therefore, MSHA has determined that it is not feasible to require NIOSH-approved facilities for medical surveillance in MNM mines.

6. Conclusions

Based on MSHA's technological feasibility analysis, MSHA has determined that all elements of the rule on *Lowering Miners' Exposure to Respirable Crystalline Silica and Improving Respiratory Protection* are technologically feasible.

B. Economic Feasibility

MSHA considers economic feasibility in terms of industry-wide revenue and overall costs incurred by the mining industry (inclusive of MNM and coal) under a given rule. To establish economic feasibility, MSHA uses a revenue screening test—whether the estimated yearly costs of a rule are less than 1 percent of estimated revenues or are negative (*i.e.,* provide net cost savings)—to presumptively establish that compliance with the regulation is economically feasible for the mining industry. If annualized compliance costs comprise less than 1 percent of revenue, the Department concludes that the entities can incur the compliance costs without significant economic impacts.[65]

MSHA received comments on economic feasibility. Several commenters argued that it would cost thousands or millions of dollars in exposure control costs to meet the new PEL (Document ID 1419; 1441; 1448; 1455). Others noted that the action level will result in more sampling above the action level and additional engineering controls needed to get below the action level, leading to greater costs (Document ID 1419, 1455).

Based on its analysis of the Agency's sampling database, MSHA believes roughly 90 percent of mines will be able to meet the PEL without incurring additional costs, and only 580 mines will need to install engineering control to meet the new PEL (see standalone FRIA document Section 4). In response to public comments that MSHA underestimated the cost of implementing necessary exposure controls, MSHA increased its estimate of the number of mine operators that will have to implement additional exposure controls to meet the requirements of the final rule.

One commenter pointed out that engineering controls need to factor in site-specific conditions (Document ID 1441). MSHA acknowledges that the exposure control costs will differ depending on the size of the mine, the current level of exposure to respirable crystalline silica, existing engineering and administrative controls, the mine layout, work practices, and other variables. MSHA's price and cost estimations are based on a variety of sources including market research and MSHA's experience and sample data. Some of the cost estimates from commenters—such as those from very large mines or those representing many mines controlled by one operator—are impossible to meaningfully compare to MSHA's estimates. Nonetheless, these and other public comments about the costs of the final rule are addressed in more detail below in *Section IX. Summary of Final Regulatory Impact Analysis and Regulatory Alternatives,* as well as in Section 8 of the standalone FRIA document.

For the MNM and coal mining sectors, MSHA estimates the projected impacts of the rule by calculating the annualized compliance costs for each sector as a percentage of total estimated revenues for that sector. To be consistent with costs that are calculated in 2022 dollars, MSHA first inflated estimated mine revenues in 2019 to their 2022 equivalent using the GDP Implicit Price Deflator. See Table VII–9.

[65] MSHA is not required to produce hard and precise estimates of cost to establish economic feasibility. Rather, MSHA must provide a reasonable assessment of the likely range of costs of its standard, and the likely effects of those costs on the industry. *See United Steelworkers,* 647 F.2d at 1264; *see also Nat'l Min. Ass'n,* 812 F.3d at 865.

Table VII-9: Total Mines, Estimated Revenues (in millions of 2022 dollars) and Employment by Sector

Mine Sector	2019 Mines	2019 Revenues Inflated to 2022 Dollars	2019 Miners Including Contract Miners[1]
Total	***12,631***	***$124,169***	***284,779***
Metal/Nonmetal	11,525	$95,070	211,203
Coal	1,106	$29,099	73,576

Note: 1. The estimated current and future number of mines and miners are based on 2019 data (MSHA, 2019a,b, 2022d) and are assumed to have remained constant through the 60 years following the start of implementation of the rule.

Table VII–10 compares aggregate annualized compliance costs for the MNM and coal sectors at a 0 percent, 3 percent, and 7 percent discount rates to each sector's total annual revenues. At a 3 percent discount rate, total aggregate annualized compliance costs for the entire mining industry are projected to be $90.3 million (including both 30 CFR part 60 and 2019 ASTM costs), while aggregate revenues are estimated to be $124.2 billion in 2022 dollars. MSHA estimates that the mining industry is expected to incur compliance costs that comprise 0.07 percent of total revenues.

For the MNM sector, MSHA estimated that the annualized compliance costs of the final rule (including both 30 CFR part 60 and 2019 ASTM update costs) would be $82.1 million at a 3 percent discount rate, which is approximately 0.09 percent of the total estimated annual revenue of $95.1 billion for MNM mine operators. For the coal sector, MSHA estimated that the annualized cost of the final rule (including both 30 CFR part 60 and 2019 ASTM costs) will be $8.2 million at a 3 percent discount rate, which is approximately 0.03 percent of the total estimated annual revenue of $29.1 billion for coal mine operators.

The ratios of screening analysis are well below the 1.0 percent of total revenues threshold. Therefore, MSHA concludes that the requirements of the final rule are economically feasible, and no sector will likely incur a significant cost.

Table VII-4: Percentage Distribution of Respirable Crystalline Silica Exposures as ISO 8-hour TWA in the Coal Industry from 2016 to 2021, by Location

Location	Activity Group	Number of Samples	Percentage of Samples in ISO Concentration Ranges, 8-hour TWA, μg/m³							Total %
			≤ 25	> 25 to ≤ 50	> 50 to ≤ 85.7	> 85.7 to ≤ 100	> 100 to ≤ 250	> 250 to ≤ 500	> 500	
Underground	*Overall: underground (all activity groups)*	53,095	72.7%	20.6%	5.1%	0.6%	1.0%	0.1%	0.0%	100%
Surface	*Overall: surface (all activity groups)*	10,032	79.5%	12.4%	4.6%	0.8%	2.3%	0.4%	0.1%	100%
Overall: coal	Overall: coal	63,127	73.8%	19.3%	5.0%	0.6%	1.2%	0.1%	0.0%	100%

Notes:

1. Personal samples presented in terms of ISO concentrations, normalized to 8-hour time-weighted averages (TWAs). The samples were originally collected for the entire duration of each miner's work shift, using an air flow rate of 2 L/min. See notes in Summary Table VII-3 for additional details.
2. Source: MSHA MSIS respirable crystalline silica data for the coal industry, August 1, 2016, through July 31, 2021 (version 20220617). All samples were of sufficient mass to be analyzed for respirable crystalline silica.

VIII. Summary and Explanation of the Final Rule

As previously mentioned, under the final rule, MSHA amends its existing standards on respirable crystalline silica or quartz, after considering all the testimonies and written comments the Agency received from a variety of stakeholders, including manufacturers, medical professionals, miners, mining associations, mining companies, labor organizations that represent mine workers, health associations, and safety associations in response to its notice of proposed rulemaking. The final rule establishes a PEL of respirable crystalline silica at 50 μg/m³ for a full-shift exposure, calculated as an 8-hour TWA for all mines. The final rule also establishes an action level for respirable crystalline silica of 25 μg/m³ for a full-shift exposure, calculated as an 8-hour TWA for all mines. In addition to the PEL and action level, the final rule includes provisions for methods of compliance, exposure monitoring, corrective actions, respiratory protection, medical surveillance for MNM mines, and recordkeeping. The final rule also replaces existing requirements for respiratory protection and incorporates by reference ASTM F3387–19 Standard Practice for Respiratory Protection.

The sections that follow address testimonies and written comments received on general issues and specific provisions in the proposal and MSHA provides its responses and final conclusions.

A. General Issues

In this section, MSHA addresses comments that relate to the rulemaking as a whole and that are not specific to a single section of the final rule. MSHA identified six general issues for discussion below: Existing Respirable Dust Standards for Coal Mines; Training for Miners—Respirable Crystalline Silica; Sorptive Minerals; OSHA Table 1 Approach for Compliance; Medical Removal/Transfer; and Compliance Assistance.

1. Existing Respirable Dust Standards for Coal Mines

MSHA will enforce the final rule's requirements for respirable crystalline silica in coal mines within the context of the Agency's existing standards for miners' exposure to respirable coal mine dust in 30 CFR parts 70, 71, and 90.

Some commenters, including the Wyoming County WV Black Lung Association, AFL–CIO, and two individuals, were concerned that controls implemented as immediate corrective actions for respirable crystalline silica at coal mines would not be incorporated into an underground coal mine's approved ventilation plan required under 30 CFR part 75 (Document ID 1393; 1449; 1399; 1412).

Under the final rule, mine operators are required to install, use, and maintain feasible engineering and administrative controls to keep each miner's exposure to respirable crystalline silica at or below the PEL. Mine operators must use feasible engineering controls as the primary means of controlling respirable crystalline silica; administrative controls can only be used, when necessary, as a supplementary control. Rotation of miners—that is, assigning more than one miner to a high-exposure task or location, and rotating them to keep each miner's exposure below the PEL—is prohibited as a means of complying with the rule.

For underground coal mines, the necessary controls to maintain compliance with existing respirable coal mine dust and respirable crystalline silica standards are contained in the ventilation plan that is approved by the appropriate District Manager. Under 30 CFR 75.370(a)(1), the approved ventilation plan shall control methane and dust and contains the detailed engineering controls that the operator will use to comply with the existing dust standards.

Under the existing respirable dust standards for coal mines, MSHA evaluates the approved ventilation plan to ensure that it is suitable to current conditions and mining systems at the mine. During each shift, the plan must be followed to protect miners from overexposure to respirable coal mine dust, which includes respirable crystalline silica. Currently, only MSHA sampling is used to evaluate miners' exposure to respirable crystalline silica. When respirable coal mine dust or respirable crystalline silica overexposures are documented, MSHA may consider the relevant portion of the ventilation plan deficient and require that the plan be revised to include additional ventilation controls, or the plan can be revoked by the Agency, as appropriate. MSHA evaluates the approved ventilation plan at least every 6 months, or more often if there are changes in the mine, mining processes, dust controls, or conditions at the mine affecting miners' exposure to respirable coal mine dust or respirable crystalline silica dust. MSHA typically samples all mechanized mining units and Part 90 miners (coal miners with evidence of pneumoconiosis) during each quarterly regular inspection of underground coal mines. MSHA typically samples the Designated Areas (DA)—outby areas of the mine—at least annually. This sampling represents an evaluation of dust exposure compliance and dust controls that are in the approved ventilation plan to ensure that they are effective. MSHA intends to continue conducting this sampling.

Under the existing respirable dust standards for coal mines, as in the final silica rule, when miners are overexposed, the operator must take immediate corrective actions to lower the miner's exposure to at or below the standard and sample to verify that the corrective actions are effective. The mine operator determines necessary engineering controls but must address the underlying conditions and practices which caused the overexposure. Corrective action sampling will be conducted with the control measures in place. Under the final silica rule, mine operators must report overexposures to the District Manager and corrective actions must be described in the record mandated in § 60.16. If a silica overexposure occurs, operators remain responsible for adjusting ventilation plans to account for additional controls needed to prevent future overexposures.

The existing respirable dust standards for coal mines will also maintain silica controls through mine operators' pre-shift and on-shift examinations. These examinations must ensure the ventilation controls that have been evaluated and found effective are maintained. The examinations protect miners from health and safety hazards between and on sampling shifts.

The UMWA, AFL–CIO, Wyoming County WV Black Lung Association, and an individual requested that additional sampling be conducted at coal mines (Document ID 1398; 1449; 1393; 1382). UMWA and an individual supported the standalone silica PEL but urged MSHA to retain the reduced dust standard concept due to the large number of quarterly dust samples operators must take that indirectly monitor silica exposure (Document ID 1398; 1382).

MSHA's enforcement of respirable coal mine dust under the existing respirable coal mine dust standards will continue. The final rule establishes a standalone silica PEL and adds operator silica sampling that may result in additional operator silica sampling (every three months) in many underground coal mines. It also requires immediate corrective actions and resampling if exposures exceed the PEL. The final rule also requires periodic evaluations at least every 6 months, or whenever there is a change in production; processes; installation and maintenance of engineering controls; installation and maintenance of equipment; administrative controls; or geologic conditions. Dependent on the results of the periodic evaluation in this final rule, coal mine operators may have to perform additional sampling. MSHA expects the final rule's requirements will result in sufficient sampling to accurately detect miners' exposures to silica at coal mines.

The final rule requires that mine operators sample miners exposed or reasonably expected to be exposed to respirable crystalline silica. If samples are above the action level and below the PEL, mine operators must continue to sample within three months. Operators must conduct representative sampling (at least two samples) of the occupations at highest risk of respirable crystalline silica exposure. The existing standards for respirable coal mine dust sampling require 15 valid representative consecutive shift samples for certain high-dust occupations, followed by more samples in other identified occupations and areas the District Manager designates based on anticipated or actual exposures.

The final rule decouples silica sampling and enforcement from the existing respirable dust standard requirements that reduce the total respirable coal mine dust limit based on the percentage of silica in the dust (an indirect way of controlling silica). Occupations and areas designated for dust sampling are likely to be the occupations and areas with the highest levels of respirable crystalline silica exposure. MSHA expects many of the same occupations will be sampled under this final rule and that the requirement that two samples be taken will mean an increased ability to accurately assess exposure. Also, the standalone respirable crystalline silica PEL allows for immediate MSHA oversight of corrective actions and resampling. Unlike the existing reduced dust standard protocols under which silica overexposures are not directly citable except through enforcement of the reduced dust standard, under the final rule, MSHA can withdraw miners under Mine Act section 104(b) if respirable crystalline silica overexposure citations are not corrected and occupations resampled within the abatement time MSHA sets. In response to comments, and to ensure that MSHA is informed of silica overexposures, the final rule requires that mine operators immediately report respirable crystalline silica samples above the PEL to the District Manager or other office designated by the District Manager.

2. Training for Miners—Respirable Crystalline Silica

MSHA received several comments both in favor of and against including respirable crystalline silica training for miners in 30 CFR part 46 (Training and Retraining of Miners Engaged in Shell Dredging or Employed at Sand, Gravel, Surface Stone, Surface Clay, Colloidal Phosphate, or Surface Limestone Mines) (part 46) and 30 CFR part 48 (Training and Retraining of Miners) (part 48). Two mining trade associations suggested that existing training requirements under parts 46 and 48 for new miner training, experienced miner training, annual refresher training, and task training remain sufficient and that an additional training requirement would be unnecessary (Document ID 1424, 1441). Other commenters, including a mining labor union and several professional associations, stated that the final rule should include new training requirements separate from parts 46 and 48 (Document ID 1398; 1351; 1377; 1373).

MSHA believes existing training standards in parts 46 and 48 require appropriate training regarding health hazards, including exposure to respirable crystalline silica dust.

Part 46 requires new miners and newly hired experienced miners to receive training on the health and safety aspects of the tasks to be assigned, including the safe work procedures of such tasks, the mandatory health and safety standards pertinent to such tasks, information about the physical and health hazards of chemicals in the miner's work area, the protective measures a miner can take against these hazards, and the contents of the mine's HazCom program. They must also receive instruction and demonstration on the use, care, and maintenance of self-rescue and respiratory devices, if used at the mine.

Annual refresher training conducted under part 46 must include instruction on changes at the mine that could adversely affect the miner's health or safety and other health and safety subjects relevant to mining operations at the mine, including mandatory health and safety standards, health, and respiratory devices.

For new task training, part 46 requires miners to receive training in the health and safety aspects of the task to be assigned, including the safe work procedures of such tasks, information about the physical and health hazards of chemicals in the miner's work area, the protective measures a miner can take against these hazards, and the contents of the mine's HazCom program. Section 46.9 requires records of training and includes specific provisions for the record requirements.

Part 48 requires new miners to receive training on health including instruction on the purpose of taking dust, noise, and other health measurements, and any health control plan in effect at the mine shall be explained. New miners must also receive training in the health and safety aspects of the tasks to be assigned, including the safe work procedures of such tasks, the mandatory health and safety standards pertinent to such tasks, information about the physical and health hazards of chemicals in the miner's work area, the protective measures a miner can take against these hazards, and the contents of the mine's HazCom program.

Experienced miner training under Part 48 must include instruction in health, including the purpose of taking dust, noise, and other health measurements, where applicable, and review of the health provisions of the Mine Act. Experienced miners must also receive training in the health and safety aspects of the tasks to be assigned, including the safe work procedures of such task, information about the physical and health hazards of chemicals in the miner's work area, the protective measures a miner can take against these hazards, and the contents of the mine's HazCom program.

For new task training, part 48 requires miners to receive training on the health and safety aspects and safe operating procedures for work tasks, equipment, and machinery, including information about the physical and health hazards of chemicals in the miner's work area, the protective measures a miner can take against these hazards, and the contents of the mine's HazCom program.

Annual refresher training conducted under part 48 must include instruction on mandatory health and safety standard requirements which are related to the miner's tasks and on the purpose of taking dust, noise, and other health measurements, as well as an explanation of any health control plan in effect at the mine. The health provisions of the Mine Act and warning labels must also be explained. Sections 48.9 (Underground Miners) and 48.29 (Surface Miners) require records of training.

Training is also a required element of the mine operator's respiratory protection program. Miners required to wear a respirator must be trained in accordance with the provisions of ASTM F3387–19 and records must be retrained in accordance with the provisions of section 9.

MSHA expects mine operators to include information in their existing training plans about respirable crystalline silica hazards and protections, including: the PEL and action level; sampling requirements; miners who are reasonably expected to be exposed to respirable crystalline silica; engineering and administrative controls used at the mine; the importance of maintaining controls; and, for MNM mines, medical surveillance requirements, including the importance of early disease detection. MSHA remains available to assist mine operators with their training plans.

3. Sorptive Minerals

The SMI, EMA, and Vanderbilt Minerals, LLC requested that MSHA follow OSHA's approach to sorptive minerals and exclude them from the scope of the final rule (Document ID 1446; 1442; 1419). These commenters asserted that lower toxicity of occluded and aged crystalline silica indicates a lack of health risks stemming from inhaling sorptive mineral dust containing respirable crystalline silica.

After considering the commenters' statements and evidence, as well as OSHA's approach to the issue, MSHA has determined that sorptive minerals should not be excluded from the scope of this rulemaking.

MSHA evaluated all the evidence submitted by commenters during the rulemaking process, including the hearings, and concludes that the balance of the best available evidence supports that there is increased risk of material impairment of health or functional capacity over the course of a miner's working life associated with regular exposure to respirable crystalline silica present at sorptive mineral mines. MSHA's approach is consistent with NIOSH's recommendation for a single PEL for respirable crystalline silica without consideration of surface properties. MSHA is unable to substantiate one commenter's statement that, in every instance, the silica in sorptive minerals is either amorphous (*i.e.,* opal) or occluded. Sorptive minerals occur as part of a geological formation with its own depositional history beginning with a volcanic eruption. The mining process will encounter all mineral constituents in the deposit, including all forms of respirable crystalline silica. To remove overburden and extract sorptive minerals, miners use large mining equipment that can disturb sedimentary and other silica-rich rock that could contain unoccluded respirable crystalline silica. In addition, the milling, screening, crushing, and bagging processes can and do affect the respirable crystalline silica dust liberated at these mines. The commenter did not submit evidence demonstrating that all sorptive mineral commodities mined in the United States exclusively contain fully or even partially occluded quartz. MSHA does not agree that occlusion is always present, that occlusion definitively provides adequate protection from adverse health effects, or that occlusion always provides any level of protection for miners exposed to respirable crystalline silica in this industry.

MSHA's method for analyzing respirable dust samples cannot differentiate between ''freshly fractured'' and occluded crystalline silica. Respirable dust enforcement samples in MNM mines are prepared for crystalline silica analysis using the MSHA P–2 method for X-ray diffraction (XRD). Crystalline materials each have their own unique diffraction patterns and are quantitatively discriminated between other crystalline and non-crystalline materials through XRD analysis. Potential interferences from other minerals are removed from the result by scanning the sample at multiple diffraction angles specific to crystalline silica and using profile fitting software to separate adjacent diffraction peaks. MSHA cannot determine if crystalline silica particles in the sample are ''freshly fractured'' or occluded with a layer of clay, only that the diffraction pattern matches that of the pure crystalline silica standard reference material.

MSHA's enforcement data in Table VIII–1 below show that miners working in this industry are exposed to respirable quartz at concentrations above both the former PEL (100 μg/m³) and new PEL (50 μg/m³). Table VIII–1 shows exposure data by contaminant code for respirable dust samples collected at ''clay'' or ''bentonite'' operations from 2005 to 2019. The samples were analyzed for respirable crystalline silica (quartz) and the results were calculated based on an 8-hour TWA.

Table VIII-1: Number of Samples by Contaminant Code and Quartz Concentration (2005-2019)

Contaminant Code	Total Analyzed	Number of Samples by Quartz Concentration		
		≤ 50 μg/m³	> 50 μg/m³	> 100 μg/m³
121	323	323	0	0
131	364	364	0	0
523	1,325	971	354	103
All Codes	2,012	1,658	354	103

Contaminant Code Descriptions:

121 - Respirable Dust Analyzed for Quartz, < 1 %, Listed Nuisance Dust

131 - Respirable Dust Analyzed for Quartz, < 1 %, Not Listed Nuisance Dust

523 - Respirable Dust Analyzed for Quartz, ≥ 1 %

The results in the table indicate that 5.1 percent of miners working at these operations during the relevant period were exposed to levels of respirable crystalline silica over the former PEL of 100 μg/m³, and 17.6 percent were exposed over the new PEL of 50 μg/m³.

MSHA disagrees with commenters' statements that the silica contained in sorptive minerals does not pose health risks. MSHA does not equate ''lower toxicity'' with other toxicological terms such as ''non-hazardous'', ''non-toxic'', or ''safe.'' ''Lower toxicity'' does not mean the absence of adverse health effects, disease, or risk of material impairment of health or functional capacity. For example, the bioactivity of respirable crystalline silica (quartz) originating from bentonite deposits is well-recognized and documented on sorptive mineral-based pet litter safety data sheets (SDSs). MSHA concludes from its own sampling data and analyses that the mining of sorptive minerals creates an inhalation hazard. As confirmed by MSHA's review of epidemiological and toxicological studies, these mineral dusts are toxic and can lead to serious adverse health effects in miners such as silicosis or lung cancer. Accordingly, MSHA concludes that there is a risk of material impairment of health or functional capacity in mining, whether or not that risk is equal to unoccluded quartz encountered in other workplaces.

In its 2016 final rule, OSHA concluded that quartz originating from bentonite deposits had some biological activity but ''lower toxicity'' than quartz encountered in most workplaces (81 FR 16377). OSHA also found that the record provided no sound basis for determining significance of risk for exposure to sorptive minerals containing quartz, and thus decided to exclude sorptive minerals from the scope of the final rule (OSHA, 2016). MSHA, unlike OSHA, has no requirement to identify a ''significant risk'' before promulgating rules to protect miners' health and safety. *Nat'l Mining Ass'n* v. *United Steel Workers,* 985 F.3d 1309, 1319 (11th Cir. 2021) (''[T]he Mine Act does not contain the 'significant risk' threshold requirement . . . from the OSH Act.''). The OSH Act is a ''differently worded statute,'' and the Mine Act ''[a]rguably . . . does not mandate the same risk-finding requirements as OSHA.'' *Nat'l Min. Ass'n* v. *Mine Safety & Health Admin.,* 116 F.3d 520, 527 (D.C. Cir. 1997). Moreover, OSHA does not regulate mining; mining presents unique risks to miners' health because it exposes miners to hazards that are not present in operations regulated by OSHA, including hazards in overburden removal and milling.

MSHA has examined research references from commenters and has conducted its own review of the scientific literature. These studies do not disprove the health-based risks associated with exposure to respirable crystalline silica or support a conclusion that sorptive minerals present no risk.

As presented by SMI, there have been few epidemiological studies of workers exposed to dust generated from sorptive minerals (Document ID 1446, Attachment 2). Two examples include Phibbs *et al.* (1971) and Waxweiler *et al.* (1988). These small cohort studies did not evaluate exposures to a wide variety of sorptive minerals and relied on data from outdated exposure assessment methods. MSHA finds that the limited epidemiological data involving sorptive minerals do not refute the conclusions drawn from other epidemiological studies included in MSHA's standalone Health Effects document and in the Agency's standalone FRA document (2023). MSHA concludes, from the best available evidence, that exposure to the crystalline silica present in sorptive minerals poses a risk of material impairment of health or functional capacity to miners.

MSHA disagrees with the comment that the occluded surface of the silica that may be found in sorptive minerals protects miners from material impairment of health, including silicosis and lung cancer. Furthermore, there is no evidence to suggest that the occluded layer of the quartz particles that are inhaled remains unchanged over time following deposition throughout the respiratory tract. It is not understood how conditions and physiological responses may alter the characteristics of occluded quartz particles deposited in the respiratory tract. Likewise, while animal studies involving respirable crystalline silica suggest that the aged form has lower toxicity than the freshly fractured form, the aged form still retains significant toxicity (Shoemaker *et al.,* 1995; Vallyathan *et al.,* 1995; Porter *et al.,* 2002c).

MSHA considered commenters' statements and evidence regarding the toxicity of quartz in sorptive minerals. MSHA's conclusions are consistent with those that NIOSH provided to OSHA (NIOSH Posthearing Brief to OSHA, 2014d). NIOSH corrected various erroneous statements that referenced published papers (*e.g.,* Waxweiler *et al.,* 1988; Phibbs *et al.,* 1971) and reports (*e.g.,* EPA, 1996; WHO, 2005), which are also a part of this rulemaking record. Four examples are provided here. First, as noted by NIOSH, Phibbs *et al.* (1971) advised that ''[b]entonite dust, once believed to be harmless, must now be added to the list of potentially hazardous dusts because of its content of free crystalline silica.'' (Document ID 0693, pg. 43). Second, NIOSH stated that, ''[w]hile no exposure-response relationship can be drawn from the Phibbs *et al.* [1971] study, it can be concluded that when exposures to respirable crystalline silica are high enough in mining/processing bentonite, severe and fatal occupational silicosis can occur among exposed workers.'' (Document ID 0693, pg. 44). Third, contrary to comments regarding the WHO report (2005), NIOSH stated, ''Although the respirable crystalline silica particles to which these bentonite workers were exposed may be less toxic than, say, respirable crystalline silica particles resulting from sandblasting, there is no way to assess relative toxicities from these two studies. Regardless of relative toxicity, the findings from these two studies indicate that, at the levels to which the workers in the studies were exposed, the crystalline silica particles were toxic enough to cause severe, disabling, and fatal silicosis in a relatively short period of time.'' Fourth, NIOSH disagreed with the commenter's reference to the lack of reporting of silicosis among cohorts of coal miners with pneumoconiosis to support its conclusion that aged/occluded silica particles do not represent a risk for silica-related health outcomes.

NIOSH addressed a commenter's presumption that further study was needed on occluded quartz before regulation was warranted. NIOSH explained that further study on occluded quartz was less pertinent for OSHA's rulemaking than the fact that the OSHA PEL was consistent with the NIOSH REL in not distinguishing respirable crystalline silica exposures based on relative age or degree of occlusion of particle surfaces. MSHA concurs with NIOSH's conclusion that ''currently available information is not adequate to inform differential quantitative risk management approaches for crystalline silica that are based on surface property measurements.'' For these reasons, MSHA does not exempt the sorptive minerals sector from the requirements of this final rule.

4. OSHA Table 1 Approach for Compliance

OSHA's ''Table 1—Specified Exposure Control Methods When Working With Materials Containing Crystalline Silica'' (Table 1) (29 CFR 1926.1153(c)(1)) identifies common construction equipment and tasks that, when properly controlled, are expected to generate levels of respirable crystalline silica below the PEL. Construction employers who follow these engineering and work practice control methods and provide the required respiratory protection outlined in Table 1 are generally not required to sample their workers' exposures to silica and are presumed to be in compliance with OSHA's standard.

MSHA did not propose adopting specified exposure control methods for task-based work practices, similar to OSHA's Table 1. However, in the proposal, MSHA sought comments on specific tasks and exposure control methods appropriate for a Table 1 approach for the mining industry that would also adequately protect miners from risk of exposure to respirable crystalline silica.

MSHA has decided not to include a Table 1 approach for the mining industry in the final rule. After considering input from stakeholders on specific tasks and exposure control methods suitable for a Table 1 approach, MSHA determined that such an approach would not provide the necessary protection for miners against overexposure to respirable crystalline silica under all mining conditions. The Agency has concluded that because of the changing nature of the mining environment, exposure monitoring is essential to ensure that controls are functioning effectively, properly maintained, and adjusted as necessary to ensure compliance.

Under the final rule, mine operators are required to implement feasible engineering controls, and administrative controls, when necessary, to maintain each miner's exposure below the PEL.

Operators are required to conduct exposure monitoring (sampling) in accordance with § 60.12 to verify that the implemented controls effectively protect miners and ensure compliance with the final rule. Compliance with the PEL and corrective actions after overexposures is required. This final rule does not allow the use of respiratory protection to achieve compliance.

Commenters from an industrial hygiene association and labor organizations, supported MSHA's decision not to include a Table 1 approach for mining activities (Document ID 1351; 1398; 1449). The UMWA stated that this approach is not necessary since mine operators already have access to proper dust control systems and MSHA-approved ventilation plans (Document ID 1398). This commenter also noted that, because mining conditions are constantly changing, it would be incorrect to assume that operators using a Table 1 approach to control respirable crystalline silica exposure would always be in compliance. Two commenters (a professional association and a labor union) stated that the Table 1 approach would be neither protective nor feasible in the mining context, while one of those commenters stated that delaying the final rule to develop a Table 1 approach will create more harm for workers (Document ID 1351; 1398).

MSHA agrees that due to constantly changing mining conditions, OSHA's Table 1 is not the most effective approach for protecting miners' health. A fundamental aspect of mining is that the mine environment is dynamic, resulting in varying exposures to respirable crystalline silica for miners. Silica exposures can fluctuate based on the amount of silica present in rock, which depends on the geological composition of the rock. Miners engaged in tasks that generate dust from this rock material may face elevated exposure levels. For example, activities that involve cutting, grinding, drilling, or crushing rock with higher-silica levels can generate dust with high silica content. In addition, mining operations are diverse, involving different types of mining, each with various mining processes. Each process involves specific equipment and methods tailored to the unique characteristics of the material being mined.

Many commenters, including trade associations, mining related businesses, a labor union, and a MNM operator urged MSHA to include a provision like Table 1 in the final rule, with Portland Cement Association, NSSGA, and CertainTeed, LLC submitting example tables for MSHA to consider (Document ID 1407; 1408; 1424; 1441; 1448; 1404; 1409; 1429; 1442; 1417; 1431; 1423). SSC noted that certain tasks, processes, and environments are at least somewhat similar or common across many MNM mines and may be characterized by the extent to which they may release respirable crystalline silica, mechanisms for doing so, and effective exposure controls (Document ID 1432). This commenter also stated that a Table 1 approach would provide mine operators with a choice between using their own controls and sampling to evaluate effectiveness (and compliance with the standard) or using the controls listed in the table. SSC noted that a clear list of controls required for each type of task, exposure, or process would simplify compliance and enforcement. SSC further noted that if a mine operator relied on the table and implemented or used all the engineering and administrative controls in the table, they would know that, in so doing, they would achieve compliance.

MSHA has determined that reliance on a task-based approach would not address all mining tasks and situations that could result in respirable crystalline silica exposures, leaving miners without adequate protection. In addition, a task-based approach may not address cumulative exposures over a shift for miners who perform multiple tasks that generate respirable silica during a single shift. MSHA has determined that because mining involves a wide range of activities, each with its own potential for different dust generating sources and potential silica exposure, a task-based approach does not protect miners, especially those miners who perform multiple tasks involving silica exposures during a single shift.

MSHA agrees with commenters that there are many job positions in the mining industry that have similar exposure risks. However, as one commenter testified, miners may work at multiple job positions or tasks throughout the shift or a workweek. This commenter noted that a miner may work as a laborer, crusher operator, or a loader operator in a single shift. Another commenter acknowledged that it would be difficult for a Table 1 approach to work because of the various tasks a miner performs (this commenter referenced a discussion on this topic between a mine operator and the Agency at the Denver, Colorado public hearing). MSHA's data indicates that a significant number of miners are classified as laborers, mobile workers, and utility workers. Approximately 31 percent of the MNM miners are mobile workers and approximately 39 percent of coal miners are laborers, utility workers and other workers who do not have specific job categories. These are job positions that perform different work activities during a shift. MSHA has determined that OSHA's Table 1 would be difficult to implement for most mines, especially mines that employ laborers, mobile workers, and utility workers.

The Portland Cement Association and NSSGA stated that OSHA's 2019 RFI, which assessed the effectiveness of Table 1, demonstrated that it was effective in lowering exposures and encouraged the adoption of engineering controls (Document ID 1407; 1448). However, AIHA explained that research indicates that worker exposure in the construction industry can exceed the OSHA PEL of 50 μg/m^3 even with Table 1 controls in place (Document ID 1351).

Portland Cement Association recommended that MSHA should adopt an OSHA Table 1 approach that encourages mine operators to install engineering controls and remove the operator's obligation to assess exposures in work environments where individual miner's respirable crystalline silica exposures are controlled by engineered devices to ensure compliance with the action level and the PEL (Document ID 1407). Under OSHA's approach, prescribed engineering controls and work practice methods, along with respiratory protection, are assumed to be sufficiently effective in reducing miners' exposures; exposure monitoring to ensure compliance with the PEL is not required. MSHA, however, has determined that exposure monitoring is critical in safeguarding miners' health. It provides the quantitative data needed to assess the effectiveness of engineering controls and is essential to ensuring that controls remain effective at all times. This is consistent with NIOSH's recommendation to OSHA during its rulemaking that Table 1 should not replace sampling requirements for the construction industry because even fully implementing the control methods and respiratory protection described in OSHA's Table 1 would not ensure compliance with the PEL. In addition, MSHA, in this final rule, does not allow respiratory protection as a means to achieve compliance.

OSHA's Table 1 approach relies on respiratory protection when engineering and administrative controls are not sufficient to limit exposures. Respiratory protection is used for compliance when control methods cannot reduce exposures below the PEL. MSHA has determined that existing engineering controls are the most effective way to protect miners from exposures to respirable crystalline silica. Engineering controls, when properly designed, implemented, and maintained, can reduce the concentration of respirable crystalline silica and protect miners from overexposures. Well designed and maintained controls can eliminate or minimize respirable silica dust at the source, preventing dispersion of the silica dust into the workplace. Respiratory protection, however, has limitations and is not as reliable as engineering controls in reducing miners' exposures to respirable crystalline silica. MSHA has determined that reliance on respiratory protection would risk miners' exposure to silica and undermine the Agency's mandate to address respiratory hazards at the source, providing the highest level of health protection for miners.

The mining industry encompasses a wide range of processes and equipment due to the diversity of mined commodities. However, as commenters noted, processes and equipment are tailored to the type of material mined. SSC noted that certain tasks, processes, and environments are at least somewhat similar or common across many MNM mines and may be characterized by the extent to which they may release respirable crystalline silica, mechanisms for doing so, and effective exposure controls (Document ID 1432). IME recommended that MSHA adopt a Table 1 approach for rock drilling operations that use a dust collection system around the drill bit and the use of low-flow water spray to wet the dust discharged from the dust collector (Document ID 1404). This commenter also noted that all drill rigs used by the explosives industry have fully enclosed cabs to isolate operators from dusty conditions. EMA suggested that a Table 1 approach could include processes with consistent/predicable dust generation characteristics, such as mobile equipment cabs, control rooms with proper ventilation and seals on doors and windows, utility vehicles, handheld power tools such as jackhammers, and tasks performed in potentially high exposure areas, such as crushing or bagging (Document ID 1442). This commenter submitted that many engineering and administrative controls or work practices can be gleaned from NIOSH's updated Dust Control Handbook for Industrial Minerals Mining and Processing, Second Edition. The commenter further noted that the NIOSH Dust Control Handbook is an excellent resource and could reduce the amount of research necessary to create a usable Table 1.

MSHA has determined that these controls cannot be relied on without independent assessment (exposure monitoring) to ensure that they are effective and continue to protect miners. For example, MSHA has found that equipment operators who are working in enclosed cabs report some of the highest exposures. These miners are exposed to high silica exposures because the enclosures are not properly maintained. Under a Table 1 approach, equipment operators would be presumed to be protected by enclosed cabs and not exposed to silica above the PEL.

A fundamental feature of mining is that the mine environment constantly changes. MSHA has concluded that miners' exposures to respirable crystalline silica vary with much greater frequency than in general industry, construction, or maritime settings. A feasible engineering control implemented in a mine (including a mill) cutting into or processing lower-quartz-containing rock might not be appropriate for a mine cutting into rock with a higher percentage of quartz or using a different mining process or modified equipment.

In addition, certain mining environments must take into account bystander exposure. For example, in underground mining environments, the ventilation is often in a series configuration, where the exhaust of one miner's controls could be the intake for other miners downwind. This results in the upwind engineering controls having an effect on all of the miners that are downwind. In contrast, OSHA's construction and general industry worksites have controls that can be exhausted to the outside atmosphere and will not affect other workers nearby.

MSHA has determined that, in the context of mining, Table 1 controls cannot be relied on without independent assessment (exposure monitoring) to ensure that they are effective, maintained, and continue to protect miners. MSHA's enforcement experience and data show that some of the highest respirable crystalline exposures result from mine operators not maintaining engineering controls. Poor maintenance of engineering controls, without exposure monitoring, can result in miners working above the PEL for extended periods, jeopardizing their health. For example, a miner working at a surface MNM mine was exposed to 192 μg/m^3 of respirable crystalline silica. The miner was working in a control booth, but the control booth ventilation system was not maintained, and the door seals were defective and leaking. A second example involved a bulldozer operator working at a surface coal mine who was exposed to 109 μg/m^3 of respirable crystalline silica. The cab's door seals were crushed, and the cab filter was broken. A third example involved a miner operating a front-end loader at surface MNM mine, who was exposed to 213 μg/m^3 of respirable crystalline silica. The cab air-conditioner was not functioning. These examples illustrate the importance of regular exposure monitoring to alert mine operators to take necessary corrective actions to repair and maintain equipment to protect miners' health. The exposure monitoring requirements in the final rule provide mine operators, miners, and MSHA with information necessary to verify that miners' exposures remain below the PEL at all times, therefore protecting miners' health. Also, the final rule does not allow respiratory protection to achieve compliance.

In addition, geological formations and quantities of quartz are not always predictable and the Agency believes that controlling exposures to respirable crystalline silica to below the PEL through sampling is the best way to protect miners' health. Accordingly, MSHA has concluded that because of the dynamic, constantly changing nature of the mining environment, exposure monitoring is essential to ensure that controls are functioning effectively, properly maintained, and adjusted as necessary to ensure compliance.

In response to MSHA's solicitation for stakeholder input on a Table 1 approach, commenters representing the stone, sand, and gravel industries provided information and data on an alternative Table 1 for MSHA's consideration. The NSSGA provided a proposed Table 1 that grouped various equipment operator positions by equipment and tasks (including a description of operation and tasks performed) and identified engineering and work practice control methods for the equipment and tasks (Document ID 1448). The commenter noted that this Table 1 is protective of workers and does not give operators an ''out'' when a worker performs a task that is listed on the table. The commenter further noted that under their proposed Table 1, the operator must ensure all engineering and work practice control methods are done to comply with the table and not engage in exposure monitoring. The commenter stated their Table 1 approach works because sampling has been done that demonstrates these controls work and keep workers below the action level.

The Portland Cement Association provided respirable crystalline silica exposure data by job classification and an alternative Table 1 that identified equipment/tasks, engineering and work practice controls, and required respiratory protection and assigned protection factor (Document ID 1407). As the commenter noted, the table shows control measures in widespread use in the cement manufacturing industry, which the commenter believes some MNM mine operators use at their operations.

MSHA considered commenters' Table 1 approaches. Like OSHA, the commenters' alternative approaches provide specific guidance on how to control work exposures to respirable crystalline silica for specific tasks. The suggested Table 1 approaches list the equipment/task and identify the similarly exposed positions and appropriate engineering and work practice control methods.

MSHA has determined that because mining involves a wide range of activities, from drilling and blasting to crushing and processing materials, each with its own potential for different dust generating sources and potential silica exposure, as well as differing silica-bearing strata, a task-based approach does not protect miners, especially those miners who perform multiple tasks involving silica exposures during a single shift. A Table 1 approach can be effective for construction activities. However, Table 1's applicability to mining and milling operations is limited due to the complexity, variability, and unique challenges inherent in mining and milling operations. Activities in these operations are highly variable, due to the types of ores, minerals, and materials processed. Mining and milling operations run continuously, unlike some construction activities which may not be continuous or steady. Continuous operations require different control measures and monitoring strategies to address sustained miner exposures over an extended period. In addition, MSHA has determined that specified control methods may not provide a continued and verifiable level of protection to miners. Exposure monitoring is essential to ensure that the controls remain effective at all times. Further, as stated earlier, this final rule does not allow respiratory protection as a means to achieve compliance.

MSHA also received comments stating that a Table 1 approach would benefit intermittent and seasonal mining operations. The NSSGA stated that these mine operators do not have as much time to conduct sampling and would benefit from a Table 1 approach (Document ID 1448). Similarly, North America's Building Trades Unions (NABTU) noted that being able to implement controls according to job function, without having to take air samples, would help portable mines and construction contractors to achieve compliance in dynamic work environments (Document ID 1414). CISC explicitly requested that MSHA conduct a final review and produce a report for comment analyzing silica exposure from all jobs associated with quarrying operations, and either exclude them from the proposed rule or create a Table 1 approach, indicating that most jobs in surface quarrying operations are incapable of exceeding the proposed PEL (Document ID 1430). As noted above, MSHA has determined that, due to the diverse range of activities involved in mining, and constantly changing mining conditions—including drilling, blasting, crushing, and material processing, each with its unique potential for silica exposure—a Table 1 approach does not adequately protect miners. This is particularly true for miners who are engaged in multiple tasks involving silica exposure within a single shift. MSHA has also concluded that control methods must be assessed to ensure they provide sufficient protection; therefore, exposure monitoring is essential to verify the ongoing effectiveness of implemented controls.

The Agency also received comments about alternative approaches to Table 1-type guidance. NSSGA stated that jobs where workers are in enclosed cabs, booths, and buildings have consensus standards and should be in Table 1 (Document ID 1448). Some commenters, including AIHA and IEEE, suggested that MSHA incorporate or recommend relevant control standards designed to protect workers performing certain tasks, such as ISO 23875: 2021, to provide operators with more tools to protect workers while continuing mandated exposure monitoring (Document ID 1351; 1377). Draeger, Inc. stated that MSHA should consider incorporating Table 1 content into a silica guidance document (Document ID 1409). NVMA suggested that MSHA should allow operators to develop their own Table 1 as part of their dust protection plan but cautioned that MSHA should not be permitted to cite the development of an internal tool unless the PEL is exceeded, and a respirator is not used (Document ID 1441). Draeger, Inc. also acknowledged that creating a Table 1 approach would be a significant effort and suggested that MSHA initially consider high-risk tasks in developing the control methods (Document ID 1409). EMA recommended that MSHA should consult the Dust Control Handbook for Industrial Minerals Mining and Processing, Second Edition, to reduce the amount of research necessary to create a Table 1 approach (Document ID 1442).

MSHA acknowledges that consensus standards can assist mine operators in the development and selection of proper engineering controls for their mine sites and supports the use of consensus standards in the design of operator enclosures for hazardous environments. MSHA also recognizes the value of providing guidance on engineering and work practice control methods for similar exposure groups to ensure compliance with the final rule. The Agency supports and encourages the use of NIOSH's Dust Handbook by mine operators to determine feasible and appropriate engineering controls for their mine sites. MSHA will work with operators and miners to develop and implement effective controls, including necessary exposure monitoring. MSHA encourages mine operators to be proactive in their approach to protecting miners from silica exposures. MSHA encourages operators to develop dust control plans or other engineering tools in their operations. MSHA also commits to developing guidance that includes information on consensus standards related to control methods. MSHA will collaborate with stakeholders, including industry and labor, as well as NIOSH, to help mine operators and miners in implementing appropriate control methods. MSHA will also provide education and training to mine operators and miners covering all aspects of the final rule.

5. Medical Removal/Transfer

MSHA does not include a medical removal/transfer option for MNM miners with evidence of silica-related disease in the final rule. MSHA intends to consider this issue in a future rulemaking.

In the proposed rule, MSHA solicited comments on whether the final rule should include a medical removal/transfer option for MNM miners who have developed evidence of silica-related disease that is equivalent to the transfer rights and exposure monitoring provided to coal miners in 30 CFR part 90 (part 90). Under part 90, any coal miner who has evidence of the development of pneumoconiosis based on a chest X-ray or other medical examination has the option to work in an area of the mine where the average concentration of respirable dust in the mine atmosphere during each shift to which that miner is exposed is continuously maintained at or below the standard for Part 90 miners. Part 90 miners are ''entitled to retention of pay rate, future actual wage increases, and future work assignment, shift and respirable dust protection.'' 30 CFR 90.3(b).

MSHA received comments from labor organizations, mining trade associations, black lung clinics, a federal elected official, an industrial hygiene professional association, an advocacy organization, a medical professional association, and an individual generally supporting medical removal/transfer rights. These commenters urged MSHA to include the provisions of part 90 in the rule and stated these protections should apply for a medically confirmed diagnosis of silicosis for any miner (Document ID 1351; 1398; 1416; 1418; 1421; 1424; 1439; 1441; 1449). Many of these commenters, as well as the Black Lung Clinics, the USW, and an individual stated that MNM miners should be provided similar medical removal/transfer rights as coal miners (Document ID 1410; 1447; 1437). The UMWA, Black Lung Clinics, and AFL–CIO noted that a medical removal/transfer program helps address the barriers related to fear of retaliation and income loss workers face when choosing to participate in medical surveillance (Document ID 1398; 1410; 1449).

After reviewing the comments and based on its experience with part 90 for coal miners, MSHA agrees that medical removal/transfer would enhance health protections for MNM miners who choose to exercise their rights; however, the Agency has determined that this would be more appropriately addressed in a future rulemaking. MSHA believes that the NIOSH-established reporting system referenced in the final rule needs to be developed and implemented before implementing medical removal/transfer requirements. For example, under part 90, NIOSH administers medical surveillance and notifies mine operators when a miner exercises their part 90 rights. Under this final rule, MNM medical surveillance is administered independent of NIOSH, and there are many more MNM miners than coal miners. Because of these differences, the Agency concluded that medical removal/transfer would benefit from additional notice and comment on a number of decision points, including protecting miners' privacy, adequacy of forms for notification, timing of benefits, what area of the mine the miner would be transferred to, whether NIOSH must make the determination, and consistent ILO classification. Further, MSHA agrees with the many commenters that urged the Agency to issue this final rule without delay.

MSHA also clarifies that, under final § 60.14(b), a mine operator must, upon receiving written notification from a PLHCP, facilitate the temporary transfer of an affected miner who cannot wear a respirator to a different area or occupation within the same mine where respiratory protection is not necessary. The final rule requires that transferred miners continue to receive compensation at no less than the regular rate of pay in the occupation that they held immediately prior to the transfer.

6. Compliance Assistance

MSHA will provide compliance assistance to the mining community (including industry and labor) after publication of the final rule. This assistance will include guidance to assist mine operators in developing and implementing appropriate controls; outreach seminars (onsite and virtual, dates and locations will be posted on MSHA's website); dust control workshops held at the National Mine Health and Safety Academy; support from the Educational Field and Small Mine Services staff; support from MSHA's Technical Support staff; silica training and best practice materials; and information on MSHA's enforcement efforts.

Additionally, MSHA will continue its Silica Enforcement Initiative by evaluating all sampling data and enforcement actions and providing compliance assistance on specific engineering controls. MSHA will continue to maintain a team of experts in regulatory compliance and respirable dust control to conduct compliance assistance visits. These visits will evaluate the conditions, mining practices, and controls that lead to silica dust overexposures. MSHA will discuss its results with mine operators and miners and make recommendations as a part of the Agency's compliance assistance activities.

As a part of its ongoing alliance agreements, MSHA will discuss issues and questions in regular alliance safety and health meetings. MSHA will continue to work with NIOSH in the development and delivery of compliance assistance materials. Compliance assistance materials will be posted on MSHA's and NIOSH's website, some of which may be reposted to the MSHA app. NIOSH's Dust Control Handbook is a useful tool for mine operators to determine feasible and appropriate engineering controls for their mine sites. MSHA encourages mine operators to use this resource. MSHA will work with mine operators and miners to develop and implement effective controls, including evaluating exposure monitoring results. MSHA encourages mine operators to be proactive in their approach to protecting miners from silica exposures and to develop dust control plans or other engineering tools in their operations. MSHA also commits to developing guidance that includes information on consensus standards related to control methods. MSHA will also provide education and training to mine operators and miners covering all aspects of the final rule.

B. Section-by-Section Analysis

Part 60 of the final rule establishes uniform mandatory health standards for exposure to respirable crystalline silica in MNM and coal mines. Part 60 includes 10 sections: Scope and compliance dates; Definitions; Permissible exposure limit (PEL); Methods of compliance; Exposure monitoring; Corrective actions; Respiratory protection; Medical surveillance for metal and nonmetal mines; Recordkeeping requirements; and Severability. For each section below, MSHA discusses the requirements of the final rule and addresses the public comments received in response to the July 2023 proposed rule.

1. Section 60.1—Scope; Compliance Dates

The final rule establishes requirements for the scope of the rule and the compliance dates in § 60.1. Section 60.1 paragraph (a) identifies the scope of the final rule, and the language is unchanged from the proposal. In a change from the proposal, paragraph (b) identifies the separate compliance dates for coal mine operators in paragraph (b)(1) and for metal and nonmetal mine operators in paragraph (b)(2). Paragraph (b)(1) establishes a compliance date for coal mine operators of 12 months after publication of the final rule. Paragraph (b)(2) establishes a compliance date for metal and nonmetal mine operators of 24 months after publication of the final rule. Below is a detailed discussion of the comments received on this section and modifications made in response to the comments.

a. Scope

MSHA received many comments regarding the scope of the rule. Some commenters, including the AIHA, ACOEM, APHA, expressed support for the proposed rule's unified approach to regulating respirable crystalline silica exposures at both MNM and coal mines, as well as at both underground and surface mines (Document ID 1351; 1405; 1416; 1412). Several other commenters, including labor organizations, advocacy organizations, mining trade associations, and MNM operators, recommended separate approaches to regulating MNM and coal mines; those commenters differed on which mines should or should not be regulated and why (Document ID 1398; 1431; 1445; 1448; 1411; 1415; 1427; 1440; 1452; 1424; 1430; 1441; 1443; 1429; 1392; 1383). Several commenters, including mining-related businesses and MNM operators, stated that the proposed rule should not apply to MNM mines (Document ID 1392; 1383; 1411; 1415; 1427). The reasons for the commenters' position included: past precedent of separate rules (*e.g.,* Document ID 1448; 1440; 1445), a need for consistency with OSHA's silica standard (*e.g.,* Document ID 1392; 1383; 1411; 1415; 1427; 1431), lower incidence of silicosis among MNM miners (*e.g.,* Document ID 1431; 1413; 1448; 1456), and higher compliance costs under the unified approach (Document ID 1392; 1411; 1415; 1427). The Pennsylvania Coal Alliance questioned the need for the rule to apply to the coal industry, stating that there had been no marked increase in compensation claims for pneumoconiosis or silicosis in coal mines (Document ID 1378). Other commenters, including a black lung clinic, a medical professional association, advocacy organizations, and a labor union, noted the risks that silica exposure poses to all miners (Document ID 1418; 1421; 1445; 1425; 1447). The Miners Clinic of Colorado at National Jewish Health observed that information about silicosis disease rates among MNM miners is less readily available in part due to a lack of medical surveillance (Document ID 1418). However, even with less information on silicosis disease rates than in coal, this commenter relayed their observations of substantial silicosis rates in MNM miners.

MSHA continues to believe that a unified approach to controlling respirable crystalline silica provides the greatest level of health protection for MNM and coal miners. The purpose of this final rule is to reduce respirable crystalline silica-related occupational diseases in miners and to improve respiratory protection against airborne contaminants. Based on MSHA's review of the adverse health effects related to respirable crystalline silica—a known carcinogen—MSHA concludes that the health risks threaten all miners exposed to respirable crystalline silica. It is important that the mandatory health standards for MNM and coal miners be consistent to ensure that all miners are equally protected from exposure. Selected surveillance data for both silicosis cases and deaths are reported in the standalone Health Effects document and in the preamble in *Section V. Health Effects Summary.* Additionally, further discussion of risk related to silica exposure is located in the standalone FRA document.

While MSHA acknowledges that MNM and coal mines have been regulated separately in the past, there is precedent for a unified approach. For example, MSHA's health standard for occupational noise covers both MNM and coal mines, as discussed in ''Evaluating hearing loss risks in the mining industry through MSHA citations'' (Sun and Azman, 2018). Like respirable crystalline silica, occupational noise is a hazard for all miners. MSHA's survey and enforcement data indicate that since the occupational noise rule became effective in September of 2000, there has been a drastic decrease in the rate of overexposures at both MNM and coal mines. Because the hazards and control methods of respirable crystalline silica are common to both coal and MNM, MSHA believes a unified standard will offer miners consistent improvement of working conditions in both sectors.

As addressed in the standalone Health Effects document, MSHA has reviewed studies supporting increased risk of adverse health effects for miners working in both coal and MNM mines. After decades of declining prevalence of pneumoconiosis among underground coal miners in the U.S., prevalence, including more advanced forms of disease, has increased since the late 1990s (Laney and Weissman, 2012; Blackley *et al.,* 2014a, 2018a; Hall *et al.,* 2019b).

MSHA does not agree with the assertion that silicosis or other diseases linked to respirable crystalline silica are not risks for MNM miners. MSHA reviewed a wide range of studies that demonstrated disease risks among miners occupationally exposed to respirable crystalline silica. These studies were not limited to coal miners and covered occupations relevant to MNM mining such as sandblasters (Hughes *et al.,* 1982; Abraham and Wiesenfeld, 1997), industrial sand workers (Vacek *et al.,* 2019), hard rock miners (Verma *et al.,* 1982, 2008), gold miners (Carneiro *et al.,* 2006a; Tse *et al.,* 2007b), metal miners (Hessel *et al.,* 1988; Hnizdo and Sluis-Cremer, 1993; Nelson, 2013), and nonmetal miners such as silica plant and ground silica mill workers, whetstone cutters, and silica flour packers (Mohebbi and Zubeyri, 2007; NIOSH, 2000a,b; Ogawa *et al.,* 2003a). Of the MNM exposure samples MSHA collected over the 2005–2019 period, 17.7 percent exceed the new PEL of 50 μg/m^3, and 6.1 percent exceed the current PEL of 100 μg/m^3. Further discussion on this analysis is presented in the standalone FRA document.

This rule will strengthen miners' health protections by reducing exposures to respirable crystalline silica, which is the root cause of silica-related disease. MSHA believes that this uniform approach provides a more protective, coherent, logical, and predictable standard for miners and mine operators. Unlike the existing standards, this final rule establishes a single, uniform PEL and action level, and eliminates any need for conversion based on percent respirable crystalline silica and any variations in calculation for different silica polymorphs. The final uniform PEL will provide all miners with a consistent level of protection that is similar to the protection provided to workers in industries covered by OSHA's silica standards, and consistent with the recommendations of NIOSH.

b. Applicability to Contractors, Portable Mines, and Sorptive Minerals Industry

Several commenters requested clarification of applicability or exemptions to specific sectors of the mining industry: mining contractors, portable mines, and the sorptive minerals sector.

Contractors

Some commenters from industry trade associations and mining trade associations requested that MSHA clarify the rule's applicability to mining contractors in the final rule (Document ID 1422; 1433; 1424; 1428; 1378). Consistent with the Mine Act, MSHA's existing standards, and the Agency's longstanding policy, independent contractors engaging in mining activities, including construction, maintenance, and drilling, are required to comply with the requirements in this final rule. *See* 30 U.S.C. 802(d) (defining ''operator'' to include ''any independent contractor performing services or construction'' at a mine) and § 802(g) (defining ''miner'' as ''any individual working in a coal or other mine''). MSHA has a long history and practice of enforcing its standards and regulations for mine operators and independent contractors designated under part 45 of 30 CFR. The Agency believes that the industry is familiar with and understands this history and practice. Based on MSHA's experience and practice, and depending upon the activities that they perform for production operators, MSHA expects that some part 45 independent contractors will comply with the requirements of this final rule, as it relates to their miners. For example, MSHA expects that drilling and blasting contractors, who perform services at different mines, generally separate from production activities, will comply with the requirements of the final rule. For other part 45 independent contractors, MSHA anticipates that the production operator may comply with the requirements of this final rule for their miners, depending upon the types of services provided. For example, MSHA expects that production operators will generally comply with the requirements of this final rule for independent contractors that perform hauling services for mines. This final rule provides improved health protections for miners of both part 45 independent contractors and production operators. As with the implementation of any new MSHA standard, the Agency expects that production operators and part 45 independent contractors will communicate and coordinate with each other, as appropriate, to comply with the final rule and ensure that miners' safety and health are protected.

Portable Mines

Some commenters (MNM operators and a mining-related business) requested that MSHA exempt portable mine operations from exposure monitoring (Document ID 1392; 1415; 1427; 1435; 1436). The mining-related business commented that an exemption should be granted for portable mines that are shut down for more than 3 months out of the year or operate in a pit for less than 30 days before moving (Document ID 1392). Several portable mine operators, including B & B Roads, Inc., stated that rock crushing jobs are typically completed within 4 to 10 days, at which point the portable mine moves to another job location, which could be between 30 to 200 miles away (Document ID 1427; 1436). These commenters specifically requested exemptions for sites that they do not own, stating that sampling data would not be applicable if done at pits where they do not conduct operations regularly. However, these commenters expressed that they were not asking for exemptions to pits where they regularly conduct operations or to locations they control.

MSHA reviewed the comments and determined that because of MSHA's clear mandate to protect the health of all miners, the final rule does not exempt portable mines. Under existing MNM standards for airborne contaminants, portable operations are not exempt from any regulatory requirements or any other health standards. This final rule, like existing standards, requires portable mine operators to protect their miners from overexposure to respirable crystalline silica and other airborne contaminants, and to monitor miners' exposures to airborne contaminants, including silica. Portable mine operations often involve crushing, which can generate substantial amounts of dust, and they handle a variety of commodities generating varying amounts of respirable crystalline silica depending on the geological features of the pit.

The final rule requires that all mine operators, including portable mine operators, conduct exposure monitoring in accordance with § 60.12, including first-time sampling. With respect to portable mine operators, MSHA has taken into consideration that these mines are unique and may move frequently. However, the final rule does not exempt portable mine operators because miners must be protected at all times, and the methods of compliance, sampling and evaluation provisions are necessary to protect miners.

Sampling ensures engineering controls put in place by mine operators are effective in protecting miners. If the portable mine operator anticipates being at the site for at least three months, MSHA expects the portable mine operator to conduct the second-time sampling at that site within the three-month timeframe under § 60.12(a)(2). If the portable mine operator moves to a different site before conducting its second-time sampling within three-months, the operator is required to conduct the second-time sample at the next site. If either operator or MSHA samples are at or above the action level and at or below the PEL, portable operators must sample every three months under § 60.12(a)(3). Similarly, if the most recent sampling was above the PEL, the portable mine operator must take immediate corrective actions, immediately report the overexposure to MSHA, ensure provided respirators are worn appropriately by affected miners before the start of the next work shift, and resample, regardless of whether the portable mine has moved to a different site by the time the sampling results are received. Under the final rule, at least every 6 months or if there are any changes in processes, production, equipment, or geological conditions, mine operators are required to conduct a qualitative evaluation. Protecting miners' health requires monitoring and controlling levels of respirable crystalline silica, and, consistent with the Mine Act, miners at portable mines must be afforded the same health protections and informational awareness of their exposures as all other miners.

If the results of the evaluation reveal that their miners may be reasonably exposed to respirable crystalline silica at or above the action level but at or below the PEL, the sampling provisions of the final rule apply. Also, if sampling indicates levels above the PEL, under the final rule, portable mine operators must take immediate corrective actions, resample, and record these actions.

MSHA provides two examples that illustrate how and why the final rule will affect portable mine operators. In example 1, the portable mine operator conducts first-time sampling on mine site A and the sample result is below 25 μg/m³. One month later, the portable mine operator moves to mine site B. The operator performs a qualitative evaluation, which the operator determines does not trigger post-evaluation sampling. Within two months (three months from the date of the first-time sample), the portable mine operator must take a second sample. This sample result is also under 25 μg/m³. Under the final rule, this portable mine operator can discontinue sampling. The portable mine operator then moves to mine site C. The portable mine operator must conduct a qualitative evaluation and, depending on the results of the evaluation, may need to perform sampling.

In example 2, the portable mine operator is located on mine site X. The portable mine operator conducts a qualitative evaluation and determines that miners' exposures may reasonably be at or above the action level, triggering sampling. The portable mine operator conducts sampling, and the results are above the PEL. The mine operator takes immediate corrective actions, immediately reports the overexposure to MSHA, ensures provided respirators are worn appropriately by affected miners before the start of the next work shift, and resamples. The operator then moves to mine site Y before corrective actions sampling results are received. Depending on the results of the corrective actions sampling from mine site X, the portable mine operator must conduct either above-action-level sampling or corrective actions sampling at mine site Y. MSHA expects that all corrective actions, including any new or improved engineering controls, will remain in place at mine site Y. Additionally, at mine site Y, the operator must perform another qualitative evaluation at the new mine site. Each time the operator moves to a new site, it must perform a new qualitative evaluation.

These examples illustrate that when sampling is required at one portable mine site, the requirement continues when the portable mine moves to a new mine site. Sampling across different portable mine sites is needed to determine whether the engineering controls applied to the portable mine (for example, dust collection or water spray) are effective to keep miners healthy. Periodic evaluations will also be critical for mines that move frequently and encounter different conditions that expose miners to respirable crystalline silica. These evaluations and any related samplings will allow operators to verify that adequate engineering controls are effective and are maintained properly to protect miners as they move to different worksites, regardless of mining location or commodity mined or milled.

MSHA encourages portable mine operators to work with their District Managers to develop an appropriate compliance approach that protects miners' health. MSHA will provide compliance assistance to portable mine operators.

Sorptive Minerals

The applicability of the rule to one specific industry within MNM—the sorptive minerals industry—was the subject of several comments from SMI, EMA, and Vanderbilt Minerals, LLC (Document ID 1446; 1442; 1419). These commenters requested that the sorptive minerals industry be exempted from the rule. The commenters stated that this industry exposes workers only to aged quartz, and that aged quartz is less toxic than freshly fractured quartz in other industries. After careful consideration, MSHA has decided not to exempt sorptive minerals mines. The Agency's rationale for this decision is discussed in detail above in *Section VIII.A. General Issues.*

c. Compliance Dates

This final rule will take effect 60 days after publication in the **Federal Register**. In response to comments, MSHA is establishing two compliance dates for the final rule—one for MNM mine operators and the other for coal mine operators. MNM operators will be required to comply starting 24 months after publication of the final rule, whereas coal mine operators will be required to comply starting 12 months after publication of the final rule.

MSHA received comments both in support of and against having compliance commence immediately when the final rule takes effect. Some commenters, including labor organizations, an industrial hygiene professional association, and an advocacy organization, supported the proposed effective date, citing the need for the new rule to be implemented as soon as possible to protect miners' health (Document ID 1398; 1425; 1351; 1449). Appalachian Voices and the AFL–CIO stated that the technologies and practices necessary to reduce dust and silica exposure are well-known and that mine operators have had ample notice that this rule was forthcoming (Document ID 1425; 1449). In contrast, several commenters, including multiple mining trade associations and a mining industry organization, expressed the need for a longer preparation period prior to compliance (Document ID 1428; 1407; 1408; 1442; 1441; 1448). Some commenters, including a state mining association, a MNM operator, and an industry trade association, suggested that MSHA allow more time, ranging from one to three years, to comply with the final rule (Document ID 1441; 1432; 1442; 1448; 1392). Some cited reasons for allowing more time include: the two-year preparation period that OSHA provided for compliance with its 2016 silica rule; the time needed for operators to plan, purchase, and implement engineering controls; and the challenges that the rule could present for MNM mine operators new to sampling and medical surveillance (Document ID 1407; 1419; 1424; 1428). Other commenters, including a professional association, industry trade associations, mining trade associations, and MNM operators, suggested a phased approach to implementation, with different compliance dates for the different requirements in the rule (Document ID 1377; 1407; 1413; 1428; 1424; 1456; 1417; 1453). Examples given of past rules that had used this approach included: OSHA's silica rule (which became effective 90 days after publication, but, for example, for construction, allowed one year after the effective date for compliance with most of the rule requirements, and two years for compliance with certain laboratory requirements); MSHA's diesel particulate matter rule (which included incremental reductions in the PEL over two years); and MSHA's 2014 RCMD Standard (which allowed operators 18 months after the effective date to comply with sampling requirements and 24 months to implement the standards) (Document ID 1407; 1424; 1441; 1442).

Several commenters, including three industry trade associations, a mining trade association, and a MNM operator, expressed concern that the rule would lead to excessive demand and backlogs for sampling devices, industrial hygienists, labs, medical facilities, and B Readers (Document ID 1407; 1404; 1413; 1428; 1419). The NSSGA stated that over 80 percent of aggregate companies have fewer than 25 employees and therefore will likely rely on their insurance companies or industrial hygiene consultants for sampling, and that scheduling of sampling will be based on priorities outside the control of the mine operator (Document ID 1448). A mining trade association, industry trade associations, and a MNM operator also asserted that because post-pandemic supply chain delays are continuing, and in some cases escalating, operators are facing long lead times for procurement of critical infrastructure items, including those essential for mandatory health and safety requirements (Document ID 1428; 1404; 1407; 1419). Finally, these commenters expressed concern that requiring mine operators to comply with the final rule 120 days after publication would not provide enough time for MSHA to issue guidance and for mine operators to digest relevant implementation and compliance guidance documents (Document ID 1428; 1404; 1407; 1419).

After careful consideration, MSHA has decided to provide additional time for mine operators to prepare for compliance with the final rule. MNM mine operators must comply with the final rule by 24 months after publication of the final rule, while coal mine operators will have 12 months to come into compliance with the rule (except for medical surveillance, which applies only to MNM mines). MSHA believes that this final compliance date gives coal mine operators sufficient time to plan and prepare for effective compliance with the new standards, while also ensuring that improved protections for miners from the hazards of respirable crystalline silica take effect as soon as practically possible. Unlike MNM mines, underground and surface coal mine operators have considerable experience with frequent sampling, and they can more quickly integrate the sampling requirements in this final rule into their existing underground mine ventilation plans and surface mine respirable dust control plans. In addition, coal mines already have existing controls in place that control for dust; therefore, coal mine operators should not need as much time to maintain, repair or implement controls. As mentioned earlier, coal mine operators will not have to implement medical surveillance under this rule.

In the case of MNM mines, MSHA has adjusted the requirements in the final rule to allow operators a total of 24 months after the publication of the final rule to comply. MSHA is allowing this longer period for compliance because MNM operators, particularly small mines, may have less experience with sampling and may also need time to prepare for compliance with medical surveillance. The longer period for compliance is generally responsive to some commenters. The Agency believes the longer period for compliance will provide operators adequate time to meet their compliance obligations under the final rule. MSHA believes that mine operators will use the compliance period to familiarize themselves with the new standard; evaluate, update, and enhance existing engineering controls; research, purchase, and install new or additional engineering controls, if necessary; arrange for sampling; and commence sampling. MSHA notes that the 24 months provided for MNM operators is the same as that provided in the OSHA rule and the same as MSHA provided in the 2014 RCMD Standard. MSHA believes that there are enough laboratories, sampling equipment, medical service providers, respiratory equipment, and contractor service providers for sampling to meet any increase in demand for equipment or services required by this final rule. The additional 24 months will provide MNM operators additional time to procure equipment and services. For a detailed discussion of the availability of respirators and laboratory and medical services necessary for compliance with the rule, see *Section VII.A. Technological Feasibility.*

MSHA believes that these compliance periods in the final rule provide operators adequate time to prepare for successful implementation, balanced against the Agency's priority goal and statutory mandate to move quickly to protect miners against respirable crystalline silica hazards. Mine operators in both MNM and coal have had many years of experience with monitoring and controlling airborne contaminants, including respirable crystalline silica, and this experience should facilitate implementation of the final rule. MSHA data show that many mines are already meeting the respirable crystalline silica PEL of 50 μg/m³ for a full-shift, calculated as an 8-hour TWA, using a variety of engineering controls. In addition, to ensure successful implementation, MSHA plans to provide compliance assistance to the mining industry. This assistance will include the development and distribution of compliance guidance materials for mine operators and training materials for miners, as well as technical assistance for small mines. Compliance assistance and training are discussed in more detail above in *Section VIII.A. General Issues.*

2. Section 60.2—Definitions

The final rule, like the proposal, includes definitions for the following terms in § 60.2: ''action level,'' ''respirable crystalline silica,'' and ''specialist.'' In a change from the proposal, MSHA removes the definition of ''objective data'' from the final rule. MSHA received multiple comments on the proposed definitions of action level and objective data, as discussed in more detail below. The Agency did not receive any comments on the proposed definitions of respirable crystalline silica or specialist.

a. Action Level

The final rule, like the proposal, defines ''action level'' as ''an airborne concentration of respirable silica of 25 micrograms per cubic meter of air (μg/m³) for a full-shift exposure, calculated as an 8-hour time-weighted average (TWA).'' If respirable crystalline silica concentrations are at or above the action level but at or below the PEL, operators are subject to the ongoing sampling requirements detailed in § 60.12. The action level enables mine operators to maintain compliance with the PEL and provide necessary protection to miners before overexposures occur.

MSHA received several comments in support of and against the proposed adoption of an action level. Several commenters including labor unions, medical professional associations, and advocacy organizations supported the proposal to institute an action level of 25 μg/m³ (Document ID 1398; 1447; 1416; 1421; 1393; 1438). The UMWA and USW stated that the proposed action level was consistent with NIOSH and IARC findings and would reduce the risk of death and disease (Document ID 1398; 1447). Other commenters, including state mine organizations, mining trade associations, and MNM mine operators, did not support the proposed action level of 25 μg/m³ for all mines (Document ID 1368; 1441; 1424; 1432; 1440; 1378; 1392; 1408; 1426). The commenters stated that it would not be achievable with current technology (Arizona Mining Association, Document ID 1368) and would not improve miners' health (AMI Silica LLC, Document ID 1440). The NLA stated that MSHA should consider setting only a PEL and not an action level because there is less need for an action level in the mining industry than in OSHA-regulated industries (Document ID 1408). The AEMA, NVMA, and Tata Chemicals Soda Ash Partners, LLC, stated that the action level should be developed on a per-mine or per-company basis or should be an internal control only (Document ID 1424; 1441; 1452). The Arizona Mining Association suggested a phased approach with incremental changes (Document ID 1368). The ACOEM, although in support of the action level and proposed PEL, urged a further lowering of the PEL to 25 μg/m³ in the future (Document ID 1405).

After careful consideration of the comments, MSHA has determined an action level of 25 μg/m³ is feasible, and the definition of action level in the final rule is the same as the proposal. MSHA's FRA shows that there will be a greater reduction of morbidity and mortality at the action level, but acknowledges that it may not be achievable for all mines to consistently maintain an exposure limit below 25 μg/m³. According to NIOSH research, wherever exposure measurements are above one-half the PEL, the employer cannot be reasonably confident that the employee is not exposed to levels above the PEL on days when no measurements are taken (NIOSH, 1975). MSHA establishes the action level and sets a sampling frequency for concentrations at or above the action level to allow mine operators to act before overexposures occur. MSHA acknowledges that, even at exposures of 25 μg/m³, some residual risks remain. For example, at 25 μg/m³, end stage renal disease (ESRD) risk is 20.7 per 1,000 MNM miners and 21.6 per 1,000 coal miners.

Commenters stated that MSHA should not have an action level. The AEMA and NVMA said the Agency does not use an action level in other air contaminant exposure rules (Document ID 1424; 1441).

At exposures of 25 μg/m³ or lower, risk of adverse health effects remains. The Agency has established action levels equivalent to 50 percent of the PEL for occupational noise exposure in MNM and coal mines (30 CFR 62.101) and equivalent to 50 percent of the exhaust gas monitoring standards for underground coal mines (30 CFR 70.1900). MSHA survey and enforcement data indicate that the action levels in the occupational noise and exhaust gas rules have contributed to greater compliance and fewer overexposures. Based on its experience, MSHA knows that action levels encourage mine operators to be more proactive in providing necessary health and safety protection to miners. Furthermore, MSHA was able to learn about the health benefits of an action level for respirable crystalline silica through the implementation of OSHA's silica final rule (2016a). In developing this final rule, MSHA took into consideration experience gained under other safety and health standards including those established by OSHA. Several OSHA standards established action levels for airborne contaminants, especially toxins such as benzene, inorganic arsenic, ethylene oxide, and methylene chloride.

Some commenters, including trade associations, MNM operators, a state mining association, and a mining-related business, stated that the action level would increase costs for mine operators (Document ID 1408; 1442; 1419; 1440; 1441; 1392). MSHA recognizes that costs may increase as a result of the sampling requirements in the final rule. Mine operators are encouraged to reduce exposures below the action level to avoid additional costs associated with the sampling requirements triggered when exposures are at or above the action level. The Agency emphasizes that the requirements of the final rule are established to protect miners from the adverse health effects resulting from exposure to respirable crystalline silica.

Several commenters, including industry trade associations, MNM operators, and a mining trade association, cautioned that the action level was too close to the limit of accurate detection of respirable crystalline silica (Document ID 1426; 1413; 1432; 1440; 1448). SSC stated that there is little confidence in the reliability of sampling results below 50 μg/m^3 (Document ID 1432).

MSHA's analytical methods for air samples can reliably detect respirable crystalline silica at or below the action level. The MSHA P–2 and P–7 analytical methods have a reporting limit of 12 μg for quartz in mine dust. Both methods are sufficiently sensitive to quantify levels of quartz collected on air samples from concentrations at the action level. Most accredited laboratories that offer crystalline silica analysis by X-ray diffraction use either the OSHA ID–142 or NIOSH 7500 methods. The OSHA method specifies a reliable quantification limit of 12 μg/m^3 for quartz, and the NIOSH method states that the estimated detection limit for quartz is 5 μg. The NIOSH infrared methods, 7603 and 7602, state estimated detection limits of 1 and 5 μg of quartz, respectively.

The AEMA and NVMA disagreed with MSHA's calculation of the action level as an 8-hour TWA (Document ID 1424; 1441). These commenters said NIOSH recommends calculating exposure levels for a 10-hour shift.

The final rule includes an 8-hour TWA because it provides more protection to miners who work extended shifts. Further discussion of the 8-hour TWA is discussed below under *Section 60.10—Permissible Exposure Limit (PEL).*

The Arizona Mining Association stated the proposed action level is not achievable with current available technology (Document ID 1368). The commenter provided testimonial information about a mine that conducted a baseline test with a continuous dust monitor in an office setting and was close to the proposed action level.

MSHA clarifies that the action level applies only to respirable crystalline silica, which is a component of respirable dust. If an office or other setting contains levels of respirable crystalline silica that meet or exceed the action level, sampling is required under the final rule.

After careful consideration of the rulemaking record, MSHA has determined the action level is appropriate. The Agency's experience with existing standards indicates that an action level of one-half the PEL provides necessary information to mine operators on actions they need to take to reduce miners' exposures below the action level, where feasible. Operator sampling at or above the action level but at or below the PEL also provides critical information to miners on their exposures. Under § 60.12(g), operators must share sampling records and laboratory reports with miners so that they have an awareness and understanding of the important role that engineering and administrative controls play in protecting their health. Mine operators who keep their exposures below the action level avoid the costs of required compliance with provisions triggered by the action level, provide improved health protection for miners, and may experience better miner health and less turnover. MSHA concludes that an action level is needed at one-half the PEL based on residual risk at the PEL of 50 μg/m^3; the feasibility of measuring exposures at an action level of 25 μg/m^3; and the administrative convenience of having the action level at one-half the PEL, as it is in other MSHA standards. As discussed in the standalone Health Effects document and standalone FRA document, risk remains at the PEL of 50 μg/m^3. Accordingly, MSHA is finalizing these additional requirements to reduce remaining risk when those requirements will afford benefits to miners and are feasible.

b. Objective Data

Under the proposal, operators could use ''objective data'' to confirm sampling results below the action level and discontinue sampling.

MSHA removes the definition of ''objective data'' in the final rule. The term ''objective data'' was defined in the proposed rule as ''information such as air monitoring data from industry-wide surveys or calculations based on the composition of a substance that indicates the level of miner exposure to respirable crystalline silica associated with a particular product or material or a specific process, task, or activity.''

MSHA received several comments on the proposed definition of objective data, with numerous commenters stating that the definition was vague and overly broad. Some commenters, including labor organizations, a Federal elected official, and an industry trade association, requested clarification on how to determine the validity and acceptability of objective data and who should make the determinations (Document ID 1398; 1449; 1439; 1442). Others, such as AIHA, Black Lung Clinics, and AFL–CIO, commented that objective data is not an accurate or reliable measure of exposure to respirable crystalline silica and that objective data should not be used to exempt operators from sampling. (Document ID 1351; 1410; 1449; 1412).

The Agency agrees with commenters who asserted sampling is more accurate than using objective data as defined in the proposed rule. Additional discussion on the comments received on objective data and MSHA's response regarding the proposal are discussed in *Section VIII.B.5. Section 60.12.—Exposure Monitoring.*

c. Respirable Crystalline Silica

The final rule, like the proposal, defines ''respirable crystalline silica'' as ''quartz, cristobalite, and/or tridymite contained in airborne particles that are determined to be respirable by a sampling device designed to meet the characteristics for respirable-particle-size-selective samplers that conform to the International Organization for Standardization (ISO) 7708:1995: Air Quality—Particle Size Fraction Definitions for Health-Related Sampling.''

MSHA did not receive any comments on the definition of respirable crystalline silica. The final rule's definition has two main advantages. First, the ISO 7708:1995 definition of respirable particulate mass represents an international consensus, and by adopting the ISO 7708:1995 criterion, MSHA is able to harmonize its standards with the standards used by other occupational health and safety organizations in the U.S. and internationally, including ACGIH, OSHA (29 CFR 1910.1053 and 29 CFR 1926.1153), NIOSH (2003b, Manual of Analytical Methods), and the European Committee for Standardization (CEN) (ISO 7708:1995). Second, the definition eliminates inconsistencies in the existing standards for MNM and coal mines. Defining respirable crystalline silica to include quartz, cristobalite, and/or tridymite and establishing a PEL for exposure to respirable particles of any combination of these three polymorphs provides consistency across different mining sectors.

d. Specialist

The final rule, like the proposal, defines ''specialist'' as ''an American Board-Certified Specialist in Pulmonary Disease or an American Board-Certified Specialist in Occupational Medicine.'' The definition is applicable to § 60.15, which addresses medical surveillance for MNM mines. Under the medical surveillance requirements, MNM mine operators are required to provide miners with medical examinations performed by a specialist in pulmonary disease or occupational medicine or a PLHCP.

MSHA did not receive any comments on the definition of specialist. The medical surveillance provisions for MNM mines require a specialist to conduct a follow-up medical examination no later than 2 years after the follow-up examination for new miners if the chest X-ray shows evidence of pneumoconiosis or the spirometry examination indicates evidence of decreased lung function (§ 60.15(c)(3)). The provision is intended to ensure that any miner who shows evidence of pneumoconiosis or decreased lung function is seen by a professional with expertise in respiratory disease. The definition is important because it ensures miners benefit from expert medical judgment and receive advice regarding how work practices and personal habits could affect their health.

3. Section 60.10—Permissible Exposure Limit (PEL)

The final rule, like the proposal, requires the mine operator to ensure that no miner is exposed to respirable crystalline silica in excess of 50 μg/m³ for a full-shift exposure, calculated as an 8-hour TWA for all mines. The PEL is the same for both MNM mines and coal mines. For coal mines, this provision establishes a PEL for respirable crystalline silica independent from the existing respirable coal mine dust standards. The PEL in the final rule replaces the Agency's existing exposure limits for respirable crystalline silica or respirable quartz in 30 CFR parts 56, 57, 70, 71, and 90. (The existing respirable coal mine dust standards unrelated to quartz remain the same.) Below is a detailed discussion of the comments received on this section and modifications made in response to the comments.

a. PEL of 50 μg/m³

MSHA analyzed and considered the comments received in response to the proposed PEL of 50 μg/m³. Most commenters supported lowering the existing quartz or silica exposure limits, and many specifically expressed support for the proposed PEL, including labor organizations, an advocacy organization, medical professional associations, and mining trade associations, (Document ID 1398; 1447; 1449; 1416; 1421; 1424; 1428; 1418; 1439; 1443). Some of these commenters, including AEMA and NMA, noted that the proposed PEL aligns with OSHA's PEL for non-mining industries, as well as with NIOSH recommendations (Document ID 1424; 1428). Several commenters, including Black Lung Clinics, APHA, and Miners Clinic of Colorado, underscored that substantial risk of silica-related disease exists at 100 μg/m³ compared to lower risks at 50 μg/m³ (Document ID 1410; 1416; 1418). Black Lung Clinics noted that the indirect approach to limiting silica exposure in coal miners has not been effective (Document ID 1410). Other commenters, including the AFL–CIO and NABTU, stated that the proposed PEL is technologically and economically feasible and would reduce the risk of death and disease to miners (Document ID 1449; 1414). Other commenters similarly expressed support for the proposed PEL, with the USW stating that the proposed PEL is necessary and feasible, and The American Thoracic Society *et al.* stating that it is supported by science and could be readily achieved with currently available engineering interventions (Document ID 1447; 1421).

AIHA and MSHA Safety Services did not believe the proposed PEL was appropriate, with the AIHA stating that the proposed PEL of 50 μg/m³ does not protect miners from adverse health effects and recommending a PEL of 25 μg/m³ instead (Document ID 1351; 1392). While some commenters such as the USW and the AFL–CIO did support MSHA's proposal to lower the existing exposure limits, these commenters noted that several other countries or jurisdictions have set standards reducing legal permissible limits to 25 μg/m³ (Document ID 1447; 1449). One commenter, MSHA Safety Services Inc., opposed the rule stating that the existing standards (*i.e.,* 100 μg/m³), if followed, would be more than sufficient (Document ID 1392). This commenter, citing data retrieved from MSHA's Mine Data Retrieval System (MDRS), stated that silicosis and pneumoconiosis affect only underground coal miners and not MNM miners.

After considering the data and evidence in the rulemaking record, the final rule establishes a PEL of 50 μg/m³. MSHA's examination of health effects evidence (discussed in the preamble in *Section V. Health Effects* and *Section VI.—Final Risk Analysis Summary,* as well as in the standalone Health Effects document and standalone FRA document) demonstrates that exposure to respirable crystalline silica at the existing exposure limits results in a risk of material impairment of health or functional capacity, and that exposure at the lower level of the PEL will reduce that risk. MSHA's FRA indicates that 45 years of exposure to respirable crystalline silica under the new PEL would lead to a total of 1,067 lifetime avoided deaths, including 248 avoided deaths from silicosis, 536 avoided deaths from all forms of non-malignant respiratory disease (including silicosis as well as other diseases such as chronic bronchitis and emphysema), 82 avoided deaths from lung cancer, and 200 avoided deaths from renal diseases.

As some commenters noted, the PEL is consistent with NIOSH's respirable crystalline silica recommended exposure limit of 50 μg/m³ for workers and with the PEL of 50 μg/m³ for respirable crystalline silica covering U.S. workplaces regulated by OSHA. In 1974, NIOSH recommended that occupational exposure to crystalline silica be controlled so that ''no worker is exposed to a TWA of silica [respirable crystalline silica] greater than 50 μg/m³ as determined by a full-shift sample for up to a 10-hour workday over a 40-hour workweek'' (NIOSH, 1974). In 2016, OSHA promulgated a rule establishing that, for construction, general industry, and the maritime industry, workers' exposures to respirable crystalline silica must not exceed 50 μg/m³, averaged over an 8-hour day (29 CFR

1910.1053(c); 29 CFR 1926.1153(d)(1)).[66]

As discussed in the standalone Health Effects document, occupational exposure to respirable crystalline silica is detrimental to an individual's health. Silicosis and other diseases caused by respirable crystalline silica exposure are irreversible, disabling, and potentially fatal. At the same time, these diseases are exposure-dependent and are therefore preventable. The lower a miner's exposure to respirable crystalline silica, the less likely that miner is to suffer from adverse health effects.

Regarding the comments recommending MSHA adopt a PEL of 25 μg/m³ and some comments noting that other countries or provinces have set standards reducing permissible limits to 25 μg/m³, MSHA considered establishing a PEL of 25 μg/m³ as part of MSHA's Regulatory Alternative 2. Under this regulatory alternative, a more stringent PEL of 25 μg/m³ is combined with less stringent monitoring provisions compared to the final rule. MSHA estimated that there will be a greater reduction of morbidity and mortality cases as a result of lowering the PEL to 25 μg/m³. MSHA also estimated that the compliance costs would outweigh the benefits resulting in negative net benefits. MSHA's enforcement experience shows that for mining occupations exposed to the highest levels of respirable crystalline silica, in both MNM mines and coal mines, a PEL of 25 μg/m³ is not generally achievable. For example, MSHA reviewed exposures of designated occupations in underground coal mines and crusher and equipment operators in MNM mines, and determined that on average, miner exposures exceed 25 μg/m³ when all feasible engineering controls are used. Although other countries and jurisdictions may have adopted a PEL of 25 μg/m³, MSHA did not choose this regulatory alternative because a PEL of 25 μg/m³ may not be achievable for all mines (Document ID 1447; 1449). For some mines, a PEL of 25 μg/m³ would present a substantial challenge. Commenters did not provide specific information on the regulatory programs for the countries and jurisdictions that have established a PEL of 25 μg/m³. Further explanation and discussion of the regulatory alternatives can be found in the standalone FRIA document and in the preamble in *Section IX. Summary of Final Regulatory Impact Analysis and Regulatory Alternatives.*

An individual urged MSHA to adopt, in addition to the proposed PEL of 50 μg/m³, an upper exposure level of 100 μg/m³ that would trigger the withdrawal of miners from the affected area rather than permit continued miner work in affected jobs in extremely elevated concentrations above the PEL (Document ID 1367). Because MSHA has determined that the final rule's sampling obligations will reduce overexposures and that the corrective actions requirements establish strong protections for miners when they are exposed over the PEL, the Agency has not set an upper limit that would automatically trigger the withdrawal of miners. As discussed at the public hearings and required in § 60.12, operators must immediately report all exposures above the PEL from operator sampling to the MSHA District Manager or any other MSHA office designated by the District Manager, so that MSHA enforcement will be apprised of exposures above the PEL and can take appropriate actions. As discussed above in *Section VIII.A. General Issues,* failure to abate miners' exposures above the PEL could merit a withdrawal order under section 104(b) of the Mine Act.

In conclusion, MSHA has determined, as presented in the standalone FRA document accompanying this final rule, that: (1) under previous respirable crystalline silica or quartz standards, miners were exposed to respirable crystalline silica at concentrations that result in a risk of material impairment of health or functional capacity and (2) lowering the PEL to 50 μg/m³ will substantially reduce this risk. According to the CDC, between 1999 and 2014, miners died from silicosis, COPD, lung cancer, and NMRD at substantially higher rates than did members of the general population; for silicosis, the proportionate mortality ratio for miners was 21 times as high.[67] Evidence in the standalone Health Effects document demonstrates that exposure to respirable crystalline silica at levels permitted under previous standards contributes to this excess mortality. Based on the evidence and data evaluated during the rulemaking process, MSHA has determined that a PEL of 50 μg/m³ is appropriate and is technologically and economically feasible for all mines. Mine operators will be able to maintain miner exposures at or below the PEL of 50 μg/m³ through some combination of properly maintaining existing engineering controls, implementing new engineering controls (*e.g.,* ventilation systems, dust suppression devices, and enclosed cabs or control booths with filtered breathing air), and requiring changes to work practices through administrative controls. MSHA determined not to set the PEL at 25 μg/m³. MSHA's enforcement experience shows that for mining occupations exposed to the highest levels of respirable crystalline silica, in both MNM mines and coal mines, a PEL of 25 μg/m³ is not generally achievable. For example, MSHA reviewed exposures of designated occupations in underground coal mines and crusher and equipment operators in MNM mines, and determined that on average, miner exposures exceed 25 μg/m³ when all feasible engineering controls are used. While MSHA estimated that there would be a greater reduction of morbidity and mortality cases as a result of lowering the PEL to 25 μg/m³, the Agency estimates that compliance costs of Regulatory Alternative 2 establishing a PEL of 25 μg/m³ would outweigh the benefits, resulting in negative net benefits. A PEL of 25 μg/m³ may not be achievable for all mines. MSHA did not choose this regulatory alternative.

b. PEL in Coal Mines

In the case of coal mines, the final rule establishes a PEL for respirable crystalline silica independent from the respirable coal mine dust (RCMD) standard. The 2014 RCMD Standard does not directly limit coal miners' exposure to respirable crystalline silica; under the existing coal mine respirable dust standard, MSHA cannot issue a separate citation for silica or quartz.

Separating the respirable crystalline silica PEL from the respirable coal mine dust standard allows for coal miners' exposure to respirable crystalline silica to be controlled directly, rather than only indirectly through the respirable

[66] NIOSH conducted a literature review of studies containing environmental data on the harmful effects of exposure to respirable crystalline silica. Based on these studies, and especially fifty years' worth of studies on Vermont granite workers during which time dust controls improved, exposures fell, and silicosis diagnoses neared zero, NIOSH recommended an exposure limit of 50 μg/m³ for all industries. OSHA's examination of health effects evidence and its risk assessment led to the conclusion that occupational exposure to respirable crystalline silica at the previous PELs, which were approximately equivalent to 100 μg/m³ for general industry and 250 μg/m³ for construction and maritime industries, resulted in a significant risk of material health impairment to exposed workers, and that compliance with the revised PEL would substantially reduce that risk. (81 FR at 16755). OSHA considered the level of risk remaining at the revised PEL to be significant but determined that a PEL of 50 μg/m³ is appropriate because it is the lowest level feasible.

[67] Data on occupational mortality by industry and occupation can be accessed by visiting the CDC website at *https://www.cdc.gov/niosh/topics/noms/default.html* (last accessed Jan. 10, 2024). The NOMS database provides detailed mortality data for the 11-year period from 1999, 2003 to 2004, and 2007 to 2014.

coal mine dust standard. This will ensure greater health protection for coal miners.

MSHA solicited comments on whether to eliminate the reduced standard for total respirable dust when quartz is present at coal mines and received feedback from stakeholders generally agreeing with the Agency's proposal to establish a standard for respirable crystalline silica that is independent from the respirable coal mine dust standard, including other mine industry organizations, a labor union, mining trade associations, and Black Lung Clinics (Document ID 1378; 1398; 1406; 1428; 1410). The ACLC expressed support for a standalone and separately enforceable PEL, but recommended maintaining a reduced standard for respirable dust when silica is present in coal mines, which would ensure that standalone effects of silica and coal dust are accounted for and allow for better monitoring overall (Document ID 1445). The NMA, the MCPA, and the Pennsylvania Coal Alliance supported the removal of the respirable dust standards when quartz is present (*i.e.,* §§ 70.101 and 71.101, and 90.101), reasoning that they are no longer needed since the rule proposes a standalone standard for respirable crystalline silica (Document ID 1428; 1406; 1378).

MSHA has concluded that establishing an independent and lower PEL for respirable crystalline silica for coal mines allows more effective control of respirable crystalline silica than the existing reduced standards because the separate standard is less complicated and more protective. MSHA believes that the adoption of a separate improved standard that carries risk of a citation and monetary penalty when overexposures of the respirable crystalline silica PEL occur is thus more protective than the indirect method under the existing reduced standards. MSHA clarifies that mine operators will continue to sample for respirable coal mine dust under existing §§ 70.100, 71.100, and 90.100. MSHA agrees with the commenters supporting the removal of §§ 70.101, 71.101, and 90.101. With the PEL and action level (both calculated as a full-shift 8-hour TWA), sampling, recordkeeping, and reporting requirements in this final rule, MSHA does not believe that retaining the reduced standard is necessary. MSHA believes that the implementation of the separate silica standard will ensure that operators are correctly evaluating and implementing controls to protect miners from respirable crystalline silica. Further, MSHA will continue its sampling. Under the final rule, MSHA is removing these sections in their entirety since they are no longer needed. See *Section VIII.C. Conforming Amendments* for additional details.

c. Full Shift, 8-Hour TWA

Under the final rule, the PEL and the action level apply to a miner's full-shift exposure, calculated as an 8-hour TWA. This limit means that over the course of any work shift, exposures can fluctuate but the average exposure to respirable crystalline silica cannot exceed 50 μg/m³ for the PEL and 25 μg/m³ for the action level. Under this final rule, a miner's work shift exposure is calculated as follows:

$$\frac{\text{Total mass of respirable crystalline silica } (\mu g) \text{ collected over a full shift}}{\text{Air flow rate (liters per minute) x 480 min x 0.001 } m^3/L}$$

Regardless of a miner's actual working hours (full shift), 480 minutes is used in the denominator. This means that the respirable crystalline silica collected over an extended period (*e.g.,* a 12-hour shift) is calculated (or normalized) as if it were collected over 8 hours (480 minutes). For example, if a miner was sampled for 12 hours and 55 μg of respirable crystalline silica was collected in the sample over that 12-hour period, the miner's respirable crystalline silica 8-hour TWA exposure would be 67 μg/m³, calculated as follows:

$$\frac{55\ (\mu g)}{1.7 \text{ (liters per minute) x 480 min x 0.001 } m^3/L}$$

This calculation method (*i.e.,* full shift, 8-hour TWA) is the one that MSHA uses to calculate exposures of MNM miners to respirable crystalline silica and other airborne contaminants under the existing standards (30 CFR 56.5001, 57.5001); it differs from the existing method of calculating a coal miner's exposure to respirable coal mine dust (30 CFR 70.101, 71.101, and 90.101). For coal miners, the existing calculation method uses the entire duration of a miner's work shift in both the numerator and denominator, resulting in the total mass of respirable coal mine dust collected over an entire work shift scaled by the sample's air volume over the same period. This is referred to as ''full shift TWA'' hereafter.

MSHA received comments both in agreement with the proposed calculation method and against it. Some commenters, including the AFL–CIO and USW, stated that they support the proposed calculation method of full-shift monitoring and calculating exposures over an 8-hour period (*i.e.,* using 480 minutes in the denominator) to actively capture the total cumulative exposure to silica dust (Document ID 1449; 1447). The American Thoracic Society *et al.* stated that working longer shifts means miners have longer exposure periods, which increases the cumulative burden of exposure and reduces the rest time miners have for recuperating and clearing their lungs (Document ID 1421). In contrast, other commenters, including other mine industry organizations, mining trade associations, state mining associations, and MNM operators preferred the use of the full shift time period in the calculation method denominator (*i.e.,* using the entire duration of the miner's extended work shift in the denominator), stating that normalizing the extended shift sampling result to an 8-hour period (*i.e.,* using 480 minutes in the denominator) inaccurately skews the results (Document ID 1378; 1424; 1428; 1441; 1443; 1432). These commenters stated that the proposed method improperly inflates the sampling results and actually makes the standard more stringent by effectively lowering the PEL for longer shifts. Some of these commenters, including MSHA Safety Services Inc. and NVMA, further stated that MSHA's statement in the proposal that the Agency uses NIOSH's recommendation is misleading because the NIOSH recommendation is, according to the commenters, for a 10-hour workday during a 40-hour workweek (Document ID 1392; 1441).

Under the final rule, the PEL and action level applies to a miner's full-shift exposure, calculated as an 8-hour TWA. MSHA agrees with commenters who stated that the full shift, 8-hour TWA captures cumulative exposure to silica dust accurately. The goal of the respirable crystalline silica final rule is to prevent miners at all times from suffering a body burden high enough to cause adverse health effects.

''Body burden'' refers to the total amount of a substance that has accumulated in the body at any given time (ATSDR, 2009). This reflects the interplay between cumulative exposure, pulmonary deposition, and lung clearance, in the case of respirable crystalline silica.[68] [69] As discussed in the standalone FRA document, cumulative exposure to respirable crystalline silica is well established as an important risk factor in the development of silica-related disease.

MSHA has determined that it is important to specify that exposures be normalized to 8-hour TWAs.[70] This is because working longer hours can lead to the inhalation of more respirable crystalline silica into the lungs, and the PEL and action level must take this into account. For example, working 12 hours leads to 50% more silica entering the lung compared with working 8 hours, assuming other factors are equal (*e.g.,* concentration of respirable crystalline silica and breathing parameters). By normalizing daily exposures to 8-hour workdays, the final rule provides miners working longer shifts a level of protection against cumulative inhaled doses that is reasonably equivalent to the protection provided to miners working shorter shifts. This is a relevant issue because MSHA has observed that miners commonly work extended shifts, with many working 10-hour or longer shifts.[71] [72] MSHA's calculation method (like the existing MNM calculation method) normalizes to an 8-hour TWA. If a miner works an extended shift of 12 hours and a sample of 55 μg of respirable crystalline silica is collected, the full shift 8-hour TWA calculation for that sample is 67 μg/m³. This result treats the full cumulative exposure occurring over the entire shift in the same way as if it occurred over 8 hours. The full shift TWA (the existing calculation method for coal miners) would yield a calculated exposure of 45 μg/m³, based on the entire duration of the miner's work shift. The full shift 8-hour TWA calculation provides more protection for miners than the full shift TWA calculation that makes no adjustment for extended shifts.

Because the full shift, 8-hour TWA calculation takes this additional factor into account, sampling using this calculation method likely results in more sampling results that show overexposures, which leads to exposure monitoring, corrective actions, and/or respiratory protection for miners that may not have otherwise been provided using the full shift TWA calculation. The concept of adjusting occupational exposure limits for ''extended shifts'' has been addressed by researchers (Brief and Scala, 1986; Elias and Reineke, 2013). Their research is based on the industrial hygiene concept that longer workdays lead to more time for the workplace chemical to accumulate in the body and less time for it to be eliminated. To account for this, the research establishes models that adjust (*i.e.,* lower) the exposure limits using formulas that factor in the longer workdays and the corresponding shorter recovery periods.

This final rule establishes a lower PEL and applies it to all miners using a consistent method for calculating exposures. These changes improve the health and safety of miners while making compliance more straightforward and transparent. NIOSH has also supported the use of the TWA and has discussed this term since the publication of the NIOSH Pocket Guide to Chemical Hazards (First Edition, 1978) (the ''White Book'').

MSHA's PEL for a miner's full-shift exposure calculated as an 8-hour TWA differs from OSHA standards for extended work shifts. In the OSHA standards, sampling for extended work shifts is conducted using the worst (*i.e.,* highest-exposure) 8 hours of a shift or collecting multiple samples over the entire work shift and using the highest samples to calculate an 8-hour TWA. 81 FR 16286, 16765. This differs from MSHA's calculation method because, under MSHA's standards, miners are sampled for the duration of their work shift and the total respirable crystalline silica collected over the entire duration of that extended work shift, not the worst 8 hours only, is used in the calculation.

The NMA and AEMA disagreed with how MSHA calculates the full shift 8-hour TWA and stated that if MSHA does not use the entire duration worked, the Agency should instead use OSHA's method of sampling for the worst 8-hour

[68] The pulmonary uptake and clearance of airborne mine dust are dependent upon many factors, including a miner's breathing patterns, exposure duration, concentration (dose), particle size, and durability or bio-persistence of the particle. These factors also affect the time it takes to clear particles, even after exposure ceases.

[69] Respirable crystalline silica is cleared slowly from the body and remains in the lungs longer than most other, more soluble minerals and organic particulates in mine air. Pairon *et al.* (1994) counted respirable crystalline silica particles in the bronchoalveolar fluid of individuals occupationally exposed to silica-bearing respirable dust and confirmed that respirable crystalline silica was one of the most persistent (*i.e.,* most slowly eliminated) mineral particles in the lung. The slow clearance of silica particles explains the accumulation (build-up) of particles in the human lung that can occur with repeated exposures to airborne silica as well as its detection in lung tissue years after exposure stops (Dobreva *et al.,* 1975; Case *et al.,* 1995; Loosereewanich *et al.,* 1995; Dufresne *et al.,* 1998; Borm and Tran, 2002).

[70] The ACGIH (2022) acknowledges the issue of extended work shifts for airborne contaminants, including respirable crystalline silica, stating, ''numerous mathematical models to adjust for unusual work schedules have been described. In terms of toxicologic principles, their general objective is to identify a dose that ensures that the daily peak body burden or weekly peak body burden does not exceed that which occurs during a normal 8-hour/day, 5-day/week shift.'' There are associated concerns with the body burden from an ''unusual work schedule'' such as a 10- or a 12-hour shift. As Elias and Reineke (2013) stated, ''if the length of the workday is increased, there is more time for the chemical to accumulate, and less time for it to be eliminated. It is assumed that the time away from work will be contamination free. The aim is to keep the chemical concentrations in the target organs from exceeding the levels determined by the TLVs® (8-hour day, 5-day week) regardless of the shift length. Ideally, the concentration of material remaining in the body should be zero at the start of the next day's work.''

[71] Sampling hours of coal mine dust samples approximate the working hours of coal miners who were sampled. According to the coal mine dust samples for a 5-year period (August 2016–July 2021), 90 percent of the samples by MSHA inspectors were from miners working 8 hours or longer and about 43 percent of the samples from miners working 10 hours or longer. The dust samples by coal mine operators show that over 98 percent of them were from miners working 8 hours or longer and over 26 percent from the miners working 10 hours or longer. Of the MNM dust samples by MSHA inspectors for a 15-year period (January 2005–December 2019), approximately 78 percent were from miners working longer than 8 hours. These dust samples are available at Mine Data Retrieval System | Mine Safety and Health Administration (MSHA), *https://www.msha.gov/data-and-reports/mine-data-retrieval-system* (last accessed Jan. 10, 2024).

[72] Unlike workers in many other sectors, miners not only work longer shifts but also typically work much longer than 40 hours per week. According to BLS data, between 2017 and 2022, the average number of weekly working hours for all miners ranged from 45.1 to 46.7. (Bureau of Labor Statistics, *Average weekly hours of production and nonsupervisory employees, mining (except oil and gas), not seasonally adjusted,* Series ID CEU1021200007, data for 2017–2022, retrieved March 9, 2024.) From a body burden standpoint, this means that longer working shifts for miners are likely also associated with a greater number of cumulative hours of exposure. That suggests that it is not the case that miners are working four 10-hour shifts instead of five 8-hour shifts, giving them shorter recovery time between some shifts but then a longer recovery time (*e.g.,* 3 days off continuously). Instead, many miners are likely working more long shifts—*e.g.,* five 10-hour shifts in a week, given the average of more than 45 hours for *all* miners—leaving their lungs very little recovery time after silica exposure.

time period for extended work shifts (Document ID 1428; 1424).

MSHA has not included the commenter's suggestion in the final rule. MSHA's requirement in the final rule to sample miners for the entire duration of their work shift will provide an accurate representation of their exposures. Calculating the full shift 8-hour TWA will better protect the health of miners who work extended shifts because it considers the heightened risks posed by increased cumulative exposure and shorter recovery time. The final rule full shift 8-hour TWA calculation is consistent with MSHA's longstanding MNM calculation method, which is based on the guidance provided by the ACGIH in 1973 (TLVs® Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973). This calculation method is supported by NIOSH and continues to be supported in the current guidance provided by the ACGIH.

d. Error Factor

Some commenters, including NSSGA and SSC, expressed concerns about whether silica can be accurately and consistently measured at the action level and PEL (Document ID 1448; 1432). The AIHA suggested that statistics of sampling and sample analysis should be considered to identify upper and lower confidence limits (Document ID 1351). Several commenters, including NMA and West Virginia Coal Association (WVCA), recommended that the PEL and action level should have a margin of error, or error factor, to account for sampling and analysis errors (Document ID 1428; 1443). WVCA recommended that, as in the 2014 RCMD Standard, MSHA should apply an error factor to the PEL to normalize results to account for errors in sampling and weighing that cause deviations in individual concentration measurements (Document ID1443). The NMA cited sources to assist with determining the error factor (Document ID 1428).

In *Section VII.A. Technological Feasibility,* MSHA determined that current methods to sample respirable dust and analyze samples for respirable crystalline silica by XRD and IR methods are capable of reliably measuring silica concentrations in the range of the final rule's PEL and action level. This finding is based on the following considerations: (1) there are many sampling devices available that conform to the ISO specification for particle-size selective samplers with an acceptable level of measurement bias, and (2) both the XRD and IR methods can measure respirable crystalline silica with acceptable precision at amounts that would be collected by samplers when airborne concentrations are at or around the PEL and action level. Thus, MSHA finds that the sampling and analysis requirements under the final rule are technologically feasible.

MSHA is confident that current sampling and analytical methods for respirable crystalline silica provide accurate estimates of measured exposures. Because there are multiple sampling methods that comply with the ISO 7708:1995 standard and variations in laboratory analysis methods, this final rule does not include a specific error factor. Mine operators can rely on sampling results from ISO-accredited laboratories to meet the sampling requirements of § 60.12(f) to determine their compliance with the PEL and action level under the final rule. Miners should be confident that those exposure results provide them with reasonable estimates of their exposures to respirable crystalline silica.

4. Section 60.11—Methods of Compliance

The final rule identifies the methods for compliance in § 60.11. Section 60.11 paragraph (a), unchanged from the proposal, requires mine operators to install, use, and maintain feasible engineering controls, supplemented by administrative controls when necessary, to keep each miner's exposure to respirable crystalline silica at or below the PEL. Paragraph (b), unchanged from the proposal, states that rotation of miners shall not be considered an acceptable administrative control used for compliance with the PEL. Below is a detailed discussion of the comments received on this section and modifications made in response to the comments.

a. 60.11(a)—Engineering and Administrative Controls

Paragraph (a) requires mine operators to use feasible engineering controls as the primary means of controlling respirable crystalline silica; administrative controls can be used, when necessary, as supplementary controls.

Examples of engineering controls include, but are not limited to, ventilation systems, dust suppression devices, enclosed cabs or control booths with filtered breathing air, and changes in materials handling or equipment used. Engineering controls generally suppress (*e.g.,* using water sprays, wetting agents, foams, water infusion), dilute (*e.g.,* ventilation), divert (*e.g.,* water sprays, passive barriers, ventilation), or capture dust (*e.g.,* dust collectors) to minimize the exposure of miners working in the surrounding areas. The use of automated ore-processing equipment and remote monitoring can also help to reduce or eliminate miners' exposures to respirable crystalline silica.

Examples of administrative controls include, but are not limited to, work practices that change the way tasks are performed to reduce a miner's exposure. These practices could include work process training; housekeeping procedures; proper work positions of miners; cleaning of spills; and measures to prevent or minimize contamination of clothing to help decrease miners' exposure to respirable crystalline silica.

MSHA requested comments on the proposed requirement that mine operators install, use, and maintain feasible engineering and administrative controls to keep miners' exposures to respirable crystalline silica at or below the proposed PEL. The Agency received comments both supporting and opposing the proposal.

Several commenters, including an industrial hygiene professional association, a labor union, and black lung clinics, expressed support for the use of feasible engineering controls and administrative controls to keep miners' exposures to respirable crystalline silica below the proposed PEL (Document ID 1351; 1398; 1410; 1353). AFL–CIO, UMWA, and NMA stated that mine operators should already be utilizing feasible engineering and administrative controls to comply with law and with their existing ventilation plans (Document ID 1449; 1398; 1428). Black Lung Clinics urged MSHA to require that mine operators rely primarily on engineering controls to limit dust exposure, with administrative controls serving as supplemental measures (Document ID 1410).

Other commenters identified limitations with engineering controls. NSSGA, US Silica, and a presenter at one of the hearings provided the following examples where engineering controls will not suffice due to the nature of the work: non-routine maintenance tasks; periodic maintenance tasks; tasks of limited duration; and seasonal tasks (Document ID 1448; 1455; 1353). US Silica also stated that MSHA must offer more flexible options for control methods and give more consideration to the challenges of implementing certain controls at certain mines (Document ID 1455).

After carefully considering the comments, MSHA has concluded that the requirement for installation, use, and maintenance of feasible engineering controls, supplemented by administrative controls, when necessary, will remain unchanged from the proposal. In MSHA's experience, engineering controls are the most effective method of compliance and the most protective means of controlling dust generation at the source.

Engineering controls, which address the generation of dust at its source, minimize respirable crystalline silica exposures of all miners, including those in surrounding work areas, who may not be working at the dust generating source. In contrast to other controls and other interventions, engineering controls can be regularly evaluated and monitored, which increase their effectiveness.

NIOSH has long promoted the use of engineering controls to control miners' exposures to respirable crystalline silica. This final rule aligns with the 1995 NIOSH recommendation that ''the mine operator shall use engineering controls and work practices [administrative controls] to keep worker exposures at or below the REL [recommended exposure limit]'' (NIOSH, 1995, page 5). Specifically, NIOSH recommends the use of engineering controls to keep free silica dust exposures below the REL of 50 μg/m³ (NIOSH, 1974). NIOSH also supported the use of engineering controls as the primary means of protecting miners from exposure to respirable crystalline silica in its public response to MSHA's 2019 RFI (AB36–COMM–36). NIOSH stated that ''[r]espirators should only be used when engineering control systems are not feasible. Engineering control systems, such as adequate ventilation or scrubbing of contaminants, are the preferred control methods for reducing worker exposures.''

Requiring engineering controls as the primary method of compliance is consistent with generally accepted industrial hygiene principles, existing Agency standards, and the Mine Act. *See* 30 U.S.C. 801(e) (explaining that operators have the ''primary responsibility to prevent the existence of [unhealthy] conditions'' in mines); 30 U.S.C. 841(b) (requiring underground coal mine operators to keep work environments sufficiently free from respirable dust); 30 U.S.C. 842(h) (stating primacy of engineering controls for underground coal mines). MSHA's existing MNM standards for airborne contaminants require that mine operators control miners' exposure to airborne contaminants, where feasible, through preventing contamination, using exhaust ventilation to remove contaminants, or diluting with uncontaminated air (30 CFR 56.5005 and 57.5005). The existing MSHA standards for respirable coal mine dust (RCMD) require mine operators to implement engineering controls to maintain compliance. In MSHA's 2014 RCMD Standard, the Agency required operators to use engineering and administrative controls and did not permit the use of respirators, including powered air-purifying respirators (PAPRs), as a method to achieve compliance. Additionally, numerous commenters representing industry, labor, and public health supported the proposal's priority of engineering controls as the primary means of reducing exposure to respirable crystalline silica.

Some commenters provided specific examples when discussing engineering control limitations. The IME stated that MSHA should allow the use of equivalent dust suppression methods, where an alternative exists, and its effectiveness can be demonstrated (Document ID 1404). USW explained that engineering controls must be capable of dealing with all belt speeds for collection and suppression and be protected from freezing in cold weather which can increase their exposure (Document ID 1447). Conspec Controls questioned whether MSHA will explain how to reduce dust particulate during operations and how different systems will be prioritized in instances where an action improves the dust conditions but exacerbates gas readings (Document ID 1324).

After reviewing these comments, the Agency agrees that differences in mine size, job duties, commodity mined, equipment, and environmental conditions across the mining industry necessitate different types of engineering controls. However, in MSHA's experience, the mine operator has the information and experience at their mine to determine which engineering controls are feasible and effective at reducing respirable crystalline silica exposures for their mining conditions. For example, MSHA agrees with commenters that exposed water sprays are not effective in freezing weather; however, the Agency has found that at least one, or more, option is available for every circumstance. For example, enclosing the process equipment or using water sprays are two options for controlling dust. Water sprays suppress dust, and enclosures limit the amount of dust in the equipment operator's breathing zone. Equipment enclosures can be constructed with baffles to slow the airflow inside the enclosure, so dust settles more quickly inside the enclosure. As another option, a ventilation dust collection system can be paired with an equipment enclosure to make both more effective for controlling dust. MSHA intends to work with stakeholders, mine operators, and the mining community to develop compliance assistance materials and share best practices on engineering controls during and after the implementation of the final rule.

MSHA received several comments on the use of administrative controls. AIHA emphasized that administrative controls, when used to supplement engineering controls, can further reduce exposures, and maintain them at or below the PEL (Document ID 1351). Several commenters, including mining trade associations, state mining associations, and MNM operators, stated that OSHA's 2016 silica rule treats engineering and administrative controls as equally effective in reducing silica dust exposures and urged MSHA to consider broader use of administrative controls and personal protective equipment to achieve compliance (Document ID 1428; 1424; 1432; 1455; 1441; 1443).

MSHA has reviewed the comments and concludes that administrative controls are effective in protecting miners from respirable crystalline silica exposures when they are used as a supplement to engineering controls. For example, NIOSH has co-developed a clothes cleaning system that can clean dusty work clothes throughout the workday. This is an example of an administrative control that is a safe and effective method to remove silica dust from a miner's clothing, reducing exposures to respirable crystalline silica. In the final rule, administrative controls are secondary to engineering controls because administrative controls require significant oversight by mine operators to ensure miners understand and follow the prescribed work processes. If not properly implemented, understood, or followed, administrative controls may not be effective in preventing miners' overexposure to respirable crystalline silica.

MSHA clarifies that administrative controls, except for rotation of miners, can be used as a method of compliance if engineering controls are not feasible. However, as MSHA discussed in the RFI and in its previous 2014 RCMD Standard, engineering controls remain the primary means to control all forms of respirable dust, including respirable crystalline silica, in the mine atmosphere (84 FR 45454; 65 FR 4214; 68 FR 10798–10799, 10818).

For these reasons, final paragraph § 60.11(a) is the same as the proposal.

b. 60.11(b)—Rotation of Miners

Paragraph (b) prohibits mine operators from using miner rotation as an administrative control.

As noted above, prioritizing engineering controls is consistent with accepted industrial hygiene principles, MSHA's existing standards, and the Mine Act. In particular, the prohibition against rotation of miners to achieve compliance with the PEL is consistent with MSHA's June 6, 2005, diesel particulate matter (DPM) final rule (70 FR 32867) and its 2014 Coal Dust Rule (79 FR 24813). Under the existing standards in the 2014 Coal Dust Rule, MSHA does not permit rotation of miners to reduce exposures to coal mine dust if feasible engineering controls are in use (79 FR 24909). In the DPM final rule, MSHA prohibited rotation of miners to reduce miners' exposure to diesel particulate matter, an airborne contaminant that is also a carcinogen. 71 FR 28926; 30 CFR 57.5060(e).

MSHA received several comments on the feasibility of prohibiting miner rotation. AISI and SSC requested that MSHA permit the use of rotation of miners when engineering controls are not feasible (Document ID 1426; 1432). Some commenters, including Portland Cement Association, NSSGA, Pennsylvania Coal Alliance, Pennsylvania Aggregates & Concrete (PACA), BMC, CISC, and Tata Chemicals Soda Ash Partners, LLC, added that, because miner rotation historically has been used to lower miners' exposures, it should continue to be a part of the hierarchy of controls (Document ID 1407; 1448; 1378; 1413; 1417; 1430; 1452; 1364). BIA stated that, in their operations, which are already understaffed, worker rotation is necessary to ensure miners are not exposed to levels above the PEL, particularly if MSHA also discontinues the use of respirators as a method of control (Document ID 1422). Other commenters, including MSHA Safety Services, Inc., and BIA, stated that some mine operators will be substantially impacted by prohibiting miner rotation (Document ID 1392; 1422), while a few commenters, including NSSGA and IAAP stated that worker rotation is sometimes the only feasible control to limit overexposure, such as when miners perform periodic or non-routine tasks that do not allow for engineering controls (Document ID 1448; 1456).

UMWA, AFL–CIO, and Black Lung Clinics stated that worker rotation could be acceptable to minimize musculoskeletal stress, but not for work involving respirable dust or carcinogens, since the practice would expose more miners to the hazards (Document ID 1398; 1449; 1410). Black Lung Clinics further stated that, because the risk of silica-related disease appears to be continuous, rather than associated with a threshold exposure, worker rotation does not reduce the risk of disease (Document ID 1410).

However, some commenters disagreed. NVMA stated that miner rotation is standard practice when dealing with non-carcinogens and since there is not enough data on whether silica exposure alone, as opposed to in combination with tobacco use, is the carcinogen causing respiratory issues, worker rotation should not be prohibited (Document ID 1441). NSSGA provided literature expressing a well-established threshold for silicosis and lung cancer and stated that the use of miner rotation to reach that limit of exposure should be allowed (Document ID 1448).

After considering the comments, the final rule prohibits rotation of miners. MSHA does not consider it to be an effective control because it does not address the root cause of the hazard, requires continuous attention and actions on the part of miners and management, and increases risks to additional miners. MSHA considers that worker rotation, which may be an appropriate control to minimize musculoskeletal stress or heat stress, is not an acceptable control for silica, which is classified as a Group 1 human carcinogen (IARC, 1997). For example, MSHA's existing standards for diesel particulate matter prohibit rotation of miners as an acceptable administrative control because diesel particulate matter is a probable human carcinogen. 30 CFR 57.5060. MSHA's risk assessment for the diesel particulate matter rule noted the majority of scientific data for regulating exposures to carcinogens supports that job rotation is an unacceptable method for controlling exposure to both known and probable human carcinogens because it increases the number of persons exposed. The Agency concludes that the rotation of miners would increase the number of miners exposed to the hazard of respirable crystalline silica.

MSHA considered these comments in light of the Agency's longstanding prohibition against rotation of miners as a means of compliance for exposures to carcinogens. Commenters did not provide specific data in support of their position that mine operators will be substantially impacted by the prohibition of miner rotation for reducing silica exposure. The intent of this final rule is to provide health protection to as many miners as possible from the adverse health effects of respirable crystalline silica exposure. The Agency has found that a combination of engineering and administrative controls can reduce miner exposures to levels at or below the PEL and is feasible for mine operators.

MSHA also received comments requesting clarification on the implementation of the prohibition of rotation of miners under the final rule. NLA and NSSGA stated that MSHA has not adequately explained the proposed prohibition of miner rotation, which creates confusion as to whether worker rotation can be used for other purposes and how the provision will be enforced (Document ID 1408; 1448). NSSGA further stated that, if MSHA does not remove the prohibition in the final rule, it should at a minimum, confirm that it will not prohibit miner rotation for purposes other than compliance with the PEL, or rotating employees to maintain exposure below the action level (Document ID 1448). Similarly, some commenters, including NLA, AEMA, NMA, and NSSGA suggested that MSHA should clarify that miner rotation can still occur for legitimate reasons, including avoidance of heat stress or musculoskeletal stress (Document ID 1408; 1424; 1428; 1448). SSC asked MSHA to explain whether an operator who rotates workers to comply with part 62 will be cited if part 60 prohibits the rotation of that miner (Document ID 1432).

MSHA clarifies that this provision is not a general prohibition of worker rotation wherever workers are exposed to respirable crystalline silica and is intended only to prohibit its use as a compliance method for the PEL. It is not intended to bar the use of miner rotation as deemed appropriate by the mine operator in activities such as cross-training or to allow workers to alternate physically demanding tasks with less strenuous activities.

MSHA received comments on the proposed rule's alignment with industry standards. MSHA Safety Services, Inc. stated that the rotation of miners is accepted by everyone except MSHA (Document ID 1392). California Construction and Industrial Materials Association (CalCIMA) stated that miner rotation is recommended by NIOSH, and under the OSHA respirable crystalline standard, the rotation of employees as an administrative control is not prohibited (Document ID 1433). A couple commenters, including NSSGA, an individual, and Vanderbilt Minerals, LLC, stated that MSHA had mischaracterized the NIOSH recommendations on worker rotation since, according to the commenters, it selectively used only parts of the language in the NIOSH Chemical Carcinogen Policy document to justify its position on worker rotation (Document ID 1448; 1367; 1419). Because of this alleged mischaracterization, an individual warned that MSHA's prohibition against miner rotation is ripe for litigation, not because MSHA chose to ban the practice, but because MSHA has not sufficiently explained their basis for doing so (Document ID 1367). MSHA acknowledges that the Agency may have mischaracterized NIOSH's position on worker rotation since its Chemical Carcinogen Policy is silent on the issue of worker rotation. In this final rule, MSHA clarifies its reference to the NIOSH policy.

Respirable crystalline silica has long been recognized as a carcinogen (IARC, 1997). The Agency considers it more protective of miner safety and health to limit the number of miners exposed to respirable crystalline silica. MSHA does not consider rotation of miners to be an effective control because it does not address the source of the hazard. NIOSH's publication entitled ''Current Intelligence Bulletin 68: NIOSH Chemical Carcinogen Policy,'' recommends that occupational exposures to carcinogens should be reduced as much as possible through the hierarchy of controls, most importantly, the elimination or substitution of other chemicals that are known to be less hazardous and engineering controls (NIOSH, 2017b). According to Stewart (2011), ''rotation of workers may reduce overall average exposure for the workday but it provides periods of high short-term exposure for a larger number of workers. As more becomes known about toxicants and their modes of action, short-term peak exposures may represent a greater risk than would be calculated based on their contribution to average exposure.'' Miner rotation is not allowed in assessing coal miners' exposure to respirable coal mine dust; coal operators must sample occupations or areas, not individual miners, to ensure that the environment is controlled. The Agency has determined it more protective of miner safety and health to limit the number of miners exposed to respirable crystalline silica and require engineering controls, supplemented by administrative controls, excluding rotation of miners.

For these reasons, final paragraph § 60.11(b) is the same as the proposal.

c. Feasible Engineering Controls

MSHA received comments regarding the definition of the term ''feasible'' and the use of feasible engineering controls. NVMA requested that MSHA supply a definition for what is ''feasible'' (Document ID 1441). Arizona Mining Association stated that the cost-benefit analysis of the proposed standard is flawed and that many mines will face more financial hardship and require far longer implementation times than MSHA has anticipated (Document ID 1368). NMA stated that engineering controls are not always economically feasible, particularly for small businesses (Document ID 1428).

MSHA clarifies that the courts have interpreted the term ''feasible'' as meaning '' 'capable of being done, executed, or effected,' both technologically and economically.'' *See Kennecott Greens Creek Min. Co.* v. *Mine Safety & Health Admin,* 476 F.3d 946, 957 (D.C. Cir. 2007) (quoting *Am. Textile Mfrs. Inst.* v. *Donovan,* 452 U.S. 490, 508–09 (1981)). Further, ''MSHA does not need to show that every technology can be used in every mine. The agency must only demonstrate a 'reasonable possibility' that a 'typical firm' can meet the permissible exposure limits in 'most of its operations.' '' *Id.* at 958 (quoting *Am. Iron & Steel Inst.* v. *Occupational Safety & Health Admin.,* 939 F.2d 975, 980 (D.C. Cir. 1991)).

Based on MSHA's experience and enforcement and sampling data, consideration of the OSHA silica rule, and documentation from NIOSH as discussed in *Section VII.A. Technological Feasibility,* MSHA has determined that feasible engineering controls exist for mining operations to reduce miners' exposures so that they would not exceed the PEL. The Agency has found that feasible engineering controls: (1) control crystalline silica-containing dust particles at the source; (2) provide reliable, predictable, and consistent protection to all miners who would otherwise be exposed to dust from that source; and (3) can be monitored. Additionally, MSHA believes this rule is feasible because a review of the Agency's available silica sampling data showed that many mines are already in compliance with the PEL in § 60.10. Further explanation and discussion of the economic feasibility can be found in the standalone FRIA document and in the preamble in *Section IX. Summary of Final Regulatory Impact Analysis and Regulatory Alternatives.*

d. Hierarchy of Controls and Respiratory Protection

MSHA received comments about how the proposed rule related to the hierarchy of controls. Several commenters, including NMA, SSC, US Silica, AEMA, WVCA, and American Road and Transportation Builders Association, stated MSHA should allow mine operators to effectively utilize the hierarchy of controls to comply with the proposed silica standard (Document ID 1428; 1432; 1455; 1424; 1443; 1353). These commenters defined the most effective controls according to the hierarchy as: elimination, substitution, engineering, administrative, and personal protective equipment (*i.e.,* respirators). Arizona Mining Association stated that the hierarchy of controls is recognized world-wide, including by OSHA, and provides flexibility to allow mine operators to make decisions for maintaining safe production (Document ID 1368).

Other commenters stated that respirators should be permitted to be used as a method of compliance. WVCA stated that the differences between mining environments across the industry mean that while engineering controls may be the most effective controls in some mines, other controls, like respirators, might protect miners more effectively in others (Document ID 1443). US Silica asked MSHA to treat respirators as engineering controls (Document ID 1455). IME stated that although engineering controls are preferred, it does not make sense to require the use of engineering and work practice controls the operator believes or knows would be inadequate to meet the PEL, knowing that respirators may be more effective for a given task (Document ID 1404). Some commenters, including the Arizona Mining Association, NVMA, and US Silica, stated that the OSHA standard recognizes the priority of engineering controls but allows respiratory protection programs as substitutes when engineering controls are not feasible (Document ID 1368; 1441; 1455; 1353; 1424; 1428).

Some commenters provided specific situations or conditions in which they believe respirators should be used as a method of compliance. NSSGA suggested that to prevent mine operators from relying on respirators for compliance, MSHA could require operators to outline their process for determining when respirators will be used in their respiratory protection plans (Document ID 1448). A few commenters, including SSC, WVCA, Vanderbilt Minerals, LLC, and IME, asked MSHA to allow for NIOSH-approved respirators as a recognized control, and not just for instances of unexpected exposures where respirator use may be temporary (Document ID 1432; 1443; 1419; 1404). The AEMA and NMA suggested adding language as reflected in OSHA's lead standard (Document ID 1424; 1428). US Silica stated that MSHA is inconsistently recognizing when the use of personal protective equipment for compliance purposes may occur since MSHA's occupational noise exposure health standards in 30 CFR part 62 allow it, while the proposed rule does not (Document ID 1455).

MSHA also received comments that supported this provision of the proposed rule, stating that respirators are an ineffective method of compliance. Black Lung Clinics discussed the limitations of respirators, stating that facial hair can interfere with the use of respirators, respirators do not provide real-time feedback on their effectiveness, miners' communication abilities may be impeded, and there is uncertainty about whether respirators are actually effective in the working environment in coal mines (Document ID 1410). USW stated that respiratory protection must never be defined as an engineering control because its effectiveness depends on too many variables (Document ID 1447). BlueGreen Alliance also supported the prohibition on respirators as a method of compliance and suggested that MSHA should strengthen the penalties for noncompliance (Document ID 1438).

MSHA understands that employers across many industries follow the NIOSH Hierarchy of Controls in structuring and applying their industrial hygiene programs and practices. This reflects a generally accepted industrial hygiene principle that recommends the use of engineering and administrative controls to implement effective control solutions, in the following order (1) elimination; (2) engineering controls; (3) administrative controls; and finally, (4) personal protective equipment. MSHA recognizes that while elimination of all respirable crystalline silica from a mine environment would be the most effective means of risk reduction, it is generally not feasible. Under the final rule, mine operators are required to use engineering or environmental controls as the primary means of maintaining compliance. MSHA acknowledges that administrative controls may be necessary to further lower exposure levels and encourages mine operators to use such controls (with the exclusion of miner rotation).

MSHA does not agree that respirators are an engineering control. Engineering controls provide consistent and reliable protection to miners; these controls work independently and verifiably. Engineering controls do not depend on individual performance, supervision, or intervention, to function as intended, and they can be continually evaluated and monitored relatively easily. Unlike PAPRs or supplied-air helmets, engineering controls operate at the hazard generation source, providing protection against both primary (miners directly involved in the task or immediate area) and secondary (miners not directly in the task or working in surrounding areas) exposures to the hazard.

MSHA's enforcement and compliance assistance experience substantiate that respirators are not as reliable as engineering controls in reducing miners' exposure to toxic substances such as respirable crystalline silica. Respirator effectiveness depends on a number of factors, including a properly developed and fully implemented respiratory protection program; individual performance in donning, wearing, and doffing the respirator; and proper supervision to ensure that the protection factor is fully achieved.

In response to comments regarding the use of respirators, MSHA amended the final rule, paragraph 60.14(a), to require MNM operators to provide respiratory protection for temporary use when miners' exposures are above the PEL. For MNM operators, temporary use of respirators is required while engineering control measures are being developed and implemented, which includes taking corrective actions to ensure miner exposures are at or below the PEL. Under the final rule, MNM mine operators are also required to use respirators, on a temporary basis, when exposures are above the PEL, and it is necessary by the nature of work involved (for example, occasional entry into hazardous atmospheres to perform maintenance or investigation). The Agency believes this will provide MNM miners additional protection during these specific circumstances. However, respiratory use under this provision does not constitute compliance with the PEL; all exposures above the PEL violate the standard. Further discussion on respiratory use in the final rule is located in *Section 60.14—Respiratory protection*.

e. Consensus Standards and Other Guidance

MSHA received one comment from ISEEE suggesting that the Agency incorporate by reference ISO 23875, Cab Air Quality Standard, to assist mine operators with compliance for installing and using filtration systems to maintain exposures at or below the PEL in operator cabs (Document ID 1377). ISO 23875 is an international standard that unifies the design, testing, operation, and maintenance of air quality control systems for heavy machinery cabs and other operator enclosures. ISEEE stated that the standard provides practical and cost-effective requirements and testing methods for engineering controls that would meet the proposed rule's requirements, given that the desired outcome in all cabs that meet the standard's requirements is compliance with air quality regulations at the 25 μg/m^3 level. The commenter added that by implementing this consensus standard, it would lead to the development of a standardized design that could be mass-produced and therefore reduce costs.

MSHA has reviewed the comment and has determined that an evaluation of the costs and benefits for economic and technological feasibility would need to be conducted, along with an examination of the costs to implement the standard for mine operators. Therefore, the Agency does not include the requirements of ISO 23875 in this final rule; however, the Agency will evaluate the standard and encourages the use of new technologies and consensus standards to improve miner safety and health.

APHA stated that guides prepared by NIOSH for MNM mines and coal mines contain helpful illustrations of feasible engineering controls that reduce exposure to respirable dust (Document ID 1416). MSHA acknowledges that NIOSH and other organizations and agencies have published information that may be helpful to mine operators. MSHA has worked in partnership with NIOSH in developing this final rule and will continue to do so and use information from NIOSH to facilitate implementation of the final rule. The Agency encourages mine operators to use NIOSH information to ensure that feasible and effective engineering controls are installed, used, and maintained.

5. Section 60.12—Exposure Monitoring

The final rule establishes requirements for exposure monitoring in § 60.12. Section 60.12 paragraph (a) establishes the requirements for sampling. Paragraph (a)(1) requires mine operators to commence sampling by the compliance date to assess the full shift, 8-hour TWA exposure of respirable crystalline silica for each miner who is or may reasonably be expected to be exposed to respirable crystalline silica.

Paragraph (a)(2) is restructured from the proposal and states how the mine operator shall proceed if the sampling under (a)(1) is: (i) below the action level, (ii) at or above the action level, or (iii) above the PEL. Paragraph (a)(3) mirrors language in the proposal indicating that where the most recent sampling indicates that miner exposures are at or above the action level but at or below the PEL, the mine operator shall continue to sample within 3 months of the previous sampling. Paragraph (a)(4) states that mine operators may discontinue sampling when two consecutive samplings indicate that miner exposures are below the action level. In a change from the proposal, paragraph (a)(4) also specifies that the second sampling must be taken after the operator receives the results of the prior sampling but no sooner than 7 days after the prior sampling was conducted. Paragraph (b) states that where the most recent sampling indicates that miner exposures are above the PEL, the mine operator shall sample after corrective actions are taken pursuant to § 60.13 until the sampling indicates that miner exposures are at or below the PEL. In a change from the proposal, paragraph (b) also requires the mine operator to immediately report all operator samples above the PEL to the MSHA District Manager or to any other MSHA office designated by the District Manager. Paragraph (c) requires mine operators to conduct periodic evaluations at least every 6 months to determine whether changes may reasonably be expected to result in new or increased respirable crystalline silica exposures. In a change from the proposal, paragraph (c) also requires mine operators to conduct an evaluation whenever there is a change in production, processes, installation and maintenance of engineering controls, installation and maintenance of equipment, administrative controls, or geological conditions. Paragraph (c)(1) requires mine operators to make a record of the evaluation and the date of the evaluation. In a change from the proposal, paragraph (c)(1) also requires the record of the evaluation to include the evaluated change and the impact on respirable crystalline silica exposure. Paragraph (c)(2) requires mine operators to post the record on the mine bulletin board and, if applicable, by electronic means, for the next 31 days. Paragraph (d) is unchanged from the proposal and includes the requirements for post-evaluation sampling. Paragraph (e) includes requirements for how mine operators must take samples. Paragraph (e)(1) requires that sampling be performed for the duration of a miner's regular full shift and during typical mining activities. In a change from the proposal, paragraph (e)(1) specifically includes shaft and slope sinking, construction, and removal of overburden. Paragraph (e)(2) requires the full-shift, 8-hour TWA exposure for miners to be measured based on: (i) personal breathing-zone air samples for metal and nonmetal operations and (ii) occupational environmental samples collected in accordance with § 70.201(c), § 71.201(b), or § 90.201(b) of this chapter for coal operations. Paragraph (e)(3) includes the requirement for sampling a representative fraction of miners and is unchanged from the proposal. Paragraph (e)(4), unchanged from the proposal, includes the requirement for mine operators to use respirable-particle-size-selective samplers that conform to ISO 7708:1995 to determine compliance with the PEL. Paragraph (f) is unchanged from the proposal and includes the methods of sample analysis. Paragraph (g) is unchanged from the proposal and includes the requirements for sampling records.

The exposure monitoring requirements help facilitate operator compliance with the PEL and harmonize MSHA's approach to monitoring and evaluating respirable crystalline silica exposures to better protect all miners' health. Below is a discussion of the comments received on this section and modifications made in response to the comments.

a. Section 60.12(a)—Sampling

Under the final rule, mine operators are required to commence sampling by the compliance date to assess miners' exposures to respirable crystalline silica. Samples will be compared to the action level and the PEL to determine the effectiveness of existing controls and the need for additional controls.

Change in Terminology

Under the final rule, MSHA removes references to ''baseline sampling'' and ''periodic sampling'' and only uses the term ''sampling''. MSHA also removes proposed § 60.12(a)(2)(i), which allowed mine operators to discontinue sampling based on objective data or historical sample data, *i.e.,* sampling conducted by the Secretary or mine operator sampling conducted within the previous 12 months.

MSHA determined that the terms ''baseline sampling'' and ''periodic sampling'' are no longer needed to describe the sampling requirements under the final rule. With the removal of objective data and historical sample data, under the final rule, discontinuing sampling is contingent upon the results of two consecutive samplings indicating that miner exposures are below the action level.

Removal of Objective Data

Under the final rule, MSHA removes the use of ''objective data'' as a method of discontinuing sampling. Proposed paragraph (a)(2) allowed operators to discontinue sampling when, among other things, objective data indicated that miner exposures were below the action level. As discussed earlier, in the proposal, MSHA defined objective data as information such as air monitoring data from industry-wide surveys or calculations based on the composition of a substance, demonstrating miner exposure to respirable crystalline silica associated with a particular product or material or a specific process, task, or activity. The data must reflect mining conditions closely resembling or with a higher exposure potential than the processes, types of material, control methods, work practices, and environmental conditions in the operator's current operations.

MSHA received several comments on its proposed use of objective data as a means for operators to discontinue periodic sampling, with some commenters in support of using objective data and some commenters against it. Several commenters, including mining and industry trade associations and a state mining association, expressed support for the use of objective data, with some commenters noting that it would reduce the sampling burden on mine operators (Document ID 1442; 1406; 1408; 1441; 1424; 1428). Some commenters, including the AEMA, NMA, and Vanderbilt Minerals, LLC, stated that objective data more than 12 months old should be permitted because exposures may not change, or the data may still be valid in certain circumstances (Document ID 1424; 1428; 1419). Several other commenters, including AIHA, UMWA, USW, and Appalachian Voices, opposed the use of objective data, with most arguing that sampling is more accurate than objective data and that such data should not be used to exempt operators from sampling (Document ID 1351; 1398; 1447; 1425; 1412). AFL–CIO, NVMA, and Rep. Robert C. ''Bobby'' Scott, stated that the term ''objective data'' is unclear, too subjective, and capable of being manipulated; that various mining aspects could invalidate or skew objective data results; and that the proposal's use of objective data is at odds with the Mine Act's requirement that newly promulgated health and safety standards do not reduce protection for miners (Document ID 1449; 1441; 1439).

While the Agency acknowledges that the use of objective data would ease operators' sampling burden, MSHA has determined that objective data cannot be used to discontinue sampling because it is not likely to represent mining conditions closely resembling the processes, types of material, control methods, work practices, and environmental conditions in the mine operator's current operations. The Agency agrees with commenters who stated that sampling is more accurate than using objective data and that the use of objective data as a means for operators to discontinue sampling, may be too subjective to confirm that sample results are below the action level. Furthermore, objective data, as defined in the proposal, utilized a historical approach, while the collection of samples will more accurately reflect respirable crystalline silica concentrations under current mining conditions.

Removal of Operator and Secretary Sampling From Preceding 12 Months

MSHA also removes the provisions in proposed paragraph (a)(2) allowing operators to discontinue sampling when sampling conducted by the Secretary or the mine operator within the preceding 12 months confirmed that miner exposures were below the action level.

Some commenters, including SSC, NVMA, Vanderbilt Minerals, LLC, and Portland Cement Association, supported the use of past sampling to discontinue sampling, noting that many operators already use such data to implement their current monitoring programs (Document ID 1432; 1441; 1419; 1407). However, the UMWA opposed allowing past sampling to be used to discontinue sampling (Document ID 1398). The UMWA stated that exempting mine operators from sampling based on past sampling fails to protect miners from unhealthy levels of respirable crystalline silica or ensure that operators are complying with the standard. The UMWA recommended that MSHA, not mine operators, regularly sample all miners.

MSHA agrees that operators cannot rely on samples taken within the preceding 12 months prior to the first sampling under the final rule to discontinue sampling. This is because past samples may not accurately represent miners' current exposures. However, operators still have pathways to discontinue sampling; the final rule requires two consecutive sample results below the action level that may come from operator or MSHA sampling. MSHA will continue to perform its own dust samplings as part of its regular health inspections and take necessary enforcement actions.

Change in Sampling Compliance Date

In a change from the proposal, the final rule requires MNM mine operators to comply with the requirements and commence sampling within 24 months of the publication date and requires coal mine operators to comply with the requirements and commence sampling within 12 months after the publication date.

Under the proposal, both MNM and coal mine operators would have been required to perform the first sampling under this standard within the first 180 days (6 months) after the effective date of the final rule. MSHA received comments both for and against the proposed 180-day compliance period, with many commenters from the MNM mining industry stating that it was not enough time and recommending a longer period ranging from 1 year to 3 years (Document ID 1408; 1432; 1433; 1417; 1392). Some commenters, including Portland Cement, SSC, CalCIMA, and NLA, stated that providing only 180 days to commence sampling was not sufficient because of the limitation of available resources for conducting sampling (Document ID 1407; 1432; 1433; 1408). Portland Cement, SSC, and AEMA stated that this requirement may not be feasible for many operators because of competition for outsourced resources such as rental equipment, media, professional services, and laboratory sample analysis (Document ID 1407; 1432; 1424). Commenters expressed concerns about performing other tasks within the proposed timeframe for compliance, including establishing contracts with accredited laboratories and other service providers necessary for sampling; performing sampling for all miners who may reasonably be expected to be exposed to respirable crystalline silica; and designing and implementing new engineering controls. These commenters recommended a phased timeline similar to OSHA's final requirement in its silica rule (which gave employers one year before the commencement of most requirements and two years before the commencement of sample analysis methods) and MSHA's final requirement in its 2014 RCMD Standard (which gave operators 18 months after the rule became effective). The NLA stated that small mines are likely to have the greatest difficulty competing for resources in a short period of time (Document ID 1408).

In contrast, some commenters, including AIHA and SKC Inc., stated that technologically feasible air sampling and analysis exists to allow mine operators to achieve compliance with the PEL using commercially available samplers (Document ID 1351; 1366). These commenters stated that technologically feasible samplers are widely available, and a number of commercial laboratories provide the service of analyzing dust containing respirable crystalline silica. Other commenters, including AFL–CIO and UMWA, supported requiring first-time sampling within 180 days of the rule's effective date (Document ID 1449; 1398). Some commenters, including Appalachian Voices, Rep. Robert C. ''Bobby'' Scott, and Robert Cohen, emphasized the need to implement the final rule quickly to protect miners (Document ID 1425; 1439; 1372). Appalachian Voices stated that the technologies and practices necessary to reduce dust and silica exposure are well-known and that mine operators have had ample warning that this rule was forthcoming (Document ID 1425).

Under the proposal, MSHA examined the capacity of laboratories that meet the ISO/IEC 17025 standard to conduct respirable crystalline sample analyses. MSHA made the preliminary determination that there would be sufficient processing capacity to meet the sampling analysis schedule and that it would be technologically feasible for laboratories to conduct the required sampling analyses (88 FR 44923). MSHA also preliminarily determined that the availability of samplers needed to conduct the required sampling is technologically feasible (88 FR 44921). This preliminary determination, however, only examined whether sampler technology exists to conduct the respirable crystalline silica sampling as required under the proposed rule, not the availability of that technology to meet the demands that the final rule would impose.

MSHA agrees with commenters that the sampling requirements of the final rule may create initial increased demand for sampling devices and related equipment and services. MSHA understands that there are more sampling devices (as well as related services and supplies) currently available based on the increased demand resulting from the promulgation of the OSHA silica rule in 2016, and MSHA expects that there may be another increase in demand because of this final rule. MSHA expects that the sampling device market will respond, as it did for OSHA, with an increase in the supply of sampling devices to meet the increased demand because of this final rule. However, AIHA stated that they concur with MSHA that technologically feasible samplers are widely available, and a number of commercial laboratories provide the service of analyzing dust containing respirable crystalline silica. The AIHA is the organization that is responsible for the AIHA-Laboratory Accreditation Program (AIHA LAP) that accredits the majority of laboratories analyzing industrial hygiene samples. MSHA has also identified more AIHA laboratories with respirable crystalline silica analysis in their scope of accreditation in 2023 compared to 2022, indicating an increase in such capabilities.

MSHA carefully considered the above information about availability of laboratory capacity and sampling devices, including the likely increase in demand for such services and devices. MSHA acknowledges commenters' concerns about the need for more time to conduct sampling and implement necessary engineering controls. All mine operators covered by the rule must initiate sampling by the compliance dates, potentially creating a peak demand for sampling and analysis around those dates. The extended compliance dates permit more time to accommodate and prepare for any increase in demand. MSHA expects many mine operators will avoid last-minute sampling and begin the sampling process earlier than required; thus, the sampling and associated analysis will be spread over many months, meaning that any eventual peak period for laboratory analysis will be longer and less intense (*i.e.,* fewer analyses per month required) than it might be otherwise. Additionally, MSHA expects that the extended lead time will be sufficient for laboratories to increase their analytical capacity. More discussion can be found in *Section VII.A. Technological Feasibility.* Additional discussion of the compliance date requirements can be found under *Section 60.1—Scope; compliance dates.*

Sampling Requirements for New Mines

A few commenters, including Petsonk PLLC and Appalachian Voices, requested that MSHA clarify the sampling requirement for mines that begin operations after the rule goes into effect (Document ID 1399; 1425). Petsonk PLLC suggested amending proposed § 60.12(a)(1) to require sampling within 180 days after the rule becomes effective or 180 days after the mine commences production, whichever occurs later.

MSHA disagrees with the commenters regarding the need to specify a separate sampling schedule for new mines since mine operators would have knowledge of the sampling requirements before commencing operations. The Agency expects that new mines begin sampling immediately upon commencing operations in accordance with the exposure monitoring requirements in § 60.12. Coal mine operators are required to begin sampling within 12 months of the publication of the final rule. Operators of new coal mines that begin operation after the 12 months must begin sampling upon commencing operations. MNM mine operators are required to begin sampling within 24 months of the publication date of the final rule. Operators of new MNM mines that begin operation after the 24 months must begin sampling upon commencing operations.

Reasonably Be Expected

Under the final rule, mine operators are required to assess the exposure of each miner ''who is or may reasonably be expected to be exposed to respirable crystalline silica.''

In the proposal, MSHA requested comments on the Agency's assumption that most miners are exposed to at least some level of respirable crystalline silica, and on the proposed requirement that these miners should be subject to sampling. MSHA described its assumption that most occupations related to extraction and processing would meet the ''reasonably be expected'' threshold for sampling. Further, MSHA assumed that some miners may work in areas or perform tasks where exposure is not reasonably expected, if at all.

MSHA received many comments from advocacy organizations, mining and industry trade associations, MNM mine operators, labor organizations, and a state mining association on the ''reasonably be expected'' basis for sampling (Document ID 1398; 1407; 1417; 1419; 1424; 1425; 1428; 1441; 1445; 1448; 1449). Commenters were generally divided on whether most miners are exposed to at least some level of respirable crystalline silica. The UMWA agreed with MSHA's assumption and stated that most mining occupations would reasonably be expected to be exposed to silica and thus meet the threshold for sampling, while some miners may not be reasonably expected to be exposed to silica, depending on their occupation (Document ID 1398). In contrast, Vanderbilt Minerals, LLC stated that it is not reasonable to assume that most miners are exposed to at least some level of respirable crystalline silica (Document ID 1419). This commenter cited MSHA's Mine Data Retrieval System (MDRS) data that shows many mine locations do not have any detectable exposure to respirable crystalline silica. Appalachian Voices, questioning MSHA's assumption about occupations related to extraction and processing meeting the ''reasonably be expected'' threshold for sampling, described testimony from several miners who worked in non-production positions and were exposed to high levels of silica dust (Document ID 1425). This commenter requested expansion of the interpretation to include or consider non-production work above ground because of the placement of engineering controls, such as return air entries near mine offices. Further, other commenters, including NSSGA and BMC, requested clarification on what the ''reasonably be expected'' threshold means since it was not defined in the proposal (Document ID 1448; 1417).

MSHA has considered these comments. Based on the Agency's enforcement and compliance assistance experience and sampling data, the final rule retains the language in the proposal. This data considers MSHA and operator sampling experience, miners' job tasks and occupations, and mining conditions when overexposures are identified and need to be corrected. Operators already are expected to know whether their miners are exposed or reasonably are expected to be exposed to respirable crystalline silica, given coal operators' existing sampling regimen (that includes regular sampling) and MNM's requirements under §§ 56.5002 and 57.5002 to conduct surveys (sampling) ''as frequently as necessary to determine the adequacy of control measures.'' MSHA believes that most occupations related to extraction and processing which generate dust are likely to meet the ''reasonably be expected'' threshold. However, MSHA clarifies that sampling should not be limited to extraction and processing occupations; in every instance, the mine operator must determine whether exposure to respirable crystalline silica is or may reasonably be expected. In the example given by the commenter, miners performing above-ground non-production work who were exposed to high levels of silica dust would reasonably be expected to be exposed to respirable crystalline silica and thus would be required to be sampled. On the other hand, MSHA recognizes that some miners are not exposed to respirable crystalline silica in day-to-day mining operations, may work in areas or perform tasks where respirable crystalline silica exposures are not reasonably likely, or may work in silica-free environments. Based on the Agency's experience, mine operators have familiarity with the occupations, work areas, and work activities where respirable crystalline silica exposures occur or are most likely to occur. Based on this knowledge, MSHA expects that operators will be able to assess the threshold conditions for sampling.

Many commenters stated that MSHA should require an exposure ''trigger'' level to be used as a basis for conducting sampling. Several commenters, including NMA, BMC, NSSGA and AEMA, stated that the ''reasonably be expected'' threshold for sampling should be associated with the action level of 25 μg/m³, similar to the OSHA standard (Document ID 1428; 1417; 1448; 1424). Some of these commenters stated that without a trigger level, even the general public would meet the criterion of ''reasonably expected to be exposed'' because the proposed requirement is too broad and lacks any meaning in the context of a standard.

Under the final rule, MSHA concludes that an action level trigger for initial sampling is not appropriate for mining conditions. The extraction and milling of minerals can reasonably be expected to expose most miners to some level of respirable crystalline silica. In MSHA's experience, dust generation is common in the mining process, and the approach in the final rule ensures that mine operators have the necessary data and information to understand which miners may be exposed to respirable crystalline silica, can make determinations regarding the adequacy of existing engineering and administrative controls, and can make necessary changes to ensure miners are not overexposed.

Sampling

In the final rule, MSHA requires mine operators to sample within 3 months of the previous sampling when the most recent sampling indicates that miner exposures are at or above the action level but at or below the PEL. The most recent sampling could be a first sample under the standard, a corrective action sample, a post-evaluation sample, or a sample taken by MSHA during its inspections. Sampling must continue until two consecutive sample analyses show miners' exposures are below the action level. Once this happens, mine operators may discontinue sampling for miners whose exposures are represented by these samples, until such time that a subsequent MSHA sampling or post-evaluation sampling by the mine operator indicates that miners may be exposed at or above the action level. MSHA clarifies that during the compliance period, the two consecutive samplings needed to discontinue further sampling may not begin with an MSHA sampling followed by an operator sampling conducted within 3 months of that MSHA sampling; however, it may begin with an operator sampling (*e.g.,* the operator's first sampling during the compliance period) followed by an MSHA sampling conducted within 3 months of that operator sampling. This is because the first sampling that operators must conduct during the compliance period includes a larger group of miners (*i.e.,* each miner who is or may reasonably be expected to be exposed to respirable crystalline silica) as compared to the targeted group of miners sampled by MSHA during its inspections.

MSHA received many comments on the proposed frequency of sampling, with some commenters stating that the 3-month sampling frequency is too frequent and other commenters stating that the sampling is not frequent enough. Some MNM mine operators, including SSC and NLA, stated that mines with sampling results consistently above the action level but below the PEL should not be required to sample every 3 months, and instead the frequency should be annual (Document ID 1432; 1408). The NVMA stated that the 3-month frequency should be associated with the PEL rather than the action level (Document ID 1441). The AISI stated that the frequency of sampling should be dictated by the history of miner exposures, noting that some miners should not be sampled as frequently as others and some miners should not be sampled at all (Document ID 1426). Portland Cement Association, NSSGA, BMC, and Vanderbilt Minerals, LLC, stated that MSHA should model its sampling requirements after OSHA's silica rule, where repeat monitoring is conducted within 6 months for exposures above the action level but below the PEL and within 3 months for exposures above the PEL (Document ID 1407; 1448; 1417; 1419). The AEMA and NMA, stated that follow-up sampling should occur no more frequently than every 6 months, as proposed in MSHA's Regulatory Alternative #1 (Document ID 1424; 1428). The commenters stated that sampling each miner whose exposure is at or above the action level but at or below the PEL every 3 months is excessive and causes undue burden on mine operators.

Other commenters, including advocacy organizations and labor unions, stated that MSHA's proposed sampling frequency was not enough (Document ID 1434; 1447; 1449; 1412; 1445; 1398; 1385). The USW and the AFL–CIO stated that the periodic sampling requirement in the proposal is not sufficient to assess silica concentrations in mining and prevent overexposures and noted the coal mining industry is already required to perform quarterly periodic sampling which they believe is not frequent enough (Document ID 1447; 1449). An individual stated that MSHA's proposed sampling frequency is not aligned with a 2014 NIOSH study cited by the Agency that referenced a 2020 report from DOL's Inspector General, which recommended more frequent monitoring where there is wide variability in silica levels (Document ID 1412). ACLC recommended that MSHA require weekly sampling (over multiple shifts) by operators and monthly sampling by MSHA inspectors (Document ID 1445). The USW, AFL–CIO, and Nicholas County Black Lung Association supported more frequent sampling by MSHA without suggesting a specific schedule and stated that mines should be constantly checking for silica dust, especially where continuous mining machine operators and roof bolters are working (Document ID 1447; 1449; 1385).

As commenters noted, OSHA requires a 6-month sampling interval for monitoring exposures between the action level and PEL and a 3-month interval for monitoring exposures above the PEL. 29 CFR 1910.1053(d)(3)(iii) and (iv). OSHA explained, ''[i]n general, the more frequently periodic monitoring is performed, the more accurate the employee exposure profile.'' 81 FR 16766. Accordingly, OSHA noted that ''[s]electing an appropriate interval between measurements is a matter of judgment,'' and determined that the 6-month and 3-month frequencies were both ''practical for employers and protective of employees.'' *Id.* MSHA took into account OSHA's approach in developing its final rule.

MSHA's sampling provisions differentiate between miners based on their exposure levels. The sampling provisions require first-time sampling of miners exposed or reasonably expected to be exposed to respirable crystalline silica, and subsequent sampling of miners exposed at or above the action level. In MSHA's experience, ever-changing mining conditions require a shorter interval between samplings to ensure that miners are protected. MSHA's monitoring approach is consistent with NIOSH's recommendation to monitor miners' silica exposures frequently due to the variability of silica content in mining environments (NIOSH, 2014e). The 3-month interval is appropriately protective of miners, providing a higher degree of confidence that miners will not be exposed to concentrations of respirable crystalline silica above the PEL. As discussed in *Section VII. Feasibility* and *Section IX. Summary of Final Regulatory Impact Analysis,* this sampling frequency is technologically and economically feasible for mine operators.

Under the final rule, when exposures are above the PEL, mine operators must take immediate corrective actions and sample until exposures are at or below the PEL. Like the proposal, the final rule does not define a specific sampling frequency above the PEL but anticipates that operators will sample upon taking corrective actions and sample as frequently as needed until corrective actions have resolved the overexposure. Once at or below the PEL, mine operators will resume the 3-month schedule.

Two Consecutive Samplings Below the Action Level

In the final rule, MSHA allows mine operators to discontinue sampling when two consecutive samplings indicate that miner exposures are below the action level. MSHA believes a short period of time—within three months—between samples is needed to verify current conditions and lack of exposure to respirable crystalline silica. In addition, MSHA sampling may indicate exposure levels that require mine operators to commence sampling. The Agency also requires operators to conduct periodic evaluations at least every 6 months or whenever there is a change in production, processes, installation or maintenance of engineering controls, installation or maintenance of equipment, administrative controls, or geological conditions, to evaluate whether the change may reasonably be expected to result in new or increased respirable crystalline silica exposures. This will ensure that mine operators continue to monitor changes in mining conditions and practices that may impact exposure levels and lead to further sampling.

MSHA received several comments on using two consecutive samples as a means of discontinuing sampling requirements. The AIHA and AFL–CIO expressed doubt that two samples can provide confidence that a task is safe from harmful exposures (Document ID 1351; 1449). A MNM operator noted that one or two sample results below the action level do not necessarily equate to overall lower exposures and it is likely that many two-samples below action level results will occur merely by chance (Document ID 1417). In contrast, the NMA agreed with using two consecutive samples and stated that OSHA has a similar requirement (Document ID 1428). The NMA stated that two samples should be enough to confirm lack of exposure in theory and in practice. Other comments from professional associations, labor organizations, and a miner health advocate questioned whether mine operators should be permanently exempted from sampling at all (Document ID 1372; 1377; 1398; 1449; 1405).

MSHA agrees with the commenter who stated that two consecutive samples should be enough to confirm lack of exposure to respirable crystalline silica. In response to the commenters' concern about discontinuing sampling, MSHA is confident that the results from two consecutive samplings will provide data to confirm that the operator's controls are working effectively and that miners' exposures are below the action level. MSHA also believes that two consecutive samplings below the action level indicate a low probability that, under the prevailing conditions, exposure levels exceed the PEL. As such, unchanged from the proposal, the final rule includes a requirement for two consecutive samples below the action level to discontinue sampling.

Mine operators may discontinue sampling once two consecutive sample analyses show the miners' exposures are below the action level. Specifically, in paragraph 60.12(a)(4), to discontinue sampling, the second sampling must be taken after the operator receives the results of the prior sampling but no sooner than 7 days after the prior sampling was conducted. However, MSHA clarifies that the final rule includes two scenarios where mine operators are required to resume sampling with actual or expected miner exposures at or above the action level but below the PEL. First, mine operators must conduct sampling within 3 months if sampling by the operator or MSHA indicates that miner exposures are at or above the action level but at or below the PEL (§ 60.12(a)(3)), and mine operators must continue to sample until two consecutive samplings indicate that miner exposures are below the action level. Second, mine operators must conduct post-evaluation sampling if they determine, as a result of their periodic evaluation, that miners may be exposed to respirable crystalline silica at or above the action level (§ (60.12(d)).

A miner health advocate stated that an inadequacy of the proposal was that it failed to address a situation in which a mine operator took multiple samples at the same time (Document ID 1372). The commenter was concerned that if one of these samples was under the action level and others were over, the operator would choose the sample under the action level as the basis for discontinuing sampling.

MSHA clarifies that, under the final rule, as in the proposal, mines that have any miners with silica exposures at or above the action level but at or below the PEL are required to continue conducting sampling for those miners at or above the action level but at or below the PEL in accordance with § 60.12(a).

Minimum Time Between Samplings

Under final paragraph (a)(4), for the purposes of discontinuing sampling, MSHA clarifies that subsequent sampling must be taken after the operator receives the results of the prior sampling but no sooner than 7 days after the prior sampling was conducted. In response to comments, this is a change from the proposed rule.

In the proposal, MSHA requested comment on whether consecutive samples should be taken at least 7 days apart. MSHA received comments from AIHA, MCPA, and SSC in response to the minimum time period between consecutive samplings (Document ID 1351; 1406; 1432). The MCPA expressed concern that requiring 7 days between samplings, combined with the time it would take a laboratory to process the samples, could result in a miner having to wear a respirator for 3–4 weeks despite effective engineering controls being in place (Document ID 1406). This commenter also asked if MSHA considered the time it takes to obtain sample results from a laboratory. The AIHA stated that consecutive samples do not necessarily need to be at least 7 days apart, depending on workplace circumstances (Document ID 1351). The SSC stated that a time limit between consecutive samples is not needed and stated that MSHA has not offered any reason or justification for requiring 7 days (Document ID 1432). The ISEEE cautioned that, without a clear requirement in the rule, mine operators might take consecutive samples only during the most favorable times, *i.e.,* when exposures are naturally mitigated by snow or rain (Document ID 1377).

MSHA reviewed the comments and decided that a minimum time between samplings is necessary to ensure that controls are in place and are effective in reducing miners' exposures to respirable crystalline silica. The final rule requires that, to discontinue sampling, subsequent sampling must be taken after the operator receives the results of the prior sampling but no sooner than 7 days after the prior sampling was conducted. This requirement is necessary to prevent situations where operators attempt to rely on samples taken too close together that do not adequately reflect representative exposure levels during regular operations, for instance, while performing a low dust generating task. MSHA notes that OSHA's silica final rule provides a 7-day minimum period between consecutive samplings under the standard for general industry and maritime (29 CFR 1910.1053 (d)(3)(v)) and construction (29 CFR 1926.1153 (d)(2)(iii)). In addition, MSHA understands that it typically takes 2 weeks or less for mine operators to receive sampling results from the laboratory. MSHA also clarifies that the 7-day minimum interval is not included in § 60.12(b) or between samples not used as a basis for discontinuation.

b. Section 60.12(b)—Corrective Actions Sampling

In the final rule, as in the proposal, where the most recent sampling indicates that miner exposures are above the PEL, MSHA requires the mine operator to conduct sampling after corrective actions are taken and until sampling indicates that miner exposures are at or below the PEL. In a change from the proposal, MSHA also requires mine operators to immediately report all exposures above the PEL from operator sampling to the District Manager or to any other MSHA office designated by the District Manager.

Portland Cement Association recommended that MSHA adopt OSHA's standard for corrective actions sampling and suggested that operators repeat sampling at 3-month intervals until exposures are at or below the PEL (Document ID 1407). An individual expressed concern that the proposal does not require a minimum number of full-shift samples to validate the effectiveness of corrective actions (Document ID 1412).

Section 60.13 requires mine operators to take corrective actions when sampling results show exposure levels above the PEL. Sampling after taking corrective actions provides operators with specific information regarding the effectiveness of the corrective actions for the mine environment and provides additional data for use in making decisions about updating or improving controls. Once sampling shows that exposures are at or below the PEL, the Agency requires mine operators to conduct repeat sampling within 3-month intervals as long as previous sampling results indicate miners' exposures are at or above the action level but at or below the PEL. Corrective action sampling is required for all samples over the PEL at all mines, including portable operations.

Some commenters, including a miner health advocate and an advocacy group, questioned whether citations will be issued if exposures are over the PEL, with Hon. Robert C. ''Bobby'' Scott suggesting that MSHA incorporate reporting requirements for dust samples (Document ID 1425; 1439; 1399). AMI Silica, LLC stated that requiring operators to report overexposures was a departure from MSHA's current practice and requires operators to ''self-incriminate'' (Document ID 1440). However, other commenters including labor organizations and a miner health advocate requested more MSHA oversight of operator sampling to ensure compliance (Document ID 1449; 1398; 1399).

Under the final rule, MSHA requires mine operators to immediately report all exposures above the PEL to the District Manager or to any other MSHA office designated by the District Manager. This is responsive to comments requesting that the Agency be more actively involved in operator sampling and consistent with the approach MSHA outlined at a public hearing. Requiring mine operators to report sampling results over the PEL will ensure that MSHA is aware of all overexposures and can take appropriate action, including compliance assistance and enforcement action. Samples indicating concentrations over the PEL should be reported immediately, without delay once the operator becomes aware of the information, and in accordance with guidance from the MSHA District Office. Once MSHA is aware that a sample indicates overexposure, the Agency can provide appropriate assistance and monitor progress toward abatement of the condition. Enforcement actions for samples that are over the PEL, where appropriate, will be handled on a case-by-case basis. Enforcement practices are discussed in *Section VIII.A. General Issues.*

c. Section 60.12(c) and (d)—Periodic Evaluation and Post-Evaluation Sampling

Under the final rule, mine operators are required to conduct periodic evaluations at least every 6 months or whenever there is a change in: production; processes; installation and maintenance of engineering controls; installation and maintenance of equipment; administrative controls; or geological conditions. Mine operators are required to make a record of the periodic evaluation and post it on the mine bulletin board and, if applicable, by electronic means, for the next 31 days. If the mine operator determines, as a result of the periodic evaluation, that miners may be exposed to respirable crystalline silica at or above the action level, the mine operator shall perform sampling for each of those miners who may be exposed at or above the action level.

Periodic Evaluation

The final rule is modified from the proposal, which would have only required operators to conduct periodic evaluations every 6 months. In addition to requiring mine operators to conduct periodic evaluations at least every 6 months, the final rule also requires mine operators to conduct an evaluation whenever there is a change in production, processes, installation and maintenance of engineering controls, installation and maintenance of equipment, administrative controls, or geological conditions.

MSHA received comments from mining trade associations, labor unions, miner health advocates, professional associations, an advocacy organization, a black lung clinic, and a federal elected official on the proposed semi-annual evaluation requirement. The UMWA, ACOEM, APHA, and AEMA stated that mine operators should be constantly conducting qualitative evaluations any time a change occurs that may reasonably be expected to result in new or increased respirable crystalline silica exposures (Document ID 1398; 1405; 1416; 1424). The ISEEE stated that it is crucial to regularly reevaluate and address any deficiencies across all aspects of the mine site to prevent unnecessary exposures and emphasized that conducting timely risk assessments is a standard practice in the mining industry (Document ID 1377). The UMWA and AFL–CIO stated the proposed evaluation requirement could create the possibility for miners to be exposed to dangerous levels of silica for up to six months (Document ID 1398; 1449). The AEMA believed the proposed evaluation requirement would be excessive given the lack of frequency with which changes occur (Document ID 1424). The AEMA and NMA recommended MSHA require an annual evaluation (Document ID 1424; 1428). The NSSGA stated that MSHA should adopt OSHA's requirement to reassess respirable crystalline silica exposures whenever there has been a change that may reasonably be expected to result in new or additional exposures at or above the action level, or when the employer has any reason to believe that new or additional exposures at or above the action level have occurred (29 CFR 1910.1053(d)(4) and 29 CFR 1926.1153(d)(2)(iv)) and eliminate the 6-month qualitative evaluation requirement (Document ID 1448). Finally, the AFL–CIO stated mine operators should report significant changes that could increase silica concentrations to MSHA, while the Miners Clinic of Colorado and a miner health advocate stated that MSHA, not mine operators, should be responsible for deciding whether additional sampling should be conducted as a result of the qualitative evaluation (Document ID 1449; 1418; 1399).

MSHA agrees with commenters who stated that mine operators should be required to conduct a qualitative evaluation when a change occurs to help minimize overexposures to respirable crystalline silica. The requirement to conduct a qualitative evaluation at least every 6 months or whenever a change occurs in production, processes, controls, or geological conditions ensures that mine operators are assessing changing processes, conditions, and practices that may impact miner exposure levels on a regular basis to determine if additional sampling is needed. The requirement to conduct an evaluation whenever a change occurs is consistent with the existing MNM requirement to conduct surveys as frequently as necessary to determine the adequacy of control measures (§§ 56.5002 and 57.5002), while the minimum 6-month requirement is consistent with the underground coal requirement to review the ventilation plan every 6 months to assure that it is suitable to current conditions (§ 75.370(g)). This requirement is also consistent with the existing MNM standard for controlling diesel particulate matter (DPM), which requires that mine operators monitor as often as necessary to effectively determine, under conditions that can be reasonably anticipated in the mine, whether the average personal full-shift airborne exposure to DPM exceeds the DPM limit (57.5071(a)). Under the final rule, mine operators are responsible for conducting periodic evaluations. The Agency emphasizes that it will not conduct periodic evaluations but may use its enforcement discretion to review a mine's records of periodic evaluations, when necessary.

In response to a comment from a miner health advocate, the final rule modifies proposed paragraph(c)(1), which required operators to ''[m]ake a record of the evaluation and the date of the evaluation.'' The commenter stated MSHA should require the record of the evaluation to specify all changes that could affect respirable crystalline silica exposures and the effect of the changes on exposure levels (Document ID 1372). MSHA agrees with the commenter who stated the record of the evaluation needs to be more informative and responds by requiring the record of the evaluation to also include the evaluated change and the impact the change has on respirable crystalline silica exposure. The additional required data will provide MSHA, mine operators, and miners with information on the specific changes that may reasonably be expected to result in new or increased respirable crystalline silica exposures.

Unchanged from the proposal, under the final rule, MSHA requires mine operators to post the record on the mine bulletin board and, if applicable, by electronic means, for 31 days. The NSSGA stated that MSHA's requirement to post results on a bulletin board is too prescriptive and may cause an issue for operators who do not have a bulletin board (Document ID 1448). The final rule includes this requirement because it is consistent with MSHA's existing standards and gives miners ready access to recent sampling results, providing additional accountability for mine operators, and necessary information for miners. Also, section 109(a) of the Mine Act requires mines to have a bulletin board where information can be posted and shared with miners and their representatives. 30 U.S.C. 819(a). For portable operations and other operators who prefer to communicate electronically, the final rule permits electronic notification in addition to posting the record on the bulletin board.

Post-Evaluation Sampling

Under the final rule, like the proposal, mine operators are required to conduct post-evaluation sampling to assess the full shift, 8-hour TWA exposure of respirable crystalline silica when the results of the periodic evaluation show that miners may be exposed to respirable crystalline silica at or above the action level.

MSHA received some comments on the post-evaluation sampling proposal from an advocacy organization, a labor union, a federal elected official, a medical professional association, and a black lung clinic stating that MSHA should require sampling whenever there are any changes in mine conditions that could lead to an increased risk of respirable crystalline silica exposures (Document ID 1416; 1398; 1439; 1405; 1418). A miner health advocate stated that mine operators should not have the discretion to decide whether miners may be exposed to respirable crystalline silica at or above the action level or whether they should perform sampling to assess miners' exposure levels as a result (Document ID 1399). The same commenter suggested that MSHA should provide simple and straightforward triggers that mandate sampling, rather than just the requirement to conduct an evaluation that might lead to additional sampling.

Post-evaluation sampling is needed to ensure workers are protected from respirable crystalline silica when a change may increase their exposure. MSHA believes that mine operators have the most knowledge about their mine's operations and conditions. Mine operators are aware of the extent and degree of miners' exposures to respirable crystalline silica because they have been complying with respirable dust standards for over 40 years. Mine operators are also aware of the occupations, work areas, and work activities where overexposures to respirable crystalline silica are most likely to occur. Further, MSHA believes that mine operators will make good-faith efforts to comply with the post-evaluation sampling requirements to ensure healthy working conditions for miners. The final rule, in a change from the proposal, requires mine operators to conduct an evaluation whenever there are changes that may reasonably be expected to result in new or increased respirable crystalline silica exposures and to require operators to maintain more detailed records of the evaluation. These records will allow miners, their representatives, and MSHA to hold operators accountable for conducting timely and appropriate evaluations and required sampling.

d. Section 60.12(e)—Sampling Requirements

The final rule includes sampling requirements to ensure mine operators' respirable crystalline silica monitoring is representative of miners' actual exposure levels. The sampling requirements in the final rule are the same sampling requirements from the proposal, with a few modifications. Each of the sampling requirements is discussed in more detail below.

Typical Mining Activities

In the final rule, MSHA includes shaft and slope sinking, construction, and removal of overburden to clarify that these mining activities are within the scope of the final rule.

Several commenters stated the proposal was vague and did not clearly specify what ''typical mining activities'' includes. Black Lung Clinics, Hon. Robert C. ''Bobby'' Scott, and a miner health advocate emphasized that MSHA should ensure the final rule covers all aspects of mining operations, including construction and development activities (Document ID 1410; 1439; 1372). The American Thoracic Society *et al.* and Appalachian Voices stated it was unclear whether slope mining, shaft mining, or exploratory mining were considered typical mining activities under the proposal (Document ID 1421; 1425). The UMWA, Miners Clinic of Colorado, AFL–CIO, and a miner health advocate asserted that high silica-cutting activities such as blasting, drilling, excavation, cutting overcasts, cutting belt channels, and other outby construction should be considered typical mining activities under the final rule (Document ID 1398; 1418; 1449; 1399).

MSHA agrees with commenters that construction and development activities are typical mining activities and clarifies this in the final rule. The Agency is aware that many construction and development activities generate silica dust, which can lead to respirable crystalline silica exposures well above the PEL. MSHA stated at the public hearings and clarifies in this final rule that typical mining activities include shaft and slope mining, construction, and removal of overburden. In June 2022, MSHA implemented its Silica Enforcement Initiative (SEI) for MNM and coal mines. The purpose of the SEI is to reduce silica exposures in MNM and coal mines, and to provide compliance assistance to mine operators, where appropriate. The SEI was posted on MSHA's website and discussed with the mining community at safety and health conferences and during frequent MSHA stakeholder calls.[73] The SEI specifically addresses silica exposures in shaft and slope mining, construction, and removal of overburden. MSHA's Enforcement and Educational Field and Small Mine Services staff also discussed the SEI with the mining community. In response to commenters' examples, MSHA agrees that exploratory mining, and blasting, drilling, or cutting rock are all considered typical mining activities.

MSHA also clarifies that the existing requirements for respirable coal mine dust sampling differ from this final rule's requirements for respirable crystalline silica sampling. Under the existing standards for respirable coal mine dust sampling, the operator is required to sample coal mine dust exposures for specific occupations and areas during consecutive normal production shifts where coal mine dust is generated from production activities. Under the final rule, MSHA interprets construction and development activities as typical mining activities subject to respirable crystalline silica sampling, even though they may not be considered production activities under the requirements for respirable coal mine dust sampling.

[73] *https://www.msha.gov/safety-and-health/safety-and-health-initiatives/2022/06/08/silica-enforcement-initiative* (last accessed Jan. 10, 2024).

Environmental Conditions

Under the final rule, MSHA does not specify any operating conditions or environmental conditions for the purposes of conducting respirable crystalline silica sampling.

In the proposal, MSHA requested comments on whether the Agency should specify environmental conditions for sampling. The AEMA, NMA, and NSSGA recommended that MSHA not specify typical operating conditions or environmental conditions (Document ID 1424; 1428; 1448). MSHA Safety Services Inc. stated that it is impossible to predict the weather (Document ID 1392). The AFL–CIO cautioned that sampling while it is raining—a natural dust suppressant—could skew results, while two commenters stated that some mines operate in areas where rain, snow, and wind are common and requiring sampling in their absence is not feasible (Document ID 1449; 1424; 1428). The NLA stated that sampling should be performed under normal or typical operating conditions while also emphasizing the need for mine operators to have flexibility to determine whether conditions for testing are appropriate on any day (Document ID 1408). Black Lung Clinics specified that sampling should be conducted at something approaching full production for typical tasks (Document ID 1410).

MSHA recognizes the existence of exposure variability due to changing mining operations and environmental conditions and agrees with commenters that operators should have the flexibility, within reason, to determine what constitutes typical operating conditions and normal production levels at their mine. MSHA also agrees with the commenters who stated it would be impossible to predict the weather, and thus determined that including specific environmental conditions would make conducting exposure sampling unduly complicated or at times difficult to achieve. MSHA believes that the consistent use of effective engineering controls and workplace practices will help reduce exposure variability and provide operators with greater confidence that they are complying with the PEL. However, MSHA acknowledges that an operator's conscientious application and maintenance of all feasible engineering controls and workplace practices cannot eliminate exposure variability.

Sampling Device Placement

Under the final rule, MSHA requires personal breathing-zone air samples for MNM operations and requires occupational environmental samples collected in accordance with § 70.201I (underground coal mines), § 71.201(b) (surface coal mines and surface work areas of underground coal mines), or § 90.201(b) (coal miners who have evidence of the development of pneumoconiosis) for coal operations.

MSHA received a few comments on the proposed sampling device placement requirements. The AIHA and NMA expressed support for taking samples from MNM miners' personal breathing-zones with the latter commenter stating that the approach makes sense because MNM miners perform various job functions over the course of a shift (Document ID 1351; 1428). NMA also reasoned that the personal breathing-zone method would be preferable for coal miners, rather than the proposed occupational environmental sampling, because occupational environmental samples may measure several miners performing the same job function over the course of a shift and make it more difficult to maintain compliance with the PEL. The NVMA stated that providing two different sampling methods under the same standard does not make sense and suggested MSHA have two separate rulemakings—one for coal mines and one for MNM mines (Document ID 1441).

The Agency reiterates that the final rule creates a uniform standard that establishes consistent, industry-wide requirements to address the adverse health effects of overexposure to respirable crystalline silica for all miners, while still recognizing the differences between MNM and coal operations. MSHA believes that the consistent use of effective engineering controls and workplace practices will help all mines—MNM and coal—maintain compliance with the PEL and ensure effective health protection of miners. MSHA established the requirements for personal breathing-zone air samples for MNM miners and occupational environmental samples for coal miners to mirror existing sampling requirements for both industries. These sampling methods are tools that, when used appropriately, achieve the purpose of the Mine Act by identifying the need for additional controls to help operators to maintain good air quality.

A miner health advocate recommended that MSHA require coal mine operators to conduct both designated area sampling and designated occupation sampling, rather than allowing them the discretion to sample either (Document ID 1399). This is a misinterpretation of the rule. Final paragraph (e)(2)(ii), which was proposed as paragraph (f)(2)(ii), states that ''[t]he full-shift, 8-hour TWA exposure for such miners shall be measured based on . . . Occupational environmental samples collected in accordance with § 70.201(c), § 71.201(b), or § 90.201(b) of this chapter for coal operations.'' Sections 70.201(c) and 71.201(b) both prescribe processes for occupational samples, including conversion of designated areas to Other Designated Occupations and requirements for how sampling devices must be used and worn. Paragraph (e)(2)(ii) does not change operators' discretion under section 70.201(c) or 71.201(b).

Representative Sampling

As a general principle, mine operators must accurately characterize miners' exposure to respirable crystalline silica. In some cases, this requires sampling all exposed miners, while in other cases, sampling a ''representative'' fraction of miners is sufficient. When a mine operator elects to engage in representative sampling, the mine operator may take, and submit for analysis, fewer samples. Under this rule, mine operators must assess the typical circumstances of each shift and each employee to identify miners most at risk for overexposure (for example, miners working near where dust collector cleaning or bagging operations are taking place) and choose those miners to be ''representative'' for sampling purposes. This approach allows mine operators to assess the highest likely exposure levels and implement and adjust engineering controls to address the highest likely concentrations of respirable crystalline silica. MSHA finds that representative sampling is sufficient to measure the effectiveness of the engineering controls in place. This applies to miners who were not included in the sampling but who are represented by the representative samples.

Under the final rule, like the proposal, where several miners perform the same tasks on the same shift and in the same work area, mine operators may sample a representative fraction (at least two) of these miners. When sampling a representative fraction of miners, mine operators are required to select the miners expected to have the highest exposure to respirable crystalline silica. For example, sampling a representative fraction may involve monitoring the exposure of those miners who are closest to the dust source. The sampling results for these miners can then be attributed to the remaining miners in the group. When miners are performing different tasks, a representative sample of miners in the same working area is not sufficient to characterize actual exposures, and therefore individual samples are necessary.

MSHA received many comments on the proposed representative sampling requirements from MNM mine operators, mining and industry trade associations, labor unions, and an industrial hygiene professional association, with many commenters supporting the proposal (Document ID 1398; 1392; 1351; 1407; 1432; 1448; 1417; 1378; 1424; 1419; 1441; 1378; 1399). The AIHA, Portland Cement Association, SSC, and NSSGA suggested that ''similar exposure groups,'' or SEGs, be used as a method to determine which miners to sample for representative sampling and to reduce operator costs for complying with the exposure monitoring requirements in the rule (Document ID 1351; 1407; 1432; 1448). Arizona Mining Association stated that mine operators should be allowed to use SEGs because the alternative of viewing all miners' exposure as the same will result in large cost increases and wasted resources (Document ID 1368).

MSHA did not adopt an SEG approach in the final rule. The Agency agrees that mine operators do not always need to conduct sampling for every exposed miner. Sampling for a representative fraction of miners is similar to the SEG concept because both approaches group miners with similar exposure characteristics for the purpose of sampling a smaller subset of the group.

However, there is likely more room for error and misclassification using SEGs in mining, especially among smaller mines. SEGs rely on the principle of grouping workers into exposure profiles and assessing the health risks to those workers based on similar exposure conditions. Accordingly, SEGs are commonly established by experienced environmental health and safety (EHS) professionals using a combination of exposure characteristics, including location, job, task, and equipment used. Small mines may not have EHS professionals to correctly define SEGs and validate data using proper statistical analyses. There is also risk for SEG misclassification if, for example, sampling data is incorrectly grouped, not representative of all exposures on all shifts, or not collected for the full shift. MSHA is also concerned with variability in silica concentrations in the ore body in mining (especially in coal). Mines are constantly changing, which means that miners' exposures will also change. SEGs would need to be continuously reviewed by EHS professionals to ensure that they are correctly defined over time.

The NSSGA, BMC, Pennsylvania Coal Alliance, and AEMA stated that samples from miners performing the same task in the same area but on different shifts should qualify as representative, with the Pennsylvania Coal Alliance stating that MSHA's limitation of samples to a single shift is unduly restrictive (Document ID 1448; 1417; 1378; 1424).

The final rule requires representative sampling to be restricted to the same shift, rather than spanning across multiple shifts. MSHA believes that where miners are not performing the same tasks on the same shift and in the same work area, representative sampling will not adequately characterize actual exposures. In the Agency's experience, mine operators may schedule high hazard-generating activities during one shift and not others, which would create differences in the environment. Humidity, changes in geology, and other environmental conditions that might impact sampling results could change across shifts, as well; for example, a typically warm and sunny day shift versus a cooler shift where temperatures approach or move further from the dewpoint. MSHA finds that rather than trying to control for potentially significant and unanticipated variables across shifts, miner health and safety is better protected if representative sampling is confined to the same shift, where conditions are more likely to be consistent across miners represented by the sampling. MSHA notes that OSHA's requirements for representative sampling for general industry and construction are also applied to individual shifts. *See* 29 CFR 1910.1053(d)(3)(i).

Sampling Devices: Incorporation of ISO 7708:1995 by Reference

ISO 7708:1995(E), ''*Air quality—particle size fraction definitions for health-related sampling,*'' First Edition, 1995–04–01, is an international consensus standard that defines sampling conventions for particle size fractions used in assessing possible health effects of airborne particles in the workplace and ambient environment. It defines conventions for the inhalable, thoracic, and respirable fractions. The ISO standard also provides formulas for determining the fractions based on the aerodynamic diameter of the particles present. MSHA is incorporating by reference ISO 7708:1995 in § 60.12(e)(4) to ensure consistent sampling collection by mine operators through the utilization of samplers conforming to ISO 7708:1995.

Under the final rule, MSHA requires mine operators to use respirable-particle-size-selective samplers that conform to the ISO 7708:1995 standard to determine compliance with the PEL. Mine operators are allowed to use any type of sampling device for respirable crystalline silica sampling, as long as the device is designed to meet the characteristics for respirable-particle-size-selective samplers that conform to the ISO 7708:1995 standard and, where appropriate, meet MSHA permissibility requirements.

Sampling devices, such as cyclones [74] and elutriators,[75] can separate the respirable fraction of airborne dust from the non-respirable fraction in a manner that simulates the size-selective characteristics of the human respiratory tract and that meets the ISO standard. These devices enable collection of dust samples that contain only particles small enough to penetrate deep into the lungs. Size-selective cyclone sampling devices are typically used in the U.S. mining industry. These samplers generally consist of a pump, a cyclone, and a membrane filter. The cyclone uses a rapid vortical flow of air inside a cylindrical or conical chamber to separate airborne particles according to their aerodynamic diameter (*i.e.,* particle size). As air enters the cyclone, the larger particles are centrifugally separated and fall into a grit pot, while smaller particles pass into a sampling cassette where they are captured by a filter membrane that is later analyzed in a laboratory to determine the mass of the respirable dust collected. The pump creates and regulates the flow rate of incoming air. As the flow rate of air increases, a greater percentage of larger and higher-mass particles are removed from the airstream, and smaller particles are collected with greater efficiency. Adjustment of the flow rate changes the particle collection characteristics of the sampler and allows calibration to a specified respirable particle size sampling definition, such as the ISO criterion.

A cyclone sampler calibrated to operate at the manufacturer's specified air flow rate that conforms to the ISO standard can be used to collect respirable crystalline silica samples under this final rule. MSHA reviewed OSHA's feasibility analysis for its 2016 silica final rule and agrees that there are commercially available cyclone samplers that conform to the ISO standard and allow for the accurate and precise measurement of respirable crystalline silica at concentrations below both the action level and PEL (OSHA, 2016a). Cyclone samplers include, but are not limited to, the Dorr-Oliver 10-mm nylon cyclone, as well as the Higgins-Dewell, GK2.69, SIMPEDS, and SKC aluminum cyclone. Each of these cyclones has different operating specifications, including flow rates, and performance criteria, but all are compliant with the ISO criteria for respirable dust with an acceptable level of measurement bias. MSHA's determination is that cyclone samplers, when used at the appropriate flow rates, can collect a sufficient mass of respirable crystalline silica to quantify atmospheric concentrations lower than the action level and meet MSHA's crystalline silica sample analysis specifications for samples collected at MNM and coal mines.

MNM mine operators who currently use a Dorr-Oliver 10 mm nylon cyclone can continue to use it at a flow rate of 1.7 L/min, which conforms to the ISO standard, to comply with the requirements. For coal mine operators, the gravimetric samplers previously used to sample RCMD (*i.e.,* coal mine dust personal sampling units (CMDPSUs)) were operated at a 2.0 L/min flow rate. Those CMDPSUs can be adjusted to operate at a flow rate of 1.7 L/min to conform to the ISO standard.

The NMA, AEMA, and SKC Inc., noted that samplers other than cyclones and elutriators should be considered acceptable under the final rule (Document ID 1428; 1424; 1366). A miner health advocate stated that when conducting sampling under OSHA requirements, they currently use a type of sampler called a ''parallel particle impactor,'' or PPI sampler, that meets the ISO 7708:1995 standard (Document ID 1375). This commenter stated that there is a disconnect between the cyclone samplers mentioned in the proposed rule and the use of PPI samplers as an acceptable sampling device, implying that PPI samplers are not acceptable because they were not included in the list of example samplers that meet the ISO 7708:1995 standard in the Sampling Methods section of the proposed rule. This commenter also suggested that the PPI sampling device be considered acceptable under this final rule. Similarly, the NMA, AEMA and SKC stated that MSHA's proposal implies that only cyclone and elutriator type samplers meet the specifications for acceptable sampling devices.

MSHA clarifies that cyclone and elutriator type samplers are not the only acceptable sampling devices that can be used to conduct sampling for respirable crystalline silica under this rule. In the Sampling Methods section of the proposed rule, MSHA included a list of example samplers that conform to the ISO 7708:1995 standard. This list was not meant to be all-inclusive, but rather provide several examples of samplers currently available in the marketplace that conform to the ISO 7708:1995 standard (88 FR 44921). As stated above, mine operators can use any type of sampling device, as long as it is designed to meet the characteristics for respirable-particle-size-selective samplers that conform to the ISO 7708:1995 standard and, where appropriate, meet MSHA permissibility requirements. MSHA clarifies that under this final rule, any sampling device that meets the ISO 7708:1995 particle size selective criteria for respirable dust samplers are acceptable for respirable crystalline silica sampling, even if the sampler is not specifically mentioned in the list of examples. Under the final rule, the PPI sampler would be acceptable.

Several commenters, including labor organizations and a federal elected official, noted the need for sampling devices with real-time or near real-time sample analysis capabilities for respirable crystalline silica (Document ID 1449; 1447; 1398; 1412; 1399; 1439). The AFL–CIO stated that one of the most significant items not included in the proposal (that was included in the 2014 Coal Dust Rule) was personal dust monitoring devices with real-time analysis (Document ID 1449). The commenter recommended the adoption of new technology used by the domestic or international mining community to better protect miners. An individual stated that MSHA should consider and incorporate continuous and rapid quartz

[74] A cyclone is a centrifugal device used for extracting particulates from carrier gases (*e.g.,* air). It consists of a conically shaped vessel. The particulate-containing gas is drawn tangentially into the base of the cone, takes a helical route toward the apex, where the gas turns sharply back along the axis, and is withdrawn axially through the base. The device is a classifier in which only dust with terminal velocity less than a given value can pass through the formed vortex and out with the gas. The particle cut-off diameter is calculable for given conditions.

[75] An elutriator is a device that separates particles based on their size, shape, and density, using a stream of gas or liquid flowing in a direction usually opposite to the direction of sedimentation. The smaller or lighter particles rise to the top (overflow) because their terminal sedimentation velocities are lower than the velocity of the rising fluid.

monitoring systems to more appropriately characterize exposures (Document ID 1412).

MSHA is aware of NIOSH's rapid field-based quartz monitoring (RQM) approach as an emerging technology. It provides a field-based method for providing respirable crystalline silica exposure measurements at the end of a miner's shift. With such an end-of-shift analysis, mine operators can identify overexposures and mitigate hazards more quickly. NIOSH Information Circular 9533, ''Direct-on-filter Analysis for Respirable Crystalline Silica Using a Portable FTIR Instrument'' provides detailed guidance on how to implement a field-based end-of-shift respirable crystalline silica monitoring program.[76] The current RQM monitor, however, was designed as an engineering tool specifically for quartz in coal mines and has not been used for measurements of cristobalite and tridymite. MSHA has determined that the RQM monitor lacks tamper-proof components and is susceptible to interferences (*e.g.,* in MNM mines) which can affect its accuracy. Thus, the RQM may not be used for compliance with the sampling requirements of the final rule. MSHA continues to support NIOSH efforts to develop the RQM monitor.

While the current RQM cannot be used for compliance with the sampling requirements under this final rule, MSHA encourages mine operators to use the RQM as an engineering tool as the Agency believes it could assist operators in identifying areas of concern, including samples that would be most appropriate for further laboratory analysis. MSHA notes that samples taken by operators using the RQM with results above the PEL are not subject to the requirements of the final rule (*i.e.,* the mine operator need not report them to MSHA, take corrective actions, or conduct additional sampling, etc.). MSHA continues to support NIOSH efforts to develop the RQM monitor to be used in mines.

MSHA maintains that analysis of samples using accredited laboratories is an accurate and reliable method of determining respirable crystalline silica exposures. Accurate laboratory analysis is needed as a reference measurement at the beginning and again at the end of an initial exposure assessment as well as when completing follow-up assessments to validate compliance. However, end-of-shift monitoring can reduce the number of samples taken and provide quick results that can be used to reduce the expense of more frequent sampling and laboratory analysis, during implementation of corrective actions, to validate the effectiveness of corrective actions between collection of gravimetric samples, and to increase awareness of potential overexposures in a timely manner.

Seasonal and Intermittent Mines

Seasonal and intermittent mines may have less time to conduct 3-month sampling. Under the rule, all operators, including seasonal and intermittent, must conduct initial sampling when commencing operations after the listed compliance dates. If that initial sampling is below the action level, MSHA believes that, although the operator may wait up to 3 months to conduct the next sample, most operators would have an incentive to take another sample as soon as practicable under § 60.12(a) in order to be relieved from the continuing 3-month sampling requirements if a second consecutive sample result is below the action level. In that situation, the operator would need only to conduct its periodic evaluation every six months or when circumstances change pursuant to § 60.12(c). If the initial sample is at or above the action level and at or below the PEL, all operators would need to take a second sample within 3 months, and within every three months after that unless they meet the criteria to discontinue sampling. Operators that are active during the 3-month period would need to meet these sampling deadlines, even if the operator is not active full-time during the 3-month period. Once operators have closed for the season, or for an extended period (more than 3 months), they would not be expected to continue sampling every 3 months. However, when they re-open, if they have not met the requirements for discontinuing sampling, they would need to start sampling immediately and every three months. MSHA encourages operators to work with their District Managers to develop a workable sampling schedule that protects miners as this rule intends.

e. Section 60.12 (f)—Methods of Sample Analysis

The final rule, like the proposal, specifies the methods to be used for analysis of respirable crystalline silica samples, including details regarding the specific analytical methods to be used and the qualifications of the laboratories where the samples are to be analyzed.

ISO/IEC 17025 Accreditation

Mine operators are required to use laboratories that are accredited to the International Organization for Standardization (ISO) or International Electrotechnical Commission (IEC) (ISO/IEC) 17025, ''*General requirements for the competence of testing and calibration laboratories*'' with respect to respirable crystalline silica analyses, where the accreditation has been issued by a body that is compliant with ISO/IEC 17011 ''*Conformity assessment—Requirements for accreditation bodies accrediting conformity assessment bodies.*'' Accredited laboratories are held to internationally recognized laboratory standards and must participate in quarterly proficiency testing for all analyses within the scope of the accreditation.

The ISO/IEC 17025 standard is a consensus standard developed by ISO/IEC and approved by ASTM International (formerly the American Society for Testing and Materials). This standard establishes criteria by which laboratories can demonstrate proficiency in conducting laboratory analysis through the implementation of quality control measures. To demonstrate competence, laboratories must implement a quality control program that evaluates analytical uncertainty and provides estimates of sampling and analytical error when reporting samples. The ISO/IEC 17011 standard establishes criteria for organizations that accredit laboratories under the ISO/IEC 17025 standard. For example, the American Industrial Hygiene Association (AIHA) accredits laboratories for proficiency in the analysis of respirable crystalline silica using criteria based on the ISO/IEC 17025 and other criteria appropriate for the scope of the accreditation.

MSHA received a few comments regarding the proposed requirement for mine operators to use laboratories accredited to ISO/IEC 17025 where the accreditation has been issued by a body that is compliant with ISO/IEC 17011 from AIHA, NVMA, BMC, and A2LA (Document ID 1351; 1441; 1417; 1388). AIHA and A2LA stated that they agree

[76] National Institute for Occupational Safety and Health (NIOSH). 2022b. Direct-on-filter analysis for respirable crystalline silica using a portable FTIR instrument. By Chubb LG, Cauda EG. Pittsburgh PA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2022–108, IC 9533. *https://doi.org/10.26616/NIOSHPUB2022108* (last accessed Jan. 10, 2024). The document is intended for industrial hygienists and other health and safety mining professionals who are familiar with respirable crystalline silica exposure assessment techniques, but who are not necessarily trained in analytical techniques. It gives general instructions for setting up the field-based monitoring equipment and software. It also provides case studies and examples of different types of samplers that can be used for respirable crystalline silica monitoring. Guidance on the use, storage, and maintenance of portable IR instruments is also provided in the document.

with MSHA's proposed requirement and BMC stated that they have no objection to the proposal. A2LA further stated that relying on accreditation for the approval of testing laboratories assures quality, technical competence, accuracy, compliance, and international recognition. A2LA stated that it provides confidence in the reliability of measurement results and supports regulatory compliance.

Under the final rule, all mine operators will have to use third-party laboratories accredited to ISO/IEC 17025 to have respirable dust samples analyzed for respirable crystalline silica. Many MNM mine operators already use third-party laboratories to perform respirable crystalline silica sample analyses. For most coal mine operators, using a third-party laboratory to analyze respirable crystalline silica samples is a new requirement because respirable coal mine quartz samples are currently analyzed by MSHA. Under the final rule, coal mine operators are responsible for directly monitoring crystalline silica (quartz) exposures in addition to coal dust. Requiring all mines to use third-party laboratories ensures that sample analysis requirements and MSHA enforcement efforts are consistent across all mines.

Analytical Methods for Sampling

The final rule requires mine operators to ensure that laboratories evaluate all samples using analytical methods for respirable crystalline silica that are specified by MSHA, NIOSH, or OSHA. These are validated methods currently being used by third party accredited laboratories for measuring respirable crystalline silica in mine dust matrices. MSHA expects that samples collected in MNM mines will be analyzed by X-ray diffraction (XRD) and samples collected in coal mines will be analyzed by Fourier transform infrared spectroscopy (FTIR).

MNM samples are currently analyzed by XRD because the XRD method can distinguish and isolate respirable crystalline silica for measurement, thereby avoiding interference or confounding of respirable crystalline silica analysis results. For MNM samples, the methods used for respirable crystalline silica sample analysis using XRD include MSHA P–2, NIOSH 7500, and OSHA ID–142. All three methods can distinguish between the three silica polymorphs.

MSHA and NIOSH have specific FTIR methods for analyzing quartz in coal mine dust. The NIOSH 7603 method is based on the MSHA P–7 method which was collaboratively tested and specifically addresses the interference from kaolinite clay. Current FTIR methods, however, cannot quantify quartz if either of the other two forms of crystalline silica (cristobalite and tridymite) are present in the sample. Additional steps such as acid treatment can be taken to remove respirable crystalline silica interferences from other minerals that can be found in mine dust sample matrices. For coal samples, the methods used for respirable crystalline silica sample analysis using FTIR include MSHA P–7, NIOSH 7602, and NIOSH 7603.

MSHA received some comments from mining trade associations, a MNM mine operator, and a labor union regarding the proposed requirements for specified analytical methods (Document ID 1398; 1424; 1417; 1428; 1443). BMC stated that they have no objection to MSHA's proposed provisions and UMWA stated that they are supportive of MSHA's proposed requirements. The AEMA, NMA and WVCA cautioned that many minerals interfere with the laboratory's analysis of silica and cited a list produced by OSHA of 18 mineral types that might interfere. Some of these commenters expressed concern that interference could erroneously elevate silica sample levels and cause mine operators to spend resources on corrective actions that are not needed.

As discussed above, MSHA expects that samples collected in MNM mines will be analyzed by XRD and samples collected in coal mines will be analyzed by FTIR. In response to the commenters' concern about mineral types that could erroneously elevate silica sample levels, MSHA disagrees with the commenters and notes that the OSHA method cited by the commenters (*i.e.,* OSHA ID–142) addresses mineral interference and is one of the XRD methods that can be used for respirable crystalline silica sample analysis under the final rule.

f. Section 60.12 (g)—Sampling Records

Under the final rule, the mine operator is required to create a record for each sample taken that includes the sample date, the occupations sampled, and the concentrations of respirable crystalline silica and respirable dust. The mine operator is also required to post the record and the laboratory report on the mine bulletin board and, if applicable, by electronic means, for the next 31 days, upon receipt.

MSHA received a few comments on the proposed sampling records provision. The APHA recommended that MSHA update § 60.12(h) to require mine operators to provide a description or data that shows the sample was taken during typical mining activities (Document ID 1416). The same commenter also recommended that MSHA require the person collecting the samples and recording the data to certify the accuracy of the records in writing. The Hon. Robert C. ''Bobby'' Scott, The American Thoracic Society *et al.* and AFL–CIO supported greater accessibility of records (Document ID 1439; 1421; 1449). Two of these commenters also recommended that sampling records be sent to the miners' representatives (Document ID 1439; 1449).

In MSHA's experience, commercial laboratories that produce reports for respirable crystalline silica exposures include information on sample locations and/or activities being performed. In some cases, the name of the person that was sampled is also included. The final rule only requires the sampling record to include the date, occupations sampled, and concentrations of respirable crystalline silica and respirable dust since the laboratory report may contain additional information. MSHA believes the elements it requires as part of the sampling record provide mine operators and miners with the most important pieces of information while balancing concerns about recordkeeping burden. As required in § 60.16(b), any sampling record that is created may be requested at any time by, and must promptly be made available to, miners, authorized representatives of miners, or an authorized representative of the Secretary.

6. Section 60.13—Corrective Actions

The final rule establishes the requirements for corrective actions in § 60.13. Section 60.13 paragraph (a) requires mine operators to take certain actions when any sampling result indicates that a miner's exposure to respirable crystalline silica exceeds the PEL. Paragraph (a) has three subparagraphs—(1), (2), and (3). Paragraph (a)(1) requires mine operators to make NIOSH-approved respirators available to affected miners before the start of the next work shift. In a change from the proposal, paragraph (a)(1) specifies that this requirement must be made in accordance with § 60.14 (b) and (c). Paragraph (a)(2), unchanged from the proposal, requires mine operators to ensure that affected miners wear respirators properly for the full shift or during the period of overexposure until miner exposures are at or below the PEL. Paragraph (a)(3), unchanged from the proposal, requires mine operators to immediately take corrective actions to lower the concentration of respirable crystalline silica to at or below the PEL. Paragraph (b) mirrors language from the proposal and specifies the mine operator's responsibility to conduct sampling and implement additional or new corrective actions until a subsequent sampling result indicates miner exposures are at or below the PEL once corrective actions have been taken. Paragraph (c), unchanged from the proposal, requires the mine operator to make a record of corrective actions and the dates of those actions. Below is a detailed discussion of the comments received on this section and modifications made in response to the comments.

MSHA received several comments including an individual who is a director at a pulmonary rehab center, advocacy organizations, and a miner health advocate, recommending that mine operators stop all production work and withdraw miners if samples are above the PEL (Document ID 1445; 1395; 1396; 1425; 1394; 1399). Some commenters (*e.g.,* AFL–CIO and an individual) suggested MSHA should include an upper exposure limit, above which operators would be required to withdraw miners, with ACLC suggesting miners be withdrawn at 100 μg/m³ (Document ID 1449; 1367; 1445). Some commenters expressed concern that allowing miners to continue working in hazardous dust levels violates the Mine Act, with one stating that conditions above the PEL should be considered an ''imminent danger'' under section 107(a) of the Mine Act.

MSHA's existing health standards do not require the withdrawal of miners when sampling is over the PEL and mine operators are taking corrective actions, except in certain circumstances based on the risk and exposure to the miner according to section 104(b) of the Mine Act. Accordingly, under § 60.13, mine operators must ensure that affected miners wear respirators properly for the full shift or during the period of overexposure while the mine operators are taking immediate corrective actions to lower miner exposures to at or below the PEL.

MSHA received several comments on the use of respirators while corrective actions are being taken by the operator. A law firm said respirators should be used permanently as a corrective action (Document ID 1353). UMWA and Rep. Robert ''Bobby'' Scott opposed the mandatory use of respirators and stated that mandating respirator use is inconsistent with the Mine Act; UMWA instead supported the voluntary usage of respirators as a supplement to engineering controls (Document ID 1353; 1398; 1439). USW cautioned that the provision could allow mine operators to justify respirator usage on more than a temporary basis (Document ID 1447). The UMWA was also concerned that using respirators as a mandatory temporary solution might lead to reduced use of engineering and environmental methods as the primary means of controlling exposures (Document ID 1398). ACLC stated that the language is vague and unclear on how long miners will be required to rely on respirators while corrective actions are being taken (Document ID 1445). Further, commenters including advocacy organizations, labor organizations, MNM operators, an industry trade association, and a medical professional association stated that the final rule needs to clarify how long miners are allowed to wear respirators when their exposure is over the PEL (Document ID 1404; 1421; 1425; 1432; 1439; 1440; 1445; 1447; 1449; 1393; 1395; 1396). AFL–CIO stated that corrective actions should be strengthened to include actions other than respirator use and if sampling shows that there is continued non-compliance with the PEL there needs to be more significant corrective actions taken to ensure that dust concentrations are reduced permanently (Document ID 1449; 1353).

As explained earlier, respirator use is not allowed for compliance. Under § 60.13, if sampling shows exposure above the PEL, mine operators are required to provide miners with approved respirators before the next shift begins, and affected miners must wear respirators properly for the full shift or during the period of overexposure until miner exposures are at or below the PEL. This provides miners with protection from respirable crystalline silica dust and thereby limits the serious health effects associated with respirable crystalline silica exposures until engineering controls are in place. Mine operators must also immediately take corrective actions to lower the concentration of respirable crystalline silica to at or below the PEL. This approach is consistent with the NIOSH 1995 Criteria Document in which NIOSH recommends the use of respirators as an interim measure when engineering controls and work practices are not effective in maintaining worker exposures at or below the PEL. Under this section, MSHA emphasizes that respirators are to be used only while mine operators take corrective actions to lower the concentration of respirable crystalline silica to at or below the PEL. MSHA clarifies that whenever exposures are over the PEL, corrective actions must be taken and MSHA must be notified immediately.

Further, MSHA emphasizes that section 202(h) of the Mine Act, an interim standard applicable to underground coal mine operators, specifically prohibits operators from using respirators as a substitute for engineering controls in the active workings. Section 202(h) of the Mine Act provides that ''Respiratory equipment approved by the Secretary and the Secretary of Health and Human Services shall be made available to all persons whenever exposed to concentrations of respirable dust in excess of the levels required to be maintained under this chapter. Use of respirators shall not be substituted for environmental control measures in the active workings.'' 30 U.S.C. 842(h). The final rule is consistent with the Mine Act, MSHA's existing standards, and case law. *See, e.g., Nat'l Min. Ass'n* v. *Sec'y, U.S. Dep't of Lab.,* 812 F.3d 843, 884 (11th Cir. 2016) (upholding MSHA's Lowering Miners' Exposure to Respirable Coal Mine Dust, Including Continuous Personal Dust Monitors rule and noting ''MSHA has interpreted the statutory command correctly, however, in requiring that mine air quality meet the regulatory standard *without* resort to a personal control''). MSHA clarifies that the final rule does not permit the use of respirators in lieu of feasible engineering and administrative controls.

MSHA believes the corrective actions provisions are appropriate and requires mine operators to make changes to reduce miners' exposures to respirable crystalline silica when exposures are above the PEL. MSHA clarifies that respirator use is not a corrective action; the corrective actions are those actions—such as watering roadways, repairing or installing new water sprays, or repairing or installing a new dust collection system—that reduce the respirable crystalline silica concentration to at or below the PEL. MSHA will determine, on a case-by-case basis, the adequacy of the corrective action that must be taken immediately and the appropriate timeframe within which it must occur. Although each engineering control employed as a corrective action is different, mine operators are expected to minimize the time spent performing corrective actions and, as a result, the time affected miners spend using respirators. Any exposures over the PEL are a violation of the standard. Additionally, when engineering controls are being developed and implemented as a part of corrective actions, mine operators are to continue corrective action sampling. Any operator samples over the PEL, including corrective action sampling, are to be reported to the District Manager. If sampling continues to be over the PEL, the District Manager will take appropriate enforcement actions and may provide assistance, depending on the circumstances.

Once corrective actions have been taken, the mine operator shall conduct sampling pursuant to paragraph 60.12(b). The operator will need to take additional or new corrective actions until sampling indicates miner exposures are at or below the PEL. Further corrective action sampling is discussed in *Section VIII.B.5. Exposure Monitoring.* Once corrective actions have been implemented, the mine operator is expected to make a record of the corrective actions promptly including the dates of the corrective actions. Record keeping is further discussed in *Section VIII.B.9. Recordkeeping Requirements.*

7. Section 60.14—Respiratory Protection

Section 60.14 expands on the requirements for the use of respiratory protection for respirable crystalline silica. Section 60.14 paragraph (a) addresses MNM mines only. This paragraph requires the temporary use of respirators at MNM mines when concentrations of respirable crystalline silica are above the PEL. In a change from the proposal, the final rule specifies that the requirements in paragraph (a) only apply to MNM mines; coal mines are not covered under this paragraph—coal mines are addressed under section 60.13 paragraph (a). The Agency also removed the term ''non-routine'' from proposed paragraph (a).

Paragraph (b), unchanged from the proposal, applies to all mines and addresses circumstances where miners are medically unable to wear respirators. Paragraph (c) also applies to all mines and addresses the respiratory protection requirements. Paragraph (c)(1), which requires mine operators to provide NIOSH-approved respirators to affected miners, is unchanged from the proposed rule. Paragraph (c)(2) is changed from the proposal and specifies that where approved respirators are used mine operators must have a written respiratory protection program in accordance with ASTM F3387–19 and lists the mandatory ASTM program elements.

MSHA received many comments regarding the respiratory protection provisions, with some commenters supporting the proposal and some opposing it. After reviewing all the comments, MSHA concludes that the proposed respiratory protection provisions should be retained, with some modifications.

a. Section 60.14(a)—Temporary Use of Respirators at Metal and Nonmetal Mines

Final 60.14(a) states that when MNM miners must work in concentrations of respirable crystalline silica above the PEL while engineering controls are being developed and implemented or it is necessary by nature of the work involved, the mine operator shall use respiratory protection as a temporary measure. In a change from the proposal, MSHA removed the term ''non-routine'' from the paragraph heading and clarified that the requirement for temporary use of respirators is applicable only to MNM mines.

MSHA received several comments on the proposed temporary non-routine use of respirators, with many commenters opposing the proposed mandatory use requirement for coal mines. Commenters identified difficulties in wearing respirators and stated that coal mine operators must comply with existing standards for ventilation and dust control plans, which have to be submitted to and approved by MSHA. Other commenters expressed concern that there was an absence of a time limit for which silica levels over the PEL are permitted.

Some advocacy organizations and a miner health advocate asked that MSHA require mine operators to withdraw miners when sampling indicated exposures above the PEL (Document ID 1445; 1395; 1367; 1396; 1425). A medical professional also requested that MSHA require operators to withdraw miners from hazardous conditions when sampling indicates they are exposed to respirable silica above the PEL (Document ID 1394).

An individual stated that mine construction and coal production, in particular, should be excluded from the circumstances in which temporary and non-routine use of respirators are allowed (Document ID 1412). Many commenters including advocacy organizations, black lung clinics, miner health advocates, and labor organizations suggested that coal miners should be prohibited from working in overexposures while using respirators, stating that the working conditions, especially in underground coal mines, make it very difficult for miners to communicate and work safely while wearing respirators (Document ID 1372; 1399; 1398; 1447; 1449; 1421; 1393; 1395; 1396; 1402; 1425; 1445; 1410; 1342; 1363; 1391; 1394). One of the labor organizations noted that respirators do nothing to address bystander exposures (Document ID 1449).

After considering the comments, MSHA agrees, and clarifies that paragraph (a) does not apply to coal mine operators. MSHA determined that coal mine operators control silica and coal mine dust through their approved ventilation and dust control plans. Underground coal mine operators are required to have ventilation plans, which include a respirable dust control plan, which must be submitted to and approved by MSHA. *See* 30 CFR 75.370(a)(1). These plans must be revised to address any overexposures to airborne contaminants. Surface coal mines that have had a dust overexposure are required to develop and implement respirable dust control plans that are approved by MSHA. *See* 30 CFR 71.300. For those areas of a surface coal mine where methane accumulation is a hazard, such as tunnels and other enclosed working areas, mine operators are required to dilute airborne contaminants with ventilation controls.

In MSHA's experience, if there are overexposures to respirable crystalline silica or coal mine dust, coal mine operators will adjust their ventilation and dust controls to address these overexposures. MSHA's experience has shown that these adjustments have generally been successful in protecting miners from silica and dust exposures without the need for respirators and that most conditions can be corrected within a day. Additionally, as is currently the case when a respirable coal dust overexposure occurs, under the final rule, citations for respirable crystalline silica overexposures will require abatement through immediate corrective actions before the citation is terminated. MSHA sets any citation abatement deadline with the protection of the miners as the primary consideration.

Also, the proposal was a departure from existing standards for coal mine operators. Under the existing standards, coal mine operators have to provide respiratory protection, but miners did not have to wear respirators. Therefore, MSHA has changed this requirement in the final rule to apply to MNM mines only for paragraph (a). MSHA reiterates under § 60.13(a) that coal mine operators must use respirators when sampling indicates that a miner's respirable crystalline silica exposure exceeds the PEL.

Commenters including advocacy organizations, labor organizations, MNM operators, an industry trade association, and a medical professional association requested that MSHA clarify the meaning of ''temporary non-routine'' to specify circumstances and time limitations (Document ID 1393; 1395; 1396; 1425; 1445; 1447; 1449; 1432; 1440; 1404; 1421; 1409; 1439; 1364). Some advocacy organizations and a labor organization asked that MSHA define ''temporary'' use for coal mines (Document ID 1393; 1395; 1449). One of the labor organizations noted that, without defined time limits, operators could require miners to wear respirators for weeks or months (Document ID 1449).

MSHA agrees with the commenters who stated that the meaning of ''temporary non-routine'' needed to be clarified. MSHA removed ''non-routine'' from the paragraph heading for clarity and to be more consistent with the existing requirements for MNM mine operators in §§ 56.5005 and 57.5005. Final paragraph (a) applies only to MNM operators, is consistent with the existing requirements for controlling exposure to airborne contaminants in §§ 56.5005 and 57.5005 and is responsive to comments.

Final paragraph (a)(1) requires respirator use as a temporary measure while MNM miners must work in concentrations of respirable crystalline silica above the PEL while engineering control measures are being developed and implemented. Final paragraph (a)(2) includes a clarifying change from the proposal to include an example in the existing MNM standard that requires MNM mine operators to use respirators in temporary situations when it is necessary by the nature of work involved (for example, occasional entry into hazardous atmospheres to perform maintenance or investigation) when miners are working in concentrations of respirable crystalline silica above the PEL. Several existing MSHA standards use the term ''temporary'' although the Agency does not specify a time limit. The mining industry is familiar with these standards. MSHA expects ''temporary'' to have the same meaning as in existing standards—a short period of time.

Under existing standards, MNM miners can work for reasonable periods of time in concentrations of airborne contaminants exceeding permissible levels if they are protected by approved respirators when developing and implementing engineering control measures or when necessary by the nature of work involved. Under these existing MNM standards, mine operators who have overexposures and are required to provide respiratory protection to miners are issued a citation for the overexposure. Generally, if MNM mine operators have a written respiratory protection program in place, the citation would be non-Significant and Substantial.

MSHA has always intended for miners to work in these conditions temporarily and the agency has enforced it as such. The final rule thus does not make any substantive changes from the existing standard in MNM. The update in language from ''reasonable periods of time'' to ''temporary'' in the final rule is an update in line with MSHA's original intent and as previously noted, with other existing MSHA standards. Husch Blackwell (on behalf of the SSC), NSSGA, U.S. Silica, and IAAP stated that respirators are the only feasible means of protection for certain tasks in mining environments, such as housekeeping, working on dust collectors, and bagging operations (Document ID 1432; 1448; 1455; 1456). MSHA emphasizes that respiratory protection under § 60.14 (a) is required to be temporary. The Agency intends for temporary to mean that miners wear respiratory protection only for short periods of time; for example, the time necessary to conduct maintenance and repair of engineering controls. Similar to existing MNM standards, the Agency, under this final rule, does not intend that miners will wear respirators for extended periods of time. As an example, when a crusher needs maintenance or repair after an overexposure resulting from a defective water spray bar, miners must wear respiratory protection when performing maintenance or conducting repairs to the spray bar. Another example includes when miners change defective dust bags that can cause overexposures to respirable crystalline silica; when replacing the dust bags, miners must wear respiratory protection.

After reviewing these comments, MSHA revised paragraph (a)(2) to provide a clarifying example on when MNM mine operators would temporarily use respirators due to the nature of the work involved. Under the final rule, the Agency prohibits use of respirator to achieve compliance with the PEL. In response to the comment that respirators are the only means to achieve compliance for certain mining tasks, MSHA has reviewed its sample data and has determined that mine operators are generally able to achieve compliance with existing engineering controls, supplemented by administrative controls. MSHA is aware that certain mining tasks related to maintenance and repair of engineering controls will require respiratory protection. However, MSHA anticipates that respirator use will be temporary, until controls are repaired and effective, and respirator use will not be considered as a means to achieve compliance. This clarifying change on the use of respirators for certain tasks such as the occasional entry into hazardous atmospheres to perform maintenance or investigation, is consistent with the Agency's existing standards.

A joint comment by The American Thoracic Society *et al.* suggested that temporary reliance on respirator use be limited to miners actively working at the time it is noted that silica exceeds the PEL, and only for as long as it takes to safely shut down operations (Document ID 1421). The AFL–CIO suggested that MSHA treat respirator use as a variance from normal activity, requiring operators to prove when respirator use is necessary (Document ID 1449).

MSHA understands that respirator use under paragraphs (a)(1) and (a)(2) will be different depending on the facts and circumstances in the MNM mines and that the temporary nature of respirator use will depend on the time needed to correct an overexposure. MSHA will determine the time required for temporary respirator use on a case-by-case basis. MSHA emphasizes that the District Manager will be informed of all overexposures under 60.12(b). MSHA can take enforcement action, including issuing a withdrawal order under 104(b) of the Mine Act, if the facts and circumstances at the mine require it.

An individual stated that the proposed rule rejected respirator use as a method of compliance in the preamble to § 60.11 but proposed § 60.14 appeared to contradict the prohibition (Document ID 1412). The Black Lung Clinics stated there is no real-time feedback for determining whether a respirator is effectively reducing exposure levels (Document ID 1410) which may provide a false sense of security that the miner is protected from cumulative exposures to respirable crystalline silica.

In response, MSHA clarifies that there is not a contradiction between § 60.11 and § 60.14. Final rule § 60.11 requires engineering controls supplemented by administrative controls to reduce exposures. In MSHA's experience, miners who use respirators under a respiratory protection program that is in accordance with MSHA's standards are protected from cumulative exposures to airborne hazards. Final § 60.14(a) additionally requires the use of respirators in MNM mines in case of an overexposure; however, MNM mine operators will be cited for the overexposure. This is consistent with MSHA's existing standards and enforcement practice for MNM mines.

Comments from MNM mining operators, mining trade associations, and state mining associations suggested that, consistent with the OSHA rule, MSHA should allow operators to use respirators as a method of compliance where engineering and administrative controls are unable to reduce silica levels below the PEL (Document ID 1368; 1424; 1428; 1441; 1448; 1455). The NMA stated that respirators, including PAPRs, should be allowed to be used whenever miners are working in exposures above the PEL (Document ID 1428). The Pennsylvania Coal Alliance and Vanderbilt Minerals, LLC stated that PAPRs are comfortable to wear for long periods and do not restrict breathing (Document ID 1378; 1419). In contrast, three labor organizations opposed the use of respirators (Document ID 1398; 1447; 1449). These commenters stated that the Mine Act forbids respirator use as a mandatory administrative control or as a substitute for environmental controls and noted that the proposed rule allowed for continued production with respirators in hazardous silica dust levels. A medical professional stated that miners should always use respirators, to ensure complete protection from respirable crystalline silica exposures (Document ID 1375).

MSHA disagrees with these commenters that respirators should be used as a method of compliance or that miners should always use respirators. MSHA has determined that respirators cannot be used as a method of compliance. Respirators do not provide effective protection from overexposures for various reasons that include: (1) without a proper fit, dust particles enter the miner's breathing zone; (2) inconsistent or incorrect use can compromise the effectiveness of the respirator; and (3) respirators can hinder effective communication among miners. MSHA has decided that respirators must not be used for compliance because they do not address the dust generation at the source. Engineering controls are reliable, provide consistent levels of protection to many miners, allow for predictable performance levels, can be monitored continually, and can remove harmful levels of airborne contaminants, including respirable crystalline silica, from the miner's environment. However, MSHA recognizes that respirators must be used, on a temporary basis, for certain mining tasks.

MSHA has provided greater health protection for miners by requiring (as opposed to making available) use of respirators for coal miners when exposed to respirable crystalline silica above the PEL, while continuing necessary protection for MNM miners. Also, in *Section VII.A. Technological Feasibility,* MSHA has determined that it is technologically feasible for mine operators to achieve the PEL using commercially available engineering controls.

Engineering controls are reliable, provide consistent levels of protection to many miners, allow for predictable performance levels, can be monitored continually, and can remove harmful levels of airborne contaminants, including respirable crystalline silica, from the miner's environment.

The AFL–CIO stated that mine operators should be required to submit scenarios where respirators are necessary under limited circumstances and if MSHA does not have evidence respirators are needed for a particular task, they should not be permitted (Document ID 1449). After considering this comment, MSHA has decided not to require MNM mine operators to submit scenarios, or plans, for the temporary use of respirators because MSHA approval takes time and, in the Agency's experience, there are unforeseen circumstances in a mine that may require the immediate implementation of engineering controls. When overexposures to respirable crystalline silica occur, paragraph 60.13(a)(3) requires the mine operator to take immediate corrective actions to lower concentrations of respirable crystalline silica to at or below the PEL. Therefore, requiring mine operators to submit a plan and receive MSHA approval before implementing changes would allow respirable crystalline silica exposures above the PEL to remain uncorrected for longer than necessary, and put miners' health at risk.

b. Section 60.14(b)—Miners Unable To Wear Respirators at All Mines

The final rule is changed from proposed paragraph 60.14(b). MSHA has revised the heading for paragraph (b) to include ''at all mines'' so that it is clear that paragraph (b) is applicable to miners unable to wear respirators at MNM and coal mines. Paragraph (b)(2) is also changed from the proposal to remove ''non-routine.'' This change is made to be consistent with the change discussed in paragraph (a). The rest of paragraph (b) is unchanged from the proposal. Paragraph (b) requires that, upon written determination by a PLHCP that an affected miner is unable to wear a respirator, the miner be temporarily transferred to work in a separate area of the same mine or to an occupation at the same mine where respiratory protection is not required. Paragraph (b)(1) states that the affected miner shall continue to receive compensation at no less than the regular rate of pay in the occupation held by that miner immediately prior to the transfer. Paragraph (b)(2) states the affected miner may be transferred back to the miner's initial work area or occupation when temporary use of respirators is no longer required.

The USW supported the temporary transfer of miners unable to wear respirators (Document ID 1447) while the Arizona Mining Association stated that it would be challenging to transfer miners who cannot wear respirators to another location or occupation where respirators are not needed (Document ID 1368).

After reviewing the comments, MSHA has determined that no change to the proposal is necessary. MSHA believes that it should not be difficult for a mine operator to temporarily transfer miners to a separate area or occupation to ensure their health and safety. Under the rule, the concentration of respirable crystalline silica to which the miner is exposed must be controlled through feasible engineering and administrative controls; therefore, instances in which a miner is transferred because of an inability to wear a respirator should be infrequent. Miners may be able to work in other areas of the mine where respirable crystalline silica concentrations are under the PEL. Furthermore, under paragraph (b)(2) the miner may be transferred back to the initial work area or occupation when the limited use of respirators is no longer required.

c. Section 60.14(c)—Respiratory Protection Requirements at All Mines

The final rule is changed from proposed paragraph (c). MSHA has revised the heading for paragraph (c) to include ''at all mines'' so that it is clear that paragraph (c) is applicable to MNM and coal mines. Paragraph (c)(1) is adopted as proposed and requires mine operators to provide affected miners with a NIOSH-approved atmosphere-supplying respirator or NIOSH-approved air-purifying respirator equipped with particulate protection classified as 100 series under 42 CFR part 84 or particulate protection classified as High Efficiency ''HE'' under 42 CFR part 84.

Some commenters, including mining and industry trade associations, stated that the NIOSH Pocket Guide to Chemical Hazards recommends the use of N–, R–, or P–95 and 99 series respirators to lower miners' exposures to respirable crystalline silica and suggested MSHA revise the final rule to also allow for these respirators

(Document ID 1407; 1419; 1424; 1428; 1442; 1448). Some mining trade associations and MNM mine operators recommended that MSHA specifically allow the use of PAPRs, (Document ID 1424; 1428; 1378; 1419; 1452).

After reviewing comments, MSHA has decided to maintain paragraph (c)(1) in the final rule, as proposed. N–, R–, or P–95 and 99 respirators may provide an appropriate level of filtration when properly fitted, worn, and maintained; however, MSHA has observed that the structural integrity of these respirators is very easily compromised in the harsh mining environment. N–, R–, or P–95 and 99 respirators are not as durable as other types of air-purifying respirators. N–, R–, or P–95 and 99 respirators are easily contaminated, damaged, and deformed and must be routinely replaced to maintain effectiveness. Also, the N–, R–, or P–95 and 99 respirators do not hold their shape or maintain an effective seal when they become wet. N–, R–, or P–95 and 99 respirators that are damaged or deformed provide little, if any, protection and may offer a false sense of security to miners. MSHA recognizes that PAPRs may be more comfortable to wear than full-face or half-face, tight-fitting air purifying respirators; however, PAPRs are still not as reliable or effective as engineering controls and are not a permanent solution. PAPRs add noise from the fan and the full-face covering making it difficult for the miner to hear or communicate effectively, which could subject the miner to hazards while working. They may also reduce the miner's peripheral vision and decrease the wearer's situational awareness around equipment or other mining hazards. PAPRs, like full-face or half-face, tight-fitting air purifying respirators, must be worn only as a temporary measure in accordance with paragraph 60.14(b).

MSHA believes that air-purifying respirators classified as 100 series or High Efficiency under the NIOSH classifications for particulate protection will provide the maximum level of protection when miners are wearing respirators and are most suitable in protecting the health and safety of miners from occupational exposure to respirable crystalline silica when exposures are above the PEL.

Paragraph (c)(2) is modified from the proposal and requires that when approved respirators are used, the mine operator must have a written respiratory protection program that meets the following requirements in accordance with ASTM F3387–19: program administration; written standard operating procedures; medical evaluation; respirator selection; training; fit testing; maintenance, inspection, and storage. The proposal did not specify the requirement for a written respiratory protection program or list the mandatory program elements. The language in the final rule is consistent with the requirements of ASTM F3387–19, *Standard Practice for Respiratory Protection,* which is incorporated by reference.

MSHA received comments on the incorporation by reference of ASTM F3387–19, with some commenters supporting the proposal and some commenters opposing it. An industrial hygiene professional association, labor organization and a mining related business supported the proposal to update the existing respirator protection standard (Document ID 1351; 1398; 1392). The AIHA and UMWA stated that the proposed incorporation by reference of ASTM F3387–19 to amend the Agency's respiratory protection program to current and comprehensive requirements was appropriate (Document ID 1351; 1398). The AEMA and NMA, who opposed the proposal, stated that MSHA should not reference the ASTM F3387–19 requirements if the Agency does not allow the use of respirators for compliance purposes (Document ID 1424; 1428). Vanderbilt Minerals, LLC asserted that incorporating ASTM F3387–19 is beyond MSHA's statutory authority and conflicts with the intent of the Mine Act (Document ID 1419).

As discussed in *Section II Pertinent Legal Authority,* the Mine Act requires the Secretary to develop and promulgate improved mandatory health or safety standards to prevent hazardous and unhealthy conditions and protect the health and safety of the nation's miners. 30 U.S.C. 811(a). Section 101(a) of the Mine Act gives the Secretary the authority to develop, promulgate, and revise mandatory health standards to address toxic materials or harmful physical agents. Under Section 101(a), a standard must protect lives and prevent injuries in mines and be ''improved'' over any standard that it replaces or revises. MSHA believes the incorporation by reference of ASTM F3387–19 is an improvement over the ANSI 1969 standard which it replaces. MSHA's incorporation by reference of ASTM F3387–19 is consistent with the Mine Act and OMB Circular A–119, ''Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity with Assessment Activities'' (81 FR 4673). The OMB Circular directs agencies to use voluntary consensus standards in lieu of government-unique standards, except where inconsistent with law or otherwise impractical.

The AIHA, NMA, and EMA stated that the proposed ASTM F3387–19 standard's requirements were too prescriptive and asked that MSHA give operators the flexibility to select the elements of that standard that are most applicable to their own needs and the hazards at their mines (Document ID 1451; 1441; 1442). The AFL–CIO expressed concern that mine operators would be allowed to determine which parts of the respiratory standard they will follow and urged MSHA to require certain components (Document ID 1449). The AEMA stated that the final rule should clarify whether a specific written respiratory protection program is required and under what standards (Document ID 1424). The AEMA also asked for more clarity from MSHA on what elements of ASTM F3387–19 will be required when respiratory protection for miners is needed.

The CISC, MSHA Safety Services, Inc., and Tata Chemicals Soda Ash Partners, LLC recommended that MSHA align the respiratory protection requirements with OSHA's requirements (Document ID 1430; 1392; 1452). Draeger Inc. asked that MSHA include in the rule additional specific provisions of ASTMF3387–19, such as the breathing gas requirements in section 13 of the ASTM F3387–19 standard and wearer seal checks, and also suggested that MSHA add requirements to the fit testing procedures to include physical movements that are more relevant to low-seam coal mines (Document ID 1409).

The Agency agrees with commenters who expressed that the requirements of the respiratory protection program are appropriate, and the Agency makes clarifying changes to the requirements in the final rule. The Agency has clarified paragraph (c)(2) to state the specific respiratory protection program requirements. In paragraph (c)(2), MSHA has deleted ''as applicable'' and added that, when respirators are used, a mine operator must have a written respiratory protection program that meets the following requirements in accordance with ASTM F3387–19: program administration; written standard operating procedures; medical evaluation; respirator selection; training; fit testing; maintenance, inspection, and storage. MSHA has the authority, both under the Mine Act and Federal regulatory guidelines, to include the incorporation by reference of consensus standards such as ASTM F3387–19. The Mine Act specifically requires MSHA to issue improved mandatory safety and health standards. The incorporation by reference of ASTM F3387–19 is an improved standard.

MSHA received a comment from the MCPA asserting that the medical evaluation and fit testing requirements for respirators in ASTM F3387–19 were too rigorous because there may be situations where a miner fails a medical evaluation or fit test simply due to personal desires, such as having a beard (Document ID 1406).

MSHA believes that the medical evaluation and fit testing requirements for use of respirators are appropriate because they are critical to ensuring proper protection and safe respirator use for respirator wearers who are exposed to airborne contaminants. In addition, medical evaluations and fit tests are required under MSHA's current respiratory protection standard (ANSI Z88.2–1969). Therefore, mine operators who have used respirators previously should be familiar with these requirements.

MSHA incorporates by reference this consensus standard for two reasons. ASTM F3387–19 reflects current respirator technology and accepted effective respiratory protection practices. For example, ASTM F3387–19 provides detailed information on respirator selection that is based on NIOSH's research and long-standing experience of testing and approving respirators for occupational use and OSHA's respiratory protection standards. The ASTM F3387–19 standard is prepared and maintained by subject matter experts, using a rigorous and well-defined process. The standard is reviewed by internationally recognized experts and is approved for use only if the appropriate procedures are followed. In addition, adopting voluntary consensus standards is consistent with OMB Circular A–119.

MSHA has observed that many operators, especially larger mine operators, have already implemented respiratory protection programs that meet many of the OSHA requirements, which are substantially similar to many requirements in ASTM F3387–19. In response to commenters who suggested that MSHA adopt the OSHA respiratory protection standards, ASTM F3387–19 references OSHA's respiratory standards that include assigned protection factors and maximum use concentrations, and fit testing. MSHA believes that the mining industry is familiar with many provisions in ASTM F3387–19. MSHA anticipates that for many large mine operators, few changes to their respiratory protection program may be warranted, whereas small mines may need to revise their respiratory protection programs in accordance with the requirements in ASTM F3387–19. The program requirements are discussed in more detail in *Section VIII.D. Updating MSHA Respiratory Protection Standards: Incorporation of ASTM F3387–19 by Reference.*

Other Comments

The AIHA stated that respirators should be used only under a comprehensive respiratory protection program and under the supervision of an industrial hygienist (Document ID 1351). AIHA suggested that MSHA should refer to the most recent edition of ASTM's respiratory protection standard and not the 2019 edition, which may become obsolete by the time the silica standard is adopted.

According to the Office of the Federal Register, MSHA is required to inform the public of the standard to be incorporated and the specific edition that the Agency intends to require. In the proposed rule, MSHA proposed to incorporate the 2019 edition of ASTM F3387, which is the most recent respiratory protection standard. MSHA is incorporating by refence ASTM F3387–19 in this final rule. MSHA is aware that larger mines may have an industrial hygienist or safety specialist administer their respiratory protection program; this practice is consistent with, but not required by, the ASTM F3387–19 standard's requirements for program administration. ASTM F3387–19 specifies that responsibility and authority for the respirator program should be assigned to a single qualified person with sufficient knowledge of respiratory protection. Qualifications could be gained through training or experience; however, the qualifications of a program administrator must be commensurate with the respiratory hazards at the mine site.

The program administrator should have access to and direct communication with the site manager about matters impacting worker safety and health. ASTM F3387–19 notes a preference that the administrator be in the company's industrial hygiene, environmental, health physics, or safety engineering department; however, a third-party entity that meets the standard's requirements may also provide this service. ASTM F3387–19 outlines the respiratory protection program administrator's responsibilities, specifying that they should include: measuring, estimating, or reviewing information on the concentration of airborne contaminants; ensuring that medical evaluations, training, and fit testing are performed; selecting the appropriate type or class of respirator that will provide adequate protection for each contaminant; maintaining records; evaluating the respirator program's effectiveness; and revising the program, as necessary.

8. Section 60.15—Medical Surveillance for Metal and Nonmetal Mines

The final rule establishes requirements for medical surveillance for MNM mines in § 60.15. Paragraph (a) requires MNM mine operators to provide each miner periodic medical examinations performed by a PLHCP or specialist, at no cost to the miner. In a change from the proposal, under paragraph (a)(2)(iv), MSHA adds that the pulmonary function test may also be administered by a pulmonary function technologist with a current credential from the National Board for Respiratory Care. The rest of paragraph (a) remains unchanged from the proposal.

Paragraph (b) establishes the requirements for each MNM mine operator to provide voluntary medical examinations every 5 years to all miners employed at the mine or who have already worked in the mining industry. In a change from the proposal, new paragraph (b)(1) specifies that the voluntary medical examinations must be offered during an initial 12-month period. New paragraph (b)(2), the same as proposed paragraph (b), requires mine operators to continue to offer voluntary medical examinations after the period in paragraph (b)(1) at least every 5 years during a 6-month period that begins no less than 3.5 years and not more than 4.5 years from the end of the last 6-month period.

Paragraph (c) specifies that each mine operator is required to provide the medical examinations specified in paragraph (a) to each miner who begins work in the mining industry for the first time. In a change from the proposal, paragraph (c)(1) requires the initial medical examination to take place no later than 60 days after beginning employment (instead of 30 days). Paragraphs (c)(2) and (c)(3) remain unchanged from the proposal.

Paragraph (d) specifies the requirements for medical examination results. In a change from the proposal, paragraph (d)(1) specifies that the medical examination results must be provided from the PLHCP or specialist within 30 days of the medical examination. Like the proposal, the medical examination results must be provided to the miner, and at the request of the miner, to the miner's designated physician. In a change from the proposal, the medical examination results may also be provided, at the request of the miner, to another designee identified by the miner. In a change from the proposal, paragraph (d)(2) specifies that within 30 days of the medical examination, the mine operator must ensure that the PLHCP or specialist also provide the results of chest X-ray classifications to NIOSH, once NIOSH establishes a reporting system. Paragraph (e) specifies the requirements for the written medical opinion and is unchanged from the proposal. Paragraph (f) requires mine operators to maintain a record of the written medical opinions received from the PLHCP or specialist under paragraph (e) and is unchanged from the proposal.

MSHA received several comments regarding the medical surveillance provisions for MNM mines, offering both support and opposition. The PACA, IAAP, and CalCIMA opposed the proposal, stated that the requirements were too prescriptive, and asked that MSHA give operators more flexibility in implementing medical surveillance programs (Document ID 1413; 1456; 1433). A mining-related business owner asserted that medical surveillance requirements are not needed, stating that there is a lack of silicosis cases in MNM miners (Document ID 1392).

Three commenters—an elected federal official, a miner health clinic, and a medical association—supported the proposal and asserted that the medical surveillance requirements would help MNM miners track their respiratory health and mitigate risks for silica-related chronic diseases (Document ID 1439; 1418; 1373). Two unions, the AFL–CIO and the USW, stated that both MNM and coal miners should be provided with the same level of protection and care through their medical surveillance programs (Document ID 1449; 1447).

After reviewing the comments, MSHA concludes that the proposed medical surveillance provisions for MNM mines should be retained, with some modifications. As discussed in *Section V. Health Effects Summary* and *Section VI. Final Risk Analysis Summary* of this preamble, many MNM mining activities generate silica dust and could lead to respirable crystalline silica exposures that result in adverse health effects such as silicosis. MSHA agrees with commenters who stated that the medical surveillance requirements will provide MNM miners with health information that could prevent silica-related diseases and believes it is necessary to include the medical surveillance requirements in the final rule. The Agency has determined that all MNM miners receive the same medical examination protections under the final rule.

Some commenters requested that the Agency use a risk-based approach for medical surveillance. The NMA, NSSGA, AEMA, and SSC urged MSHA to adopt OSHA's risk-based medical surveillance framework, which requires medical monitoring only for those miners exposed to respirable silica above the action level for more than 30 days per year (Document ID 1428; 1448; 1424; 1432).

The Agency disagrees with this approach. Unlike OSHA's silica standard, the final rule does not include an exposure trigger provision because the Agency believes it is important to maintain consistency between the medical surveillance requirements for MNM and coal mines to ensure all miners have the information necessary for the early detection of silica-related disease. The purpose of medical surveillance is to provide MNM miners necessary information to determine if their health may be adversely affected by exposure to respirable crystalline silica and enable miners to take appropriate action to stop further disease progression.

Below is a detailed discussion of the comments received on this section and modifications made in response to the comments.

a. 60.15(a)—Medical Surveillance

Paragraph § 60.15(a) requires that each MNM mine operator make medical examinations, performed by a PLHCP or specialist, available to each MNM miner, at no cost to the miner. Mine operators must ensure that medical examinations follow the requirements under § 60.15(a)(2)(i)–(iv). In a change from the proposed rule, under paragraph (a)(2)(iv), MSHA adds that the pulmonary function test may be administered by a pulmonary function technologist with a current credential from the National Board for Respiratory Care.

MSHA received several comments on proposed paragraph 60.15(a). The AIHA, AANP, and CertainTeed, LLC supported MSHA's proposal to require MNM mine operators to provide MNM miners with medical examinations performed by a PLHCP or specialist and agreed with MSHA's broad definition of PLHCP (Document ID 1351; 1400; 1423). The BIA and the Arizona Mining Association expressed concerns with this requirement and asserted that many MNM mines may experience issues with getting access to a PLHCP or specialist qualified to perform the examinations (Document ID 1422; 1368). The APHA and AOEC advocated for medical surveillance to be performed only by physicians who are board-certified in occupational medicine or pulmonary medicine, or who have experience in silica medical surveillance (Document ID 1416; 1373). Two commenters recommended that MNM miners should be able to choose their own health care provider (Document ID 1439; 1412). The Arizona Mining Association inquired about whether medical examinations may be incorporated within the mine operator's health care plans (Document ID 1368).

After reviewing the comments, MSHA adds under paragraph (a)(2)(iv) that the pulmonary function test may be administered by a pulmonary function technologist with a current credential from the National Board for Respiratory Care. This option will provide a larger pool of qualified respiratory care professionals who may administer pulmonary function tests.

MSHA believes that MNM mine operators should not encounter any significant issues with identifying and hiring a qualified PLHCP or specialist to conduct medical examinations. The final rule provides flexibility in the selection of health care professionals. As discussed in § 60.1, the final rule allows MNM mine operators more time to comply; MNM mine operators will have 24 months after the publication of the final rule, rather than 4 months after the publication of the final rule as specified in the proposed rule. This additional time addresses commenters' concerns about time needed for establishing a medical surveillance program.

The Agency also clarifies that mine operators may give miners the option to choose their own health care provider, if the provider meets the requirements of this section. As stated in the proposal, a qualified PLHCP is an individual whose legally permitted scope of practice (*i.e.,* license, registration, or certification) allows that individual to independently provide or be delegated the responsibility to provide the required health services (*i.e.,* chest X-rays, spirometry, symptom assessment, and occupational history). ''Specialist'' is defined in § 60.2 as an American Board-Certified Specialist in Pulmonary Disease or an American Board-Certified Specialist in Occupational Medicine.

MSHA does not require medical examinations in the final rule to be performed only by physicians who are board-certified in occupational medicine or pulmonary medicine, because PLHCPs may have the knowledge and skills to conduct these examinations independently or under the supervision of board-certified specialists. MSHA believes this will provide mine operators more provider choices and improve accessibility to PLHCPs for miners. MSHA also clarifies that medical examinations may be integrated into mine operators' health care plans; while noting that in such cases, mine operators must ensure that the examinations are conducted in accordance with the requirements in § 60.15. The final rule ensures that medical examinations are comprehensive and tailored to identify and mitigate potential health risks associated with miners' occupational exposures to respirable crystalline silica. The final rule will ensure that the medical examinations provide MNM miners with health surveillance information so that they are aware of the early development and advancement of any silica-related disease.

The Agency received comments regarding the use of NIOSH facilities and NIOSH B Readers. The American Industrial Hygiene Association and National Coalition of Black Lung and Respiratory Disease Clinics stated that MSHA should require MNM operators to use NIOSH-approved facilities (Document ID 1351; 1410). However, several commenters, including the ACOEM, NLA, NVMA, and NSSGA, expressed concerns about the limited availability and geographic distribution of these facilities (Document ID 1405; 1408; 1441; 1448). The NMA, Portland Cement Association, and AEMA noted that there are only a limited number of B Readers available (Document ID 1428; 1407; 1424). The Black Lung Clinics supported MSHA's assertion that the availability of digital radiography allows for the electronic transmission of chest radiographs to remotely located B Readers (Document ID 1410).

MSHA agrees with commenters who expressed concerns about the accessibility of NIOSH-approved facilities, and, like the proposal, the final rule does not include a requirement to use such facilities. MSHA believes that requiring a NIOSH-certified B Reader to classify chest X-rays and requiring either a spirometry technician with a current certificate from a NIOSH-approved Spirometry Program Sponsor or a pulmonary function technologist with a current credential from the National Board for Respiratory Care to perform pulmonary function tests, will ensure that miners receive the necessary standard of care to protect their health while providing broader access to PLHCPs. As did OSHA in its 2016 silica final rule (81 FR 16286, 16821), MSHA has determined that the number of B Readers in the United States is adequate to classify the additional chest X-rays that will be required under this rule. In addition, digital X-rays can be transmitted electronically to B Readers anywhere in the United States, so this requirement will provide operators greater access to B Readers. Further, as discussed more below, under § 60.15(d)(2), mine operators are required to ensure that, within 30 days of the medical examination, the PLHCP or specialist provides the results of chest X-ray classifications to NIOSH, once NIOSH establishes a reporting system.

In the proposed rule, MSHA solicited comment on whether other diagnostic technology, such as high-resolution computed technology (CT), should be included in the final rule. The AOEC, APHA, USW, and a medical professional urged MSHA to include a low-dose CT scan, either as a primary test or if recommended by the examining clinician, because such scans are more sensitive than conventional chest radiographs and would facilitate earlier detection of disease or dysfunction (Document ID 1373; 1416; 1447; 1437). The UMWA cautioned against requiring CT scans because they are not as readily available and are more costly (Document ID 1409). The American Thoracic Society *et al.* commented and acknowledged the benefits of low-dose chest CT scans for individual disease detection but noted that such a requirement might limit population-level disease surveillance because of a lack of standardization for interpreting CT scans for diagnosing pneumoconiosis (Document ID 1421). The AFL–CIO highlighted other initiatives such as the Worker Health Protection Program and the Building Trades National Medical Screening Program that provide low-dose CT scans through a mobile van to serve smaller population centers and suggested that similar programs could be created for MNM miners (Document ID 1449).

MSHA agrees with commenters regarding the cost concerns and limited availability of low-dose chest CT scans. MSHA is aware that there are increased health risks from higher radiation exposures from screening with low dose chest CT scans. MSHA is also aware that ''ultra-low-dose'' methods for CT scans are available that would subject the miner to lower radiation doses than other screening chest CT scans; however, this method is not widely available and is therefore not a practical resource for mine operators at this time. Also, as a medical professional association acknowledged, low-dose chest CT scans do not have a standard for the classification of the results, unlike classification standards for chest X-rays (Document ID 1421). For the reasons above, the final rule does not add CT scans to the medical examination requirements in § 60.15(a).

The Agency received some comments recommending adding testing requirements. The Miners Clinic of Colorado and the Black Lung Clinics suggested requiring diffusion capacity testing as a pulmonary function test (Document ID 1418; 1410). MSHA considered these comments and determined that diffusion capacity testing is not as widely available as forced vital capacity (FVC) and forced expiratory volume tests (*i.e.,* spirometry tests). Spirometry is the most common and widely used lung function test. The final rule does not add diffusion capacity testing to the medical examination requirements in § 60.15(a).

MSHA also received comments on tuberculosis testing requirements. Commenters—the AOEC, APHA, and the NSSGA—recommended that a test for latent tuberculosis be required as an initial test or if recommended by the examining PLHCP, noting that it is included in OSHA's silica standard (Document ID 1373; 1416; 1448). However, the Portland Cement Association argued that testing for tuberculosis is unnecessary (Document ID 1407). After considering these comments, MSHA has decided not to include a tuberculosis test requirement because it would be duplicative of the information provided in the medical and work history examination, which requires an assessment of the miner's history of tuberculosis under § 60.15(a). The Agency determined that the information gathered through the medical and work history examination will effectively screen for tuberculosis. In MSHA's experience, tuberculosis is not a significant health concern in the MNM mining industry.

b. 60.15(b)—Voluntary Medical Examinations

Final 60.15(b) requires mine operators to provide the opportunity to all miners employed at the mine to have the medical examinations under 60.15(a). Based on its review of the comments, MSHA has modified the language to clarify the timing of medical examinations. Under final paragraph (b), MNM mine operators must provide the opportunity for miners to receive medical examinations as specified under (b)(1) and (b)(2). This applies to all MNM miners who are not new to the mining industry. Miners who are new to the industry are required to receive medical examinations as specified under paragraph (c).

Paragraph (b)(1) requires mine operators to provide medical examinations during an initial 12-month period. This change ensures that examinations are offered to miners during a 12-month period that begins by the compliance date or during a 12-month period that begins whenever a new mine commences operation.

Under paragraph (b)(2), mine operators must provide subsequent medical examinations to miners not new to the mining industry at least every 5 years after the period in paragraph (b)(1). The medical examinations must be available during a 6-month period that begins no less than 3.5 years and not more than 4.5 years from the end of the last 6-month period. As discussed in *Section VII.A. Technological Feasibility,* MSHA has determined that it is technologically feasible for MNM mine operators to provide periodic examinations. Miner participation would be voluntary, as is the case for coal miners in 30 CFR 72.100(b). In the proposal, MSHA solicited comments on possible alternative surveillance strategies or schedules, including whether each voluntary examination should be mandatory.

MSHA received many comments about proposed § 60.15(b). Several commenters, including the AEMA, NVMA, NSSGA, SSC, and USW, urged that the medical examinations remain voluntary in the final rule (Document ID 1424; 1441; 1448; 1432; 1447; 1437;1412). The NSSGA asked MSHA to clarify that while operators are required to offer workers the option of participating in medical surveillance, workers can decline if they wish, unless employers require it as a condition of employment. (Document ID 1448).

In response to comments, MSHA emphasizes that while MNM mine operators are required to make the medical examinations available, miner participation is voluntary. However, MSHA believes mine operators should encourage miner participation because medical surveillance is crucial for early detection and prevention of silica-related diseases to ensure miners' well-being and safety. MSHA expects mine operators to include information on medical surveillance in their parts 46 and 48 training plans. MSHA will provide guidance to mine operators on how medical surveillance, as well as other silica requirements in this final rule, can best be integrated in their existing training plans.

MSHA also considered comments supporting different timelines for medical surveillance frequency for medical examinations. The American Thoracic Society *et al.* and an industry expert recommended the adoption of a 3-year surveillance frequency (Document ID 1421; 1437). ACOEM also supported a 3-year frequency and suggested a more frequent timeline based on the discretion of the physician (Document ID 1405). The AFL–CIO stated that the examination frequency should be more than every 5 years but did not specify an alternative frequency (Document ID 1449). The APHA stated that medical examinations every 5 years may not be sufficient for all miners, particularly those with health issues or early evidence of silica-related diseases and recommended that MSHA revise this provision to allow for more frequent examinations if recommended by a PLHCP or specialist (Document ID 1416). Arizona Mining Association asked MSHA to clarify the required timing for medical surveillance examinations (Document ID 1368).

Some commenters referenced the OSHA standard as a rationale for more frequent medical examinations. The AOEC, a medical professional, NSSGA, and USW said that all miners should have the same medical examination frequency and should follow OSHA's standard of making medical examinations available every 3 years (Document ID 1373; 1437; 1448; 1447). The Portland Cement Association expressed support for using OSHA's exposure-based approach if medical surveillance is in the final rule, but with a frequency of every 5 years as in MSHA's proposal (Document ID 1407).

After considering the comments, MSHA has determined that the 5-year period for voluntary medical examinations is appropriate, after an initial examination within a 12-month period starting no later than the compliance date or within an initial 12-month period of a new mine commencing operations after the compliance date. The 5-year period along with the initial examination will provide miners with information needed for the timely detection of silica-related diseases. Miners should use the information obtained from medical surveillance to establish a baseline and make informed decisions regarding their health. MSHA does not believe a schedule requiring more frequent periodic examinations is necessary. . In the Agency's experience with the coal miners' medical surveillance program, 5-year periodic examinations are appropriate to provide miners with information needed for early detection of silica-related disease. MSHA intends to provide miners and mine operators with information and education to help them recognize the signs and symptoms of silica related diseases. MSHA expects miners will use this information to help inform their decisions regarding their medical care. The Agency believes the medical examinations under the final rule are comprehensive and will promote miners' health and safety.

The Agency received comments on the timeline in proposed paragraph 60.15(b). NSSGA and IAAP stated that that prescribing a 6-month period when examinations must be offered creates logistical challenges for scheduling resources and accounting for miners' work schedules, and they urged MSHA not to specify when examinations should be scheduled (Document ID 1448; 1456). However, BMC offered support for this language, stating that they supported MSHA's provision that mine operators must provide medical surveillance to miners no later than a specified number of years, but within a certain range (Document ID 1417).

MSHA agrees that operators must provide medical surveillance to miners employed at the mine on a consistent schedule. However, in response to comments, MSHA has modified the language in this paragraph to clarify the timing of the voluntary medical examinations. Paragraph (b)(1), changed from the proposed rule, requires mine operators to provide medical examinations during an initial 12-month period. Under paragraph (b)(2), the mine operators must provide medical examinations at least every 5 years after the period in paragraph (b)(1). The final rule specifies that medical examinations must be available during a 6-month period that begins no less than 3.5 years and not more than 4.5 years from the end of the last 6-month period. The Agency believes the change in paragraph (b)(1) will provide miners necessary health information earlier than under the proposed rule. The final rule will ensure miners have early detection of adverse health effects from silica exposure. MSHA believes the final rule safeguards miners' health, while fostering enhanced preventative and protective measures within the mining industry.

MSHA received comments asking the Agency to clarify how to verify whether miners have had previous medical evaluations. NVMA asked for clarification about how operators should verify whether a miner new to the operator but experienced in the industry has already completed a medical examination (Document ID 1441). Other commenters, including the USW, recommended that more efforts should be made to encourage participation and educate workers (Document ID 1447; 1437). The USW further stated that

MSHA should encourage participation, by reducing barriers such as lack of awareness, privacy and medical confidentiality concerns, and the fear of retaliation, job loss, loss of potential job advancement, and future employment (Document ID 1447).

In response to the commenter regarding verification of medical examinations of newly hired experienced miners, MSHA encourages mine operators to work together to determine the completion of prior medical examinations without compromising the confidentiality and privacy of the miners' health information. MSHA clarifies that, under the final rule, mine operators have no obligation to verify whether a newly-hired experienced miner had a medical examination.

MSHA believes that the rule is designed to prioritize the health and safety of miners by making medical examinations available to them. MSHA requires operators offer medical examinations, ensuring that miners are aware, through training, of their availability, purpose, and health benefits. MSHA agrees with commenters that fostering an informed environment where miners are made aware of the risk of silica exposure will encourage miners to take advantage of the availability of medical examinations. The final rule is designed to help miners become more aware of how medical surveillance can protect them against silica risks. In response to commenters' concern about discrimination and retaliation, MSHA investigates, in accordance with its responsibility under the Mine Act, discrimination complaints to encourage miners to exercise their rights under the Mine Act, including the right to medical evaluations. 30 U.S.C. 815(c).

c. 60.15(c)—Mandatory Medical Examinations

Final paragraph (c) requires MNM mine operators to provide a mandatory initial medical examination for each MNM miner who is new to the mining industry. Under paragraph (c)(1), the mandatory initial medical examination must occur no later than 60 days after a miner new to the industry begins employment. This is a change from the proposed rule, which required the initial medical examination within 30 days. Final paragraphs (c)(2) and (3) are unchanged from the proposed rule. Under paragraph (c)(2), mine operators are required to provide a mandatory follow-up medical examination to the miner no later than 3 years after the miner's initial medical examination. Final paragraph (c)(3) requires that, if a miner's 3-year follow-up medical examination shows evidence of pneumoconiosis or decreased lung function, the operator provide the miner with another mandatory follow-up medical examination with a specialist, as defined in § 60.2, within 2 years.

MSHA determined that a 3-year follow-up is appropriate because there are some individuals who respond adversely to respirable coal mine dust exposure relatively quickly, and it is important to identify those individuals early. A 3-year interval at the start of a miner's career will provide necessary information for evaluating the results of subsequent spirometry tests and final paragraph (c)(1) requires a mandatory follow-up examination be given 3 years after the miner's initial examination. This is consistent with the 2014 RCMD Standard. *See* 30 CFR 72.100.

MSHA received comments on mandatory medical examinations. A couple of commenters, including BMC and AOEC, offered support for mandatory medical examinations, with some stating that medical examinations should be a mandatory requirement for both new and existing miners (Document ID 1417; 1373). MCPA opposed mandatory examinations even for new miners, stating that participation in medical surveillance is a personal choice that should be left up to each miner (Document ID 1406). NLA stated that making medical examinations mandatory for new miners would make it difficult to retain new hires (Document ID 1408).

NSSGA, IAAP, and BMC stated that MSHA should not prohibit operators from making participation in medical surveillance a mandatory condition of employment, if the mine operator believes mandatory participation is warranted (Document ID 1448; 1456; 1417). Some commenters, including USW, were opposed to mine operators mandating medical examinations as a condition of employment (Document ID 1447; 1437; 1412). One commenter emphasized that miners could be terminated for declining to visit an operator's selected PLHCP (Document ID 1412). The Brick Industry Association stated that if participation in a medical surveillance program is a condition of employment, companies will not be able to staff their operations (Document ID 1422).

Arizona Mining Association requested clarification on whether medical surveillance services are mandatory or are just required to be made available to the miners upon request. (Document ID 1368). PACA, IAAP, and NSSGA asked MSHA to clarify whether operators can make medical surveillance mandatory, and whether operators may conduct more extensive medical surveillance than required under the proposed rule (Document ID 1413; 1456; 1448). BMC asked if operators can make medical examinations mandatory as long as they meet MSHA's minimum medical surveillance requirements (Document ID 1417).

In response to these comments, MSHA notes that it is aware that some mine operators already have mandatory health screening as part of their employment policies. MSHA is also aware that some operators require periodic health examinations as part of their industrial hygiene practices. As a result, mandatory medical examinations may not be new for some mine operators. Many operators make participation in medical surveillance a mandatory condition of employment as a part of their overall safety and health program for their workforce. In response to comments, operators can conduct more extensive medical surveillance and can make medical examinations mandatory as long as they meet MSHA's minimum medical surveillance requirements. The Agency does not intend for the final rule's requirements to interfere with the operator's decision-making process with respect to managing its operation and miners.

The Agency has weighed USW and other commenters' concerns about the final rule making medical examinations mandatory and determined that it is critical to administer medical examinations when MNM miners first enter the profession. Mandatory examinations provided in close proximity to when miners are first hired and first exposed to respirable coal mine dust are necessary in order to establish an accurate baseline of each miner's health. Miners may not recognize early symptoms of silica-related disease; therefore, they might not be likely to seek medical assistance.

MSHA received comments requesting a longer period for initial medical examinations. The NSSGA, PACA, CalCIMA, and IAAP suggested that many miners new to the industry will not continue employment beyond an initial probation period due to the physical demands of the work (Document ID1448; 1413; 1433; 1456). During the Denver, Colorado public hearing, one commenter suggested making the period for medical examinations for new miners longer, so that mine operators would be providing medical examinations for those new miners who are more likely to remain employed (Document ID 1375). MSHA agrees with the commenter and has changed final paragraph (c)(1) to require an initial medical examination no later than 60 days after beginning employment. This is a change from the proposed rule, which would have required mine operators to ensure miners had a medical examination within 30 days after beginning employment. This will help mine operators use their resources to provide medical examinations for new miners who are more likely to continue employment.

The NSSGA and Vanderbilt Minerals, LLC suggested eliminating the mandate for a follow-up examination after an observed decrease in lung function, as that requirement is too broad, and the decrease could be due to non-occupational contaminants (Document ID 1448; 1419). In response to comments, the Agency has not included this change in the final rule. MSHA acknowledges the complex nature of lung function decrease; the final rule includes a medically sound approach that aligns examinations and subsequent actions with individual miner's health statuses and occupational exposure profiles. Evaluating lung function and changes in lung burden is a normal function of assessing the development of lung diseases. This provision will allow for a uniform approach to medical surveillance that is already implemented in the coal industry.

Some mining trade associations suggested that mandatory examinations be triggered by a specific level of exposure, instead of being required for all miners new to the industry (Document ID 1408; 1428; 1448; 1424). The final rule does not include a ''trigger provisions because the Agency believes it is necessary to maintain consistency between the final rule's requirements for MNM mines and existing medical surveillance standards for coal mines. In MSHA's experience, medical surveillance requirements benefit coal miners, and the Agency has implemented outreach initiatives to expand coal miners' participation. MSHA believes that aligning the MNM medical surveillance requirements with the requirements for coal mines will effectively protect the health and safety of MNM miners.

d. 60.15(d)—Medical Examinations Results

Proposed paragraph (d) would have required that the results of any medical examination performed under this section be provided by the PLHCP or specialist only to the miner and, at the request of the miner, to the miner's designated physician. In response to comments, MSHA added language under paragraph (d)(1) to require the PLHCP or specialist to provide test results within 30 days of the medical examination and added a requirement that the PLHCP provide test results to another designee identified by the miner. Under paragraph (d)(2), the proposed provision was changed to require mine operators to ensure, within 30 days of the medical examination, that the PLHCP provide results of the chest x-ray classifications to NIOSH, once NIOSH establishes a reporting system.

MSHA received comments regarding the sharing of the medical examination results. Several commenters from MNM operators and mining industry organizations stated the medical examination results should be shared with the operator (Document ID 1424; 1417; 1456; 1441; 1448). The NSSGA suggested medical providers be required to send a written medical opinion to the operator if the operator requires the miner to sign a medical release form stating what information can be shared with the operator (Document ID 1448). This commenter also stated that examination results need to be shared with the operator as soon as possible, so that the operator can take actions to protect miners' health (Document ID 1448). Other commenters, including BMC, AEMA, and NVMA, suggested that medical examination results should be shared with mine operators (Document ID 1417; 1424; 1441). AEMA stated that the failure to communicate a confirmed diagnosis to the mine operator may inadvertently adversely hamper the miner's ability to receive compensation under workers' compensation program (Document ID 1424). However, commenters from labor organizations and medical professional associations stated that the proposed standard ensures that miners' medical confidentiality is protected when those miners undergo medical surveillance (Document ID 1398; 1447; 1449; 1410; 1373).

MSHA agrees with the commenters who expressed concerns regarding the confidentiality and timeliness of medical examination results. Under final paragraph (d)(1), MSHA modified the language of the proposal to clarify that the final rule requires the mine operator to ensure the PLHCP or specialist provide the medical examination results only to the miner, or to the miner's designated physician or another designee identified by the miner, and that this be done within 30 days of the examination. Paragraph (d)(1) ensures that the mine operator does not receive the miner's medical examination results. MSHA also added a provision to paragraph (d)(1) specifying that the miner can add a designee to receive the examination results in addition to the miner's physician, in case the miner needs to provide the examination results to other persons, such as family members or a health care professional who is not a physician. MSHA believes the timely receipt of medical examination results is important to allow the miner to make informed decisions regarding their health. Therefore, the Agency adds the requirement that the mine operator must ensure that the PLHCP or specialist provide the miner with their medical examination results within 30 days.

Under paragraph (e), the mine operator will obtain a written medical opinion from the PLHCP or specialist within 30 days of the medical examination. The written opinion must contain only the following: the date of the medical examination, a statement that the examination has met the requirements of this section, and any recommended limitations on the miner's use of respirators. No other information from the miner's medical examination may be obtained by the mine operator. Based on MSHA's experience with medical surveillance for coal miners, the Agency believes that confidentiality regarding medical conditions is essential, because it encourages miners to take advantage of the opportunity to detect early adverse health effects caused by respirable crystalline silica. (79 FR 24813, 24928).

The AIHA and the Black Lung Clinics expressed support for a requirement that operators submit medical surveillance plans to NIOSH for approval (Document ID 1351; 1410). ACOEM stated that if submitting for NIOSH approval creates administrative bottlenecks, employers should instead be allowed to contract with qualified physicians for these examinations, with the requirement that the supervising physician be board-certified in pulmonary disease or occupational medicine or another American Board of Medical Specialties (ABMS) (Document ID 1405). Two commenters, the NVMA and AEMA, stated that NIOSH is not a regulatory agency, and thus should not oversee medical surveillance plans (Document ID 1441; 1424).

The Black Lung Clinics suggested that medical examination results should be reported to NIOSH so that MSHA can monitor the effectiveness of dust controls (Document 1410). This commenter further suggested that MSHA create a repository for all screening results accessible to health care providers that can help detect early disease (Document ID 1410). The UMWA recommended that MSHA work with NIOSH to expand the Coal Workers Health Surveillance Program's mobile units to screen MNM miners as well or, alternatively, create new Health Surveillance Program mobile units targeting MNM miners (Document ID 1398).

After considering the comments, MSHA agrees with commenters that medical examination results should be submitted to NIOSH. MSHA has added a new final paragraph (d)(2) that requires the mine operator to ensure that, within 30 days of a miner's medical examination, the PLHCP or specialist provides the results of chest X-ray classifications to NIOSH, once NIOSH establishes a reporting system. The final rule does not require medical surveillance plans or NIOSH approval of them. MSHA agrees with commenters' concerns that having MNM mine operators develop and submit a medical surveillance plan for approval could cause administrative delays and adversely affect miners' health. The new requirement to submit chest X-ray classifications to NIOSH for occupational health research will provide the public important health information related to respirable crystalline silica disease and MSHA expects this information will provide a public health benefit.

This requirement is important because NIOSH intends to work with MSHA and the MNM mining community to create a reporting system to help mine operators ensure that PLHCPs or specialists may easily submit the required information. MSHA and NIOSH will inform mine operators and other stakeholders in a timely manner when the reporting system is available. When NIOSH establishes the system, NIOSH and MSHA will issue a joint notice to the mining community. In this notice, NIOSH and MSHA will include the logistics of the reporting system, information on how operators can ensure that the PLHCPs provide the required information to NIOSH, and information on how miners and medical professionals can effectively use the system. This information will be posted on both Agencies' websites. MSHA enforcement and Educational Field and Small Mine Services (EFSMS) staff will work with operators to facilitate compliance.

e. 60.15(e)—Written Medical Opinion

As discussed above, final paragraph (e), unchanged from the proposed rule, requires MNM mine operators to obtain a written medical opinion from a PLHCP or specialist within 30 days of the medical examination, and requires that this opinion include only the date of a miner's medical examination, a statement that the examination has met the requirements of this section, and any recommended limitations on the miner's use of respirators. The purpose of the opinion is to enable the mine operator to verify the examination has occurred and to provide the operator with information on miners' ability to use respirators.

The Agency received several comments regarding proposed paragraph (e). One commenter, the CalCIMA, was concerned about whether the medical opinion would be available in a timely manner (Document ID 1433). MSHA understands the commenter's concern. The Agency believes that the 30-day requirement to provide the medical opinion regarding the recommended limitation on the miner's use of respirators should provide the mine operator sufficient notice to address any issues.

The AOEC suggested that MSHA should follow OSHA in requiring clinicians to prepare a written report to the worker and provide a written medical opinion to the employer (Document ID 1373). That commenter stated that under OSHA's rule, the report remains confidential, the clinician discusses the examination results with the worker, and the worker signs a medical release form that clarifies what information the employer has received (Document ID 1373). MSHA notes that its final rule includes requirements similar to OSHA's reporting requirements in that the operator receives very limited information and will not be apprised of the results of the examination. Because the mine operator is receiving very limited information, MSHA determined that a medical release form signed by the miner is not necessary.

f. 60.15(f)—Written Medical Opinion Records

Final paragraph (f), unchanged from the proposed rule, requires the mine operator to maintain a record of the written medical opinion obtained from the PLHCP or specialist under paragraph (e). This requirement provides a record to ensure compliance with the standard. MSHA received comments on the record retention requirements for written medical opinion records that are discussed further in *Section VIII.B.9.a. Records retention periods.*

g. Compliance Assistance

The NSSGA highlighted the importance of compliance assistance for mines, especially small mines that do not have experience with medical surveillance programs (Document ID 1448). MSHA agrees with the commenter that compliance assistance is needed and will develop compliance materials to assist mine operators in implementing the final rule, including the medical surveillance requirements. MSHA will work with the mining community to ensure the final rule is implemented consistently and in a manner that adds to existing protections for miners. See the more complete discussion on MSHA's compliance assistance for this rulemaking under *Section VIII.A. General Issues.*

9. Section 60.16—Recordkeeping Requirements

Section 60.16 identifies recordkeeping retention requirements for records created in part 60. The final rule requires mine operators to retain evaluation, sampling, and corrective actions records for at least 5 years. The final rule requires mine operators to retain written determination records and written medical opinion records for the duration of a miner's employment plus 6 months. It also requires mine operators, upon request from an authorized representative of the Secretary, from an authorized representative of miners, or from miners, to promptly provide access to any record listed in § 60.16.

In the proposal, MSHA sought comment on the utility of the recordkeeping requirements in this section. MSHA received several comments on the proposed recordkeeping requirements, including from an industrial hygiene professional association and mining trade association, supporting the Agency's proposed recordkeeping provisions (Document ID 1351; 1424). A MNM operator and mining trade association opposed the recordkeeping requirements, stating that the requirements were duplicative and should be more flexible (Document ID 1419; 1448). Below is a detailed discussion of the comments received on this section.

a. Records Retention Periods

MSHA received comments from labor unions, advocacy organizations, one MNM operator, and a federal elected official requesting an increase in the retention periods for sampling records (Document ID 1398; 1416; 1417; 1425; 1439; 1447; 1449). Records that were to be retained by the mine operator under this section include evaluation, sampling, and corrective actions records, as described in proposed paragraphs 60.16(a)(1) to (3).

USW and AFL–CIO stated that increased record retention is particularly important for MNM mines, which are typically surface mines and are inspected less frequently than underground coal mines (Document ID 1447; 1449). The UMWA recommended that, for MNM miners, operators should be required to keep records specified under paragraphs (a)(1) to (3) for 30 years and to provide those records to the miner on termination of employment; operators be required to transfer records to a successor employer; and when an employer is ceasing operations and there is no successor employer to receive the record, the employer notify affected employees of their rights of access to records at least 3 months prior to the cessation of the employer's business (Document ID 1398). BMC stated that the sampling and corrective actions records proposed to be retained for at least 2 years should be required to be preserved indefinitely (Document ID 1417). Appalachian Voices recommended that all records regarding sampling be retained for longer than the life of the mine operation (Document ID 1425).

USW and AFL–CIO expressed concern that retaining records for 2 years would be insufficient to establish a pattern of exposure or provide other critical information such as the evaluation of corrective actions. Labor unions, advocacy organizations, a MNM operator, and an individual suggested that MSHA should align its recordkeeping requirements with the OSHA silica standard recordkeeping requirements (29 CFR 1910.1020) (Document ID 1398; 1412; 1416; 1417; 1425; 1447).

In response to comments requesting an increase in the record retention period, the final rule increases the record retention period for evaluation, sampling, and corrective actions records in paragraphs (a)(1) to (3) to at least 5 years. Increasing to the 5-year record retention period for evaluation, sampling, and corrective actions records will help mine operators, miners, and MSHA better evaluate and monitor changes in exposures, understand health hazards, and ensure the implementation and maintenance of proper controls to protect miners from health hazards associated with respirable crystalline silica.

Under final (a)(1) and (2), evaluation and sampling records confirm that sampling results accurately represent current exposure conditions. The 5-year recordkeeping requirement for evaluation and sampling records will provide mine operators with robust information to enable them to understand a history of occupational exposures at the mines and to take appropriate actions to protect miners, such as implementing engineering and administrative controls. Evaluation and sampling records can identify overexposures due to changes in production, processes, controls, or geological conditions. These records help mine operators develop, implement, and adjust controls and other measures that protect miners from overexposures. In addition, these expanded records will provide miners and their representatives with information about exposure patterns over time to understand health hazards at their mines and to make informed decisions about their health care. As some commenters noted, this information can be invaluable to miners who have already been diagnosed with an illness or experienced negative health effects and help them to make decisions about their health and future employment. The 5-year records of evaluation and sampling will also enable MSHA staff in Technical Support and Educational Field and Small Mine Services to provide needed compliance assistance.

The 5-year recordkeeping requirement for corrective actions records in final paragraph (a)(3) will help mine operators and MSHA enforcement staff determine if existing controls are effective, or if maintenance or additional controls are needed. In MSHA's experience, the cumulative record provides MSHA and mine operators with information to identify trends in exposures and operational changes. Mine operators can use trend information to determine the effectiveness of controls over time and to take proactive measures to prevent future overexposures, while miners and their representatives can use the trend information to determine health hazards and protection needs at their mines.

MSHA has determined that the 5-year retention period in final paragraphs (a)(1) to (3) balances the operator's burden to maintain records and the need for this information to take appropriate action to protect miners' health. The 5-year record retention is also consistent with MSHA's record retention period for operator samples collected for diesel particulate matter in underground metal and nonmetal mines (§ 57.5071(d)(2)) and other injury and illness reports required for all mines (§ 50.40). From MSHA's experience and observation, informed miners who are aware of occupational health hazards around them are more likely to follow safe work practices and to report these hazards to their operators or MSHA when necessary. When miners are aware of occupational health hazards and participate in the identification, remediation, and control of those hazards, the overall level of safety and health at the mine will be improved. In sum, informed miners are more likely and better able to play an active role in safety and health as the Mine Act envisions and better protect themselves and other miners.

MSHA notes that minor changes have been made to final paragraphs (a)(1) to (3) to change the citation for the records addressed and to reflect changes discussed in § 60.12 and 60.13. MSHA has similarly revised the citations in Table 1 to Paragraph (a)—Recordkeeping Requirements.

Like the proposal, final paragraphs (a)(4) and (5) require that the written determination by a PLHCP that a miner is unable to wear a respirator under § 60.14(b), as well as the medical surveillance records under§ 60.15(f), be retained for the duration of the miner's employment plus 6 months. MSHA received several comments regarding the retention period for medical surveillance records, with most commenters supporting a longer retention period.

UMWA recommended that medical surveillance records be kept for 30 years and provided to the miner on termination of employment; that operators be required to transfer records to a successor employer; and that when an employer is ceasing operations and there is no successor employers to receive the record, the employer be required to notify affected employees of their rights of access to records at least 3 months prior to the cessation of the employer's business Document ID 1398). AOEC, APHA, and USW suggested that MSHA should align its recordkeeping requirements for medical surveillance records with the OSHA silica standard recordkeeping requirements (29 CFR 1910.1020) (Document ID 1373; 1416; 1447). These same commenters and a black lung clinic and an individual suggested that, given the latency periods associated with health effects from silica exposure, medical surveillance records are invaluable for miners who are diagnosed with silica-related health conditions (Document ID 1373; 1416; 1447; 1418; 1412).

In response to these comments, MSHA reiterates that mine operators do not have access to a miner's medical information and therefore, do not maintain a record of such information. Only the PLHCP's written determination made under paragraph 60.14(b) on whether a miner is able to wear a respirator must be provided to mine operators. Under the final rule, as in the proposal, the mine operator will retain the written determination record for the duration of miner employment plus six months.

Under final 60.15(d), medical examination results must be provided to the miner, at the request of the miner, to the miner's designated physician or another designee identified by the miner, and to NIOSH, once NIOSH establishes a reporting system. MSHA is not regulating the retention of medical examination results since they are not provided to the mine operator. The medical surveillance information (the written medical opinion records) that the mine operator will retain under final paragraph (a)(5) includes a record of the date of the medical examination, a statement that the examination has met the requirements of this section, and any recommended limitations on the miner's use of respirators. MSHA believes that retaining these medical surveillance records for the duration of the miner's employment plus 6 months is appropriate. The requirement to retain records for an additional 6 months beyond the miner's employment gives a miner more time to request records if the miner is employed at another mine. For example, a miner who was determined to be medically unable to wear a respirator may need this record for new mine operator. The final rule does not increase the retention period because, as described above, the written medical opinion that the operator receives contains only basic information compared to the medical examination records that are in the miner's possession and control.

NVMA asked for clarification on the medical surveillance recordkeeping requirements, remarking that the rule does not include provisions requiring tracking of miners' exposure throughout their careers and noting that miners often change companies over the course of their careers (Document ID 1441). This commenter asked whether it would be assumed that a miner's occupational illness stems from work with their current employer, even if all samples and medical surveillance show the miner was not exposed above the PEL during their current employment.

MSHA reiterates that each miner's medical examination results are provided to that miner, to the miner's physician or other designee at the request of the miner, and to NIOSH, once NIOSH establishes a reporting system. NIOSH's reporting system, once established, will provide public health information on rates of silica-related disease, tenure, and prevalence in the MNM industry.

Miners will have access to all medical examination results obtained under this part and will be able to track any impacts of exposure. The purpose of the medical surveillance examination requirements is to help miners seek help from medical professionals who can identify early symptoms of respirable crystalline silica-related diseases and inform them of their health status, so that they can take early and necessary steps to protect their health.

Vanderbilt Minerals, LLC stated that medical records are required to be collected under the Health Insurance Portability and Accountability Act and that an additional requirement by MSHA would be duplicative and unnecessary (Document ID 1419). MSHA clarifies that the mine operator is not responsible for obtaining and preserving the miner's medical examination results or records. Therefore, there is no duplication of collecting medical records.

b. Access to Records Maintained Under 60.16

Final paragraph 60.16(b), like the proposal, requires mine operators to make records in this section available promptly upon request to miners, authorized representatives of miners, and authorized representatives of the Secretary of Labor. A federal elected official stated that MSHA should require sampling records and any other information required to be posted on the mine bulletin board to be submitted to miner representatives (Document ID 1439). This commenter also urged MSHA to require operators to provide cumulative exposure records to the miner upon request, similar to 30 CFR 57.5040. A miner health advocate suggested that corrective actions records should be required to be submitted to MSHA and miner representatives (Document ID 1372).

After considering the comments, MSHA determined that no change to final paragraph (b) is necessary. The requirement to provide all the listed records promptly upon request to miners, authorized representatives of miners, and authorized representatives of the Secretary of Labor ensures that miners and MSHA will have access to records as needed which facilitates enforcement and transparency. Miners, miners' representatives, and MSHA can request the records in this section at any time; therefore, MSHA has determined that it is not necessary to require operators submit records to miners, miners' representatives, and MSHA without request.

c. Other Comments

The APHA suggested that all required records should be made available to NIOSH (Document ID 1416). As discussed in response to comments under paragraph 60.15(d)(2), MSHA is requiring that the results of chest X-ray classifications obtained under medical surveillance examinations be made available to NIOSH for its research. MSHA has determined that it is not necessary to provide other records required under part 60 to NIOSH.

The AIHA supported the proposed recordkeeping requirements and recommended that operators be required to develop and maintain exposure control plans that identify the tasks that involve miners' exposures above the PEL and the methods used to protect miners, including procedures to restrict access to work areas where high exposures may occur (Document ID 1351).

After considering the comment, MSHA has concluded that an exposure control plan record is not necessary, because of the sampling and control methods required. As required under part 60, mine operators must use engineering and administrative controls to prevent overexposures to respirable crystalline silica. Under § 60.12(c), mine operators are required to evaluate these controls at least every 6 months or whenever there is a change in production, processes, installation and maintenance of engineering controls, installation and maintenance of equipment, administrative controls, or geological conditions to determine if the change is reasonably expected to result in new or increased respirable crystalline silica exposures. The operator must make a record of the evaluation, including the evaluated change, the impact on respirable crystalline silica exposure, and the date of the evaluation and post the record on the mine bulletin board and, if applicable, by electronic means, for the next 31 days. Operators are expected to conduct these evaluations to assess changing conditions on a regular basis to ensure miners are not exposed at levels above the PEL. The evaluation records provide important information to mine operators to enable them to implement effective control methods to protect miners, to identify occupations and work areas where there is a risk of overexposure, and to make necessary adjustments. MSHA has determined requiring exposure control plan records is not necessary.

Under paragraph 60.12(g), when mine operators sample for respirable crystalline silica, operators must make a record of the sample date, the occupations sampled, and the concentrations of respirable crystalline silica and respirable dust, must obtain the laboratory report, and must make the information available to the miners. This record will enable operators and miners to identify those tasks where overexposures may have occurred and individuals who may be overexposed, as the commenter suggested. Under § 60.13(b), operators must make a record of any corrective actions. This record will provide mine operators with necessary information to determine which control methods should be developed, implemented, and maintained to prevent exposures above the PEL. Miners can use this information to take a proactive approach to their health.

10. Section 60.17—Severability

The final rule includes a statement of severability that each section of this part, as well as sections in 30 CFR parts 56, 57, 70, 71, 72, 75, and 90 that address respirable crystalline silica or respiratory protection, is separate and severable from the other sections and provisions.

The severability clause under § 60.17 serves two purposes. First, it expresses MSHA's intent that if any section or provision of the *Lowering Miners' Exposure to Respirable Crystalline Silica and Improving Respiratory Protection* rule—including its conforming amendments in sections of 30 CFR parts 56, 57, 70, 71, 72, 75, and 90 that address respirable crystalline silica or respiratory protection—is held invalid or unenforceable or is stayed or enjoined by any court of competent jurisdiction, the remaining sections or provisions should remain effective and operative. Second, the severability clause expresses MSHA's judgment, based on its technical and scientific expertise, that each individual section and provision of the rule can remain effective and operative if some sections or provisions are invalidated, stayed, or enjoined. Accordingly, MSHA's inclusion of this severability clause addresses the twin concerns of Federal courts when determining the propriety of severability: identifying agency intent and clarifying that any severance will not undercut the structure or function of the rule more broadly. *Am. Fuel & Petrochem. Mfrs.* v. *Env't Prot. Agency,* 3 F.4th 373, 384 (D.C. Cir. 2021) (''Severability 'depends on the issuing agency's intent,' and severance 'is improper if there is substantial doubt that the agency would have adopted the severed portion on its own''') (quoting *North Carolina* v. *FERC,* 730 F.2d 790, 796 (D.C. Cir. 1984) and *New Jersey* v. *Env't Prot. Agency,* 517 F.3d 574, 584 (D.C. Cir. 2008)).

Under the principle of severability, a reviewing court will generally presume that an offending provision of a regulation is severable from the remainder of the regulation, so long as that outcome appears consistent with the issuing agency's intent, and the remainder of the regulation can function independently without the offending provision. See *K Mart Corp.* v. *Cartier, Inc.,* 486 U.S. 281, 294 (1988) (invalidating and severing subsection of a regulation where it would not impair the function of the statute as a whole and there was no indication the regulation would not have been passed but for inclusion of the invalidated subsection). Consequently, in the event that a court of competent jurisdiction stays, enjoins, or invalidates any provision, section, or application of this rule, the remainder of the rule should be allowed to take effect.

MSHA did not receive any comments on this section. Final § 60.17 is the same as proposed.

C. Conforming Amendments

The final rule makes conforming amendments in 30 CFR parts 56, 57, 70, 71, 72, 75, and 90 based on the new part 60. The compliance dates for the conforming amendments align with the compliance dates for part 60. Compliance with the conforming amendments to parts 56 and 57 is required by 24 months after publication, for MNM operators; and compliance with the conforming amendments to parts 70, 71, 72, 75, and 90 is required by 12 months after publication, for coal mine operators. The compliance dates for the conforming amendments assure that miners are protected under the existing standards until mine operators are required to comply with part 60.

In other words, existing sections in parts 56 and 57 will remain in place for 24 months following publication. For MNM operators, compliance with the conforming amendments in parts 56 and 57 is not required until 24 months after publication. Existing sections in parts 70,71, 72, 75, and 90 will remain in place for 12 months following publication. For coal operators, compliance with the conforming amendments in these parts is not required until 12 months after publication.

For the conforming amendments, a set of instructions involving the establishment of temporary sections and redesignation of those sections are required for the **Federal Register** to maintain existing standards for parts 56, 57, 70, 71, 72, 75, and 90 until their respective compliance dates. On the effective date of the final rule (60 days after publication), the conforming amendments will be published to temporary sections, designated by the suffix ''T'' at the end of the section number (*e.g.,* § 56.5001T). These temporary sections indicate how the paragraphs will read on the compliance dates. On the compliance dates, the existing sections associated with conforming amendments will be removed and the temporary sections will be redesignated without the ''T'' to replace the removed section (*e.g.* § 56.5001T will be redesignated § 56.5001). With the redesignation, compliance with the conforming amendments will be required.

The conforming amendment changes to respiratory protection standards are discussed in *Section VIII.D Updating MSHA Respiratory Protection Standards: Incorporation of ASTM F3387–19 by Reference.*

1. Part 56—Safety and Health Standards—Surface Metal and Nonmetal Mines

a. Section 56.5001—Exposure Limits For Airborne Contaminants

The final rule, like the proposal, amends § 56.5001(a) to add respirable crystalline silica as an exception. Amended paragraph (a) governs exposure limits for airborne contaminants other than respirable crystalline silica and asbestos for surface MNM mines. MSHA did not receive any comments on the proposed change.

In a change from the proposal, MSHA makes a non-substantive change to paragraph (a) to update the terminology for the name of the MSHA District Office to the Mine Safety and Health Enforcement District Office. The Mine Safety and Health Enforcement District Office covers both MNM mines and coal mines since the Agency no longer maintains separate offices for both types of mines. The Agency no longer differentiates between MNM District Offices and Coal District Offices. This change was not discussed in the proposal.

b. Temporary Section Until Compliance Date

As described above, 60 days after publication of the final rule, a new temporary section with the suffix ''T'' will be added for the conforming amendments in part 56. Then, 720 days after publication of the final rule, the existing section for the conforming amendments in part 56 will be removed and the temporary section will be redesignated without the ''T'' to replace the removed section. The result of these technical changes is that mine operators must comply with the existing standards until the compliance dates in part 60.

2. Part 57—Safety and Health Standards—Underground Metal and Nonmetal Mines

a. Section 57.5001—Exposure Limits For Airborne Contaminants

The final rule, like the proposal, amends § 57.5001(a) to add respirable crystalline silica as an exception. Amended paragraph (a) governs exposure limits for airborne contaminants other than respirable crystalline silica and asbestos for underground MNM mines. MSHA did not receive any comments on the proposed change.

In a change from the proposal, MSHA makes a non-substantive change to paragraph (a) to update the terminology for the name of the MSHA district office to the Mine Safety and Health Enforcement District Office. The Mine Safety and Health Enforcement District Office covers both MNM mines and coal mines since the Agency no longer differentiates between MNM District Offices and Coal District Offices. This change was not discussed in the proposal.

b. Temporary Section Until Compliance Date

As described above, 60 days after publication of the final rule, a new temporary section with the suffix ''T'' will be added for the conforming amendments in part 57. Then, 720 days after publication of the final rule, the existing section for the conforming amendments in part 57 will be removed and the temporary section will be redesignated without the ''T'' to replace the removed section. The result of these technical changes is that mine operators must comply with the existing standards until the compliance dates in part 60.

3. Part 70—Mandatory Health Standards—Underground Coal Mines

a. Section 70.2—Definitions

The final rule, like the proposal, removes the *quartz* definition in § 70.2 since the Agency is adopting an independent respirable crystalline silica standard in part 60. Therefore, the term quartz no longer appears in part 70. MSHA did not receive any comments on the proposed change.

b. Section 70.101—Respirable Dust Standard When Quartz Is Present

The final rule, like the proposal, removes § 70.101 in its entirety and reserves the section number. Section 70.101, *Respirable dust standard when quartz is present,* is no longer needed because MSHA is adopting an independent respirable crystalline silica standard in part 60.

As discussed in greater detail in *Section VIII.B.3.b PEL in coal mines,* of this preamble, MSHA solicited comments on whether to eliminate the reduced standard for total respirable dust when quartz is present at coal mines and received feedback from stakeholders generally agreeing with the Agency's proposal to establish a standard for respirable crystalline silica that is independent from the respirable coal mine dust standard. For example, the NMA, the MCPA and the Pennsylvania Coal Alliance supported the removal of the respirable dust standards when quartz is present (*i.e.,* §§ 70.101 and 71.101, and 90.101), reasoning that they are no longer needed since the rule proposes a standalone standard for respirable crystalline silica (Document ID 1428; 1406; 1378).

In response to commenters, MSHA has concluded that establishing an independent and lower PEL for respirable crystalline silica for coal mines allows more effective control of respirable crystalline silica than the existing reduced standards, because the separate standard is more transparent and protective. MSHA clarifies that the respirable coal mine dust standard is not eliminated, only the sampling requirements for when silica is present under § 70.101. MSHA agrees with the commenters supporting the removal of § 70.101.

c. Section 70.205—Approved Sampling Devices; Operation; Air Flowrate

The final rule, like the proposal, amends paragraph 70.205(c) to remove the reference to the reduced RCMD standard. References to the RCMD exposure limit specified in § 70.100 replace references to the applicable standard. The rest of the section remains unchanged.

d. Section 70.206—Bimonthly Sampling; Mechanized Mining Units

The final rule, like the proposal, removes § 70.206 and reserves the section number. Section 70.206 included requirements for bimonthly sampling of mechanized mining units which were in effect until January 31, 2016, and are no longer applicable.

e. Section 70.207—Bimonthly Sampling; Designated Areas

The final rule, like the proposal, removes § 70.207 and reserves the section number. Section 70.207 included requirements for bimonthly sampling of designated areas that were in effect until January 31, 2016, and are no longer applicable.

f. Section 70.208—Quarterly Sampling; Mechanized Mining Units

The final rule, like the proposal, amends § 70.208 to remove references to a reduced RCMD standard. Paragraph (c) in § 70.208 is removed and the paragraph designation reserved. References to the respirable dust standard specified in § 70.100 replace references to the applicable standard throughout the section.

A new table 1 is added to § 70.208. The new table contains the Excessive Concentration Values (ECV) for the section based on a single sample, 3 samples, or the average of 5 or 15 full-shift coal mine dust personal sampler unit (CMDPSU) or continuous personal dust monitor (CPDM) concentration measurements. The new table contains the remaining ECV after the removal of the reduced standard in § 70.101 and was generated from data previously contained in Tables 70–1 and 70–2 in Subpart C of part 70. Conforming changes are made to paragraphs (e) and (f)(1) and (2) to update the name of the table to table 1. MSHA did not receive any comments on the proposed changes.

g. Section 70.209—Quarterly Sampling; Designated Areas

The final rule, like the proposal, amends § 70.209 to remove references to a reduced RCMD standard. Paragraph (b) in § 70.209 is removed and the paragraph designation reserved. References to the RCMD exposure limit specified in § 70.100 replace references to the applicable standard.

A new table 1 is added to § 70.209. The new table contains the ECVs for the section based on a single sample, 2 or more samples, or the average of 5 or 15 full-shift CMDPSU/CPDM concentration measurements. This table contains the remaining ECV after the removal of the reduced RCMD standard in § 70.101 and was generated from data previously contained in Tables 70–1 and 70–2 in Subpart C of part 70. Conforming changes are made to paragraphs (c) and (d)(1) and (2) to update the name of the table to table 1. MSHA did not receive any comments on the proposed changes.

h. Subpart C—Table 70–1 and Table 70–2

The final rule, like the proposal, removes Table 70–1 to Subpart C of Part 70, *Excessive Concentration Values (ECV) Based on Single, Full-Shift CMDPSU/CPDM Concentration Measurements* and Table 70–2 to

Subpart C of Part 70, *Excessive Concentration Values (ECV) Based on the Average of 5 or 15 Full-Shift CMDPSU/CPDM Concentration Measurements* because § 70.101 is removed. These tables are replaced with new tables in §§ 70.208 and 70.209. MSHA did not receive any comments on the proposed change.

i. Temporary Section Until Compliance Date

As described above, 60 days after publication of the final rule, a new temporary section with the suffix ''T'' will be added for most of the conforming amendments in part 70. Then, 360 days after publication of the final rule, the existing section for these conforming amendments in part 70 will be removed and the temporary section will be redesignated without the ''T'' to replace the removed section. The result of these technical changes is that mine operators must comply with the existing standards until the compliance dates in part 60.

4. Part 71—Mandatory Health Standards—Surface Coal Mines and Surface Work Areas of Underground Coal Mines.

a. Section 71.2—Definitions

The final rule, like the proposal, removes the *Quartz* definition in § 71.2 because the Agency is removing the respirable dust standard when quartz is present in § 71.101. The term quartz no longer appears in part 71. MSHA did not receive any comments on the proposed change.

b. Section 71.101—Respirable Dust Standard When Quartz Is Present

MSHA is removing § 71.101 in its entirety and reserving the section number. The respirable coal mine dust standard when quartz is present in § 71.101 is no longer needed because MSHA is adopting an independent respirable crystalline silica standard in part 60.

As discussed in greater detail in *Section VIII.B.3.b. PEL in coal mines,* of this preamble, MSHA solicited comments on whether to eliminate the reduced standard for total respirable dust when quartz is present at coal mines and received feedback from stakeholders generally agreeing with the Agency's proposal to establish a standard for respirable crystalline silica that is independent from the respirable coal mine dust standard. For example, the NMA, the MCPA and the Pennsylvania Coal Alliance supported the removal of the respirable dust standards when quartz is present (*i.e.,* §§ 70.101 and 71.101, and 90.101), reasoning that they are no longer needed since the rule proposes a standalone standard for respirable crystalline silica (Document ID 1428; 1406; 1378).

In response to commenters, MSHA has concluded that establishing an independent and lower PEL for respirable crystalline silica for coal mines allows more effective control of respirable crystalline silica than the existing reduced standards, because the separate standard is more transparent and protective. MSHA clarifies that the respirable coal mine dust standard is not eliminated, only the sampling requirements for when silica is present under § 71.101. MSHA agrees with the commenters supporting the removal of §§ 71.101.

c. Section 71.205—Approved Sampling Devices; Operation; Air Flowrate

The final rule, like the proposal, amends paragraph (c) to remove the reference to the reduced RCMD standard. References to the respirable dust standard specified in § 71.100 replace the reference to the applicable standard.

d. Section 71.206—Quarterly Sampling; Designated Work Positions

The final rule, like the proposal, amends § 71.206 to remove references to the reduced RCMD standard. Paragraph (b) in § 71.206 is removed and the paragraph designation reserved. Other conforming changes for § 71.206 remove references to the applicable standard and replace them, where needed, with references to the respirable dust standard specified in § 71.100.

MSHA is also amending paragraph (l) by removing Table 71–1 *Excessive Concentration Values (ECV) Based on Single, Full-Shift CMDPSU/CPDM Concentration Measurements* and Table 71–2 *Excessive Concentration Values (ECV) Based on the Average of 5 Full-Shift CMDPSU/CPDM Concentration Measurements* since reference to a reduced RCMD standard in § 71.101 is removed. A new table has been added to § 71.206.

Final paragraph (m), like the proposal, removes the language, ''in effect at the time the sample is taken, or a concentration of respirable dust exceeding 50 percent of the standard established in accordance with § 71.101,'' because the reduced standard in § 71.101 is removed.

A new table 1 is added to § 71.206. This table contains the ECV for the section based on a single sample, two or more samples, or the average of five full-shift CMDPSU/CPDM concentration measurements. This table contains the remaining ECV after the removal of the reduced standard in § 71.101. It was generated from data contained in existing Tables 71–1 and 71–2 to Subpart C of part 71. Conforming changes are made to paragraphs (h) and (i)(1) and (2) to update the name of the table to table 1. MSHA did not receive any comments on the proposed changes.

e. Section 71.300—Respirable Dust Control Plan; Filing Requirements

Final § 71.300, like the proposal, removes references to the reduced RCMD standard. The respirable dust standard specified in § 71.100 replaces references to the applicable standard. MSHA did not receive any comments on the proposed change.

f. Section 71.301—Respirable Dust Control Plan; Approval by District Manager and Posting

Final § 71.301, like the proposal, removes references to the reduced RCMD standard. The respirable dust standard specified in § 71.100 replaces references to the applicable standard. MSHA did not receive any comments on the proposed change.

g. Temporary Section Until Compliance Date

As described above, 60 days after publication of the final rule, a new temporary section with the suffix ''T'' will be added for most of the conforming amendments in part 71. Then, 360 days after publication of the final rule, the existing section for these conforming amendments in part 71 will be removed and the temporary section will be redesignated without the ''T'' to replace the removed section. The result of these technical changes is that mine operators must comply with the existing standards until the compliance dates in part 60.

5. Part 72—Health Standards for Coal Mines

a. Section 72.800—Single, Full-Shift Measurement of Respirable Coal Mine Dust

Final § 72.800, like the proposal, removes references to the reduced RCMD standard. The section also replaces references to Tables 70–1, 71–1, and 90–1 with references to the new tables in §§ 70.208, 70.209, 71.206, and 90.207. MSHA did not receive any comments on the proposed changes.

b. Temporary Section Until Compliance Date

As described above, 60 days after publication of the final rule, a new temporary section with the suffix ''T'' will be added for the conforming amendments in part 72. Then, 360 days after publication of the final rule, the existing section for the conforming amendments in part 72 will be removed and the temporary section will be redesignated without the ''T'' to replace the removed section. The result of these technical changes is that mine operators must comply with the existing standards until the compliance dates in part 60.

6. Part 75—Mandatory Safety Standards—Underground Coal Mines

a. Section 75.350(b)(3)(i) and (ii)—Belt Air Course Ventilation

The final rule, like the proposal, updates § 75.350 by revising paragraph (b)(3)(i) and removing paragraphs (b)(3)(i)(A) and (B) and (b)(3)(ii). Paragraph (b)(3)(i) is revised to ''[T]he average concentration of respirable dust in the belt air course, when used as a section intake air course, shall be maintained at or below 0.5 mg/m^3.'' Paragraph (b)(3)(i)(A) is removed because its provision has not been in effect since August 1, 2016. Paragraph (b)(3)(i)(B) is removed because the language has been incorporated in revised paragraph (b)(3)(i), making (b)(3)(i)(B) redundant. Existing paragraph (b)(3)(ii) is removed since it refers to a reduced RCMD standard under § 70.101 that is also removed. Existing paragraph (b)(3)(iii) is redesignated to (b)(3)(ii). MSHA did not receive any comments on the proposed changes.

b. Temporary Section Until Compliance Date

As described above, 60 days after publication of the final rule, a new temporary section with the suffix ''T'' will be added for the conforming amendments in part 75. Then, 360 days after publication of the final rule, the existing section for the conforming amendments in part 75 will be removed and the temporary section will be redesignated without the ''T'' to replace the removed section. The result of these technical changes is that mine operators must comply with the existing standards until the compliance dates in part 60.

7. Part 90—Mandatory Health Standards—Coal Miners Who Have Evidence of the Development of Pneumoconiosis.

a. Section 90.2—Definitions

The final rule, like the proposal, removes the *Quartz* definition in § 90.2 because the Agency is removing the respirable dust standard when quartz is present in § 90.101. The term quartz no longer appears in part 90.

In addition, MSHA is revising the definition of *Part 90 miner* to remove ''the applicable standard'' (which referred to the reduced RCMD standard). The revised definition just includes ''the standard'' (which refers to the respirable dust standard specified in § 90.100). MSHA did not receive any comments on the proposed change.

b. Section 90.3—Part 90 Option; Notice of Eligibility; Exercise of Option

The final rule, like the proposal, revises paragraph (a) in § 90.3 to remove ''the applicable standard'' (which referred to the reduced RCMD standard) and just include ''the standard'' (which refers to the respirable dust standard specified in § 90.100). MSHA did not receive any comments on the proposed change.

c. Section 90.100—Respirable Dust Standard

In a change from the proposal, MSHA updates § 90.100 by removing paragraphs (a) and (b) and revising the section to, ''After the 20th calendar day following receipt of notification from MSHA that a part 90 miner is employed at the mine, the operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which the part 90 miner in the active workings of the mine is exposed, as measured with an approved sampling device and expressed in terms of an equivalent concentration, at or below 0.5 mg/m^3.'' Paragraph (a) is removed because its provision has not been in effect since August 1, 2016. Paragraph (b) is removed because the language has been incorporated in the revised language above, making it redundant. MSHA makes this change in the final rule to match the change made in § 75.350(b)(3)(i).

d. Section 90.101—Respirable Dust Standard When Quartz Is Present

The final rule, like the proposal, removes § 90.101 in its entirety and reserves the section number. The respirable coal mine dust standard when quartz is present in § 90.101 is no longer needed because MSHA is adopting an independent respirable crystalline silica standard in part 60.

As discussed in greater detail in *Section VIII.B.3.b PEL in coal mines,* of this preamble, MSHA solicited comments on whether to eliminate the reduced standard for total respirable dust when quartz is present at coal mines and received feedback from stakeholders generally agreeing with the Agency's proposal to establish a standard for respirable crystalline silica that is independent from the respirable coal mine dust standard. For example, the NMA, the Metallurgical Coal Producers Association (MCPA) and the Pennsylvania Coal Alliance supported the removal of the respirable dust standards when quartz is present (*i.e.,* §§ 70.101 and 71.101, and 90.101), reasoning that they are no longer needed since the rule proposes a standalone standard for respirable crystalline silica (Document ID 1428; 1406; 1378).

In response to commenters, MSHA has concluded that establishing an independent PEL of 50 μg/m^3 for a full-shift exposure, calculated as an 8-hour TWA for respirable crystalline silica allows more effective control of respirable crystalline silica than the existing reduced standards, because the separate standard is more transparent and protective. MSHA clarifies that the respirable coal mine dust standard is not eliminated, only the sampling requirements for when silica is present under §§ 90.101. MSHA agrees with the commenters supporting the removal of §§ 90.101.

e. Section 90.102—Transfer; Notice

The final rule, like the proposal, amends § 90.102 to remove ''the applicable standard'' (which referred to the reduced RCMD standard) and just include ''the standard'' (which refers to the respirable dust standard specified in § 90.100). MSHA did not receive any comments on the proposed change.

f. Section 90.104—Waiver of Rights; Re-Exercise of Option

The final rule, like the proposal, amends § 90.104 to remove ''the applicable standard'' (which referred to the reduced RCMD standard) and just include ''the standard'' (which refers to the respirable dust standard specified in § 90.100). MSHA did not receive any comments on the proposed change.

g. Section 90.205—Approved Sampling Devices; Operation; Air Flowrate

The final rule, like the proposal, amends § 90.205 to remove ''the applicable standard'' (which referred to the reduced RCMD standard) and just include ''the standard'' (which refers to the respirable dust standard specified in § 90.100). MSHA did not receive any comments on the proposed change.

h. Section 90.206—Exercise of Option or Transfer Sampling

The final rule, like the proposal, amends § 90.206 to remove ''the applicable standard'' (which referred to the reduced RCMD standard) and just include ''the standard'' (which refers to the respirable dust standard specified in

§ 90.100). MSHA did not receive any comments on the proposed change.

i. Section 90.207—Quarterly Sampling

The final rule, like the proposal, amends § 90.207 to remove ''the applicable standard'' (which referred to the reduced RCMD standard) and just include ''the standard'' (which refers to the respirable dust standard specified in § 90.100).

Paragraph (b) in § 90.207 is removed and the paragraph designation reserved. Conforming changes are made to paragraphs (c) and (d)(1) and (2) to update the name of the table to table 1.

MSHA is amending paragraph (g) by removing Table 90–1 *Excessive Concentration Values (ECV) Based on Single, Full-Shift CMDPSU/CPDM Concentration Measurements* and Table 90–2 *Excessive Concentration Values (ECV) Based on the Average of 5 Full-Shift CMDPSU/CPDM Concentration Measurements* because § 90.101 is removed. A new table 1 is added to paragraph (g) to replace the tables removed. The new table contains the ECV for the section based on a single sample, two or more samples, or the average of 5 full-shift CMDPSU/CPDM concentration measurements. This table contains the remaining ECV after the removal of the reduced standard in § 90.101 and was generated from data contained in Tables 90–1 and 90–2. MSHA did not receive any comments on the proposed changes.

j. Section 90.300—Respirable Dust Control Plan; Filing Requirements

The final rule, like the proposal, amends § 90.300 to remove ''the applicable standard'' (which referred to the reduced RCMD standard) and just include ''the standard'' (which refers to the respirable dust standard specified in § 90.100). MSHA did not receive any comments on the proposed change.

k. Section 90.301—Respirable Dust Control Plan; Approval by District Manager; Copy to Part 90 Miner

The final rule, like the proposal, amends § 90.301 to remove ''the applicable standard'' (which referred to the reduced RCMD standard) and just include ''the standard'' (which refers to the respirable dust standard specified in § 90.100). MSHA did not receive any comments on the proposed change.

l. Temporary Section Until Compliance Date

As described above, 60 days after publication of the final rule, a new temporary section with the suffix ''T'' will be added for the conforming amendments in part 90. Then, 360 days after publication of the final rule, the existing section for the conforming amendments in part 90 will be removed and the temporary section will be redesignated without the ''T'' to replace the removed section. The result of these technical changes is that mine operators must comply with the existing standards until the compliance dates in part 60.

D. Updating MSHA Respiratory Protection Standards: Incorporation of ASTM F3387–19 by Reference

MSHA is updating the Agency's existing respiratory protection standard to help safeguard the life and health of all miners exposed to respirable airborne contaminants at MNM and coal mines. The final rule amends the Agency's existing respiratory protection standards to incorporate by reference ASTM F3387–19, ''*Standard Practice for Respiratory Protection*'', in §§ 56.5005T and 57.5005T for MNM mines and § 72.710T for coal mines (which will become permanent §§ 56.5005 and 57.5005 720 days after publication and permanent § 72.710 360 days after publication). This change is consistent with the incorporation by reference of ASTM F3387–19 in final § 60.14(c)(2) making the standard's requirements applicable to respirable crystalline silica, and other airborne hazards encountered by miners. The ASTM F3387–19 standard includes provisions for selection, fitting, use, and care of respirators used to remove airborne contaminants from the air using filters, cartridges, or canisters, as well as respirators that protect in oxygen-deficient or immediately dangerous to life or health (IDLH) atmospheres. ASTM F3387–19 is the most recent consensus standard developed by experts in government and professional associations on the selection, use, and maintenance for respiratory equipment. The ASTM Standard replaces American National Standards Institute's ANSI Z88.2–1969, ''*Practices for Respiratory Protection*'' (ANSI Z88.2–1969), which was incorporated in the existing standards.

Incorporating this voluntary consensus standard complies with the Federal mandate—as set forth in the National Technology Transfer and Advancement Act of 1995 and OMB Circular A–119—that agencies use voluntary consensus standards in their regulatory activities unless doing so would be legally impermissible or impractical. This standard also improves clarity because it is a consensus standard developed by stakeholders.

Under existing standards, whenever respiratory protective equipment is used, mine operators are required to have a respiratory protection program that is consistent with the provisions of ANSI Z88.2–1969. At the time of its publication, ANSI Z88.2–1969 reflected a consensus of accepted practices for respiratory protection.

Respirator technology and knowledge on respiratory protection have since advanced, and as a result, changes in respiratory protection standards have occurred. For example, in 2006, OSHA revised its respiratory protection standard to add definitions and requirements for Assigned Protection Factors (APF) and Maximum Use Concentrations (MUCs) (71 FR 50122, 50123). In addition to this rulemaking, OSHA updated Appendix A to § 1910.134: Fit Testing Procedures (69 FR 46986, 46993, Aug. 4, 2004).

After withdrawing the 1992 version of Z–88.2 in 2002, ANSI published the American National Standard, ANSI/AIHA Z88.10–2010, ''*Respirator Fit Testing Methods,*'' approved in 2010. These rules and standards addressed the topics of APFs and fit testing. APFs provide employers with critical information to use when selecting respirators for employees exposed to atmospheric contaminants found in industry. Finally, in 2015, ANSI published ANSI/ASSE Z88.2–2015, ''*Practices for Respiratory Protection,*'' which referenced OSHA regulations. These updates included requirements for classification of considerations for selection and use of respirators, establishment of cartridge/canister change schedules, use of fit factor value for respirator fit testing, calculation of effective protection factors, and compliance with compressed air dew requirements, compressed breathing air equipment, and systems and designation of positive pressure respirators. In July 2017, ANSI/ASSE transferred the responsibilities for developing respiratory consensus standards to ASTM International.

The ASTM standard contains detailed guidance and provisions on respirator selection that are based on NIOSH's extensive experience with testing and approving respirators for occupational use and OSHA's research and rulemaking on respiratory protection. ASTM F3387–19 also addresses all aspects of establishing, implementing, and evaluating respiratory protection programs and establishes minimum acceptable respiratory protection program requirements in the areas of program administration, standard operating procedures, medical evaluation, respirator selection, training, fit testing, respirator maintenance, inspection, and storage. ASTM F3387–19 comprehensively covers numerous aspects of respiratory protection and provides the most up-to-date provisions for current respirator technology and effective respiratory protection. Therefore, MSHA believes that ASTM F3387–19 will provide mine operators with information and guidance on the proper selection, use, and maintenance of respirators, which will protect the health and safety of miners.

1. Respiratory Protection Program Requirements

Under the final rule, MSHA requires that the respiratory protection program be in writing and be consistent with the requirements of ASTM 3387–19, including program administration, standard operating procedures, medical evaluation, respirator selection, training, fit testing; and maintenance, inspection, and storage. The following subsections discuss some of the requirements listed in ASTM F3387–19.

a. Program Administration

ASTM F3387–19 specifies several practices related to respiratory protection program administration, including the qualifications and responsibilities of a program administrator. For example, ASTM F3387–19 provides that responsibility and authority for the respirator program be assigned to a single qualified person with sufficient knowledge of respiratory protection. Qualifications may have been gained through training or experience; however, the qualifications of a program administrator must be commensurate with the respiratory hazards present at a worksite.

This individual administering the program should have access to and direct communication with the site manager about matters impacting worker safety and health. ASTM F3387–19 notes a preference that the administrator be in the company's industrial hygiene, environmental, health physics, or safety engineering department; however, a third-party entity meeting the provisions may also provide this service. ASTM F3387–19 outlines the respiratory protection program administrator's responsibilities, specifying that they should include: measuring, estimating, or reviewing information on the concentration of airborne contaminants; ensuring that medical evaluations, training, and fit testing are performed; selecting the appropriate type or class of respirator that will provide adequate protection for each contaminant; maintaining records; evaluating the respirator program's effectiveness; and revising the program, as necessary.

b. Standard Operating Procedures (SOP)

Written SOPs shall be established by the employer and shall cover a complete respirator program for routine and emergency. ASTM F3387–19 also states that written SOPs for respirator programs are necessary when respirators are used routinely or sporadically. Written SOPs should cover hazard assessment; respirator selection; medical evaluation; training; fit testing; issuance, maintenance, inspection, and storage of respirators; schedule of air-purifying elements; hazard re-evaluation; employer policies; and program evaluation and audit. ASTM F3387–19 also provides that wearers of respirators be provided with copies of the SOP and that written SOPs include special consideration for respirators used for emergency situations. The procedures are reviewed in conjunction with the annual respirator program audit and are revised by the program administrator, as necessary.

c. Medical Evaluation

Medical evaluations determine whether an employee has any medical conditions that would preclude the use of respirators, limitation on use, or other restrictions. ASTM F3387–19 provides that a program administrator advise the PLHCP of the following conditions to aid in determining the need for a medical evaluation: type and weight of the respirator to be used; duration and frequency of respirator use (including use for rescue and escape); typical work activities; environmental conditions (*e.g.,* temperature); hazards for which the respirator will be worn, including potential exposure to reduced-oxygen environments; and additional protective clothing and equipment to be worn. ASTM F3387–19 also incorporates ANSI Z88.6 *Respiratory Protection—Respirator Use—Physical Qualifications for Personnel.*

d. Respirator Selection

Proper respirator selection is an important component of an effective respiratory protection program. ASTM F3387–19 provides that proper respirator selection consider the following: the nature of the hazard, worker activity and workplace factors, respirator use duration, respirator limitations, and use of approved respirators. ASTM F3387–19 states that the respirator selection process for both routine and emergency use should include hazard assessment, selection of respirator type or class that can offer adequate protection, and maintenance of written records of hazard assessment and respirator selection.

ASTM F3387–19 provides specific steps to establish the nature of inhalation hazards, including determining the following: the types of contaminants present in the workplace; the physical state and chemical properties of airborne contaminants; the likely airborne concentration of the contaminants (by measurement or by estimation); potential for an oxygen-deficient environment; an occupational exposure limit for each contaminant; existence of an IDLH atmosphere; and compliance with applicable health standards for the contaminants.

ASTM F3387–19 includes other information to support the respirator selection process, including information on operational characteristics, capabilities, and performance limitations of various types of respirators. These limitations must be considered during the selection process. ASTM F3387–19 also describes types of respirators and considerations for their use, including service life, worker mobility, compatibility with other protective equipment, durability, comfort factors, compatibility with the environment, and compatibility with job and workforce performance. Finally, ASTM F3387–19 provides other information that is essential for respirator selection, including degree of oxygen deficiency, ambient noise, and need for communication.

e. Training

Employee training is essential for correct respirator use. ASTM F3387–19 provides that all users be trained in their area of responsibility by a qualified person to ensure the proper use of respirators. A respirator trainer must be knowledgeable about the application and use of the respirators and must understand the site's work practices, respirator program, and applicable regulations. Employees who should receive training under ASTM F3387–19 include the workplace supervisor, the person issuing and maintaining respirators, respirator wearers, and emergency teams. To ensure the proper and safe use of a respirator, the standard also provides that the training for each respirator wearer should cover, at a minimum: the need for respiratory protection; the nature, extent, and effects of respiratory hazards in the workplace; reasons for particular respirator selections; reasons for engineering controls not being applied or reasons why they are not adequate; types of efforts made to reduce or eliminate the need for respirators; operation, capabilities, and limitations of the respirators selected; instructions for inspecting, donning, and doffing the respirator; the importance of proper respirator fit and use; and maintenance and storage of respirators. The standard provides for each respirator wearer to receive initial and annual training. Workplace supervisors and persons issuing respirators are retrained as determined by the program administrator. Training records for each respirator wearer are maintained and include the date, type of training received, performance results (as appropriate), and instructor's name.

f. Respirator Fit Testing

A serious hazard may occur if a respirator, even though properly selected, is not properly fitted. For example, if a proper face seal is not achieved, the respirator will provide a lower level of protection than it is designed to provide because the respirator could allow contaminants to leak into the breathing area. Proper fit testing verifies that the selected make, model, and size of a respirator fits adequately and ensures that the expected level of protection is provided. ASTM F3387–19 includes provisions for qualitative and quantitative fit testing to determine the ability of a respirator wearer to obtain a satisfactory fit with a tight-fitting respirator and incorporates ANSI/AIHA Z88.10, *Respirator Fit Testing Methods,* for guidance on how to conduct fit testing of tight-fitting respirators and on appropriate methods to be used. This includes information on the application of fit factors and assigned protection factors, and how these factors are used to ensure that a wearer is receiving the necessary protection. ASTM F3387–19 provides for each respirator wearer to be fit tested before being assigned a respirator; this fit testing should happen at least once every 12 months or when a wearer expresses concern about respirator fit or comfort or has a condition that may interfere with the face piece seal.

g. Maintenance, Inspection, and Storage

Proper maintenance and storage of respirators are important in a respiratory protection program. ASTM F3387–19 includes specific provisions for decontaminating, cleaning, and sanitizing respirators, inspecting respirators, replacing, and repairing parts, and storing and disposing of respirators. For example, the decontamination provisions state that respirators must be decontaminated after each use and cleaned and sanitized regularly per manufacturer instructions. Following cleaning and disinfection, reassembled respirators are inspected to verify proper working condition. ASTM F3387–19 states that employers consult manufacturer instructions to determine component expiration dates or end-of-service life, inspect the rubber or other elastomeric components of respirators for signs of deterioration that would affect respirator performance, and repair or replace respirators failing inspection. ASTM F3387–19 also provides that respirators are stored according to manufacturer recommendations and in a manner that will protect against hazards (*e.g.,* physical, biological, chemical, vibration, shock, temperature extremes, moisture). It also provides that respirators are stored in a way that prevents distortion of rubber or other parts.

2. Section-by-Section Analysis of Incorporation by Reference—ASTM F3387–19

a. Part 56—Safety and Health Standards—Surface Metal and Nonmetal Mines

Section 56.5005—Control of Exposure to Airborne Contaminants

Final § 56.5005 is changed from the proposal. The final rule requires a written respiratory protection program consistent with the requirements of ASTM F3387–19. In the NPRM, MSHA proposed to revise paragraph (b) to remove the incorporation by reference to ANSI Z88.2—1969 and incorporate by reference ASTM F3387–19 to state that approved respirators must be selected, fitted, cleaned, used, and maintained in accordance with the requirements of ASTM F3387–19 ''as applicable.'' MSHA proposed to update the Agency's existing respiratory protection standard to help safeguard the life and health of all miners when exposed to respirable airborne contaminants at MNM mines while wearing respirators. The ASTM F3387–19 standard includes, for example, provisions for selection, fitting, use, and care of respirators used to remove airborne contaminants from the air using filters, cartridges, or canisters, as well as respirators that protect in oxygen-deficient or immediately dangerous to life or health (IDLH) atmospheres. MSHA proposed to incorporate by reference ASTM F3387–19 because it is the most recent consensus standard developed by experts in government and professional associations on the selection, use, and maintenance for respiratory equipment.

AEMA stated that the final rule should clarify whether a specific written respiratory protection program is required and under what standards (Document ID 1424. MSHA's response to these comments is discussed in detail in *Section VIII.B.7. Section 60.14—Respiratory protection.* Also, the Agency provides a detailed description of some requirements for the respiratory protection program in *Section VIII.D.1. Respiratory Protection Program Requirements.*

In response to comments, MSHA has modified the language in paragraph (b) in the final rule compared to the proposal. The modifications include: the removal of ''as applicable''; clarification that a respiratory protection program must be in writing, and one non-substantive edit in the introductory clause. These changes clarify what the requirements are for MNM mine operators' respiratory protection programs.

MNM mine operators do not have to create a separate written respiratory protection program under each of 30 CFR parts 56, 57, and 60 where ASTM F3387–19 is incorporated by reference. Operators may create one single program that is applicable to respirable crystalline silica hazards (part 60) and other airborne contaminants (parts 56 and 57). However, as required by ASTM F3387–19 and MSHA standards, the respiratory protection program must assess the potential respiratory hazard or hazards and the mine operator must then select approved respirators which are appropriate for the airborne hazard(s) encountered. MSHA believes the final rule provides MNM mine operators with additional time which should be sufficient to allow them to prepare and develop written respiratory protection programs, if necessary, that are based on the finalrule's requirements.

Consistent with the proposal, MSHA is changing paragraph (c) to require the presence of at least one other person with backup equipment and rescue capability when respiratory protection is used in atmospheres that are IDLH. This change is needed to conform to language in the incorporation by reference of ASTM F3387–19, which defines IDLH as ''any atmosphere that poses an immediate hazard to life or immediate irreversible debilitating effects on health'' (ASTM International, 2019).

As described above in *Section VIII.C. Conforming Amendments,* 60 days after publication of the final rule, a new temporary section with the suffix ''T'' will be added for the conforming amendments in part 56. Then, 720 days after publication of the final rule, the existing section for the conforming amendments in part 56 will be removed and the temporary section will be redesignated without the ''T'' to replace the removed section. The result of these technical changes is that mine operators must comply with the existing standards until the compliance dates in part 60.

b. Part 57—Safety and Health Standards—Underground Metal and Nonmetal Mines

Section 57.5005—Control of Exposure to Airborne Contaminants

Final § 57.5005 is changed from the proposal for the same reasons discussed in § 56.5005. The final rule requires a written respiratory protection program consistent with the requirements of ASTM F3387–19. In the NPRM, MSHA proposed to revise paragraph (b) to remove the incorporation by reference to ANSI Z88.2—1969 and incorporate by reference ASTM F3387–19 to state that approved respirators must be selected, fitted, cleaned, used, and maintained in accordance with the requirements of ASTM F3387–19 ''as applicable.'' MSHA proposed to update the Agency's existing respiratory protection standard to help safeguard the life and health of all miners when exposed to respirable airborne contaminants at MNM mines while wearing respirators. The ASTM F3387–19 standard, for example, includes provisions for selection, fitting, use, and care of respirators used to remove airborne contaminants from the air using filters, cartridges, or canisters, as well as respirators that protect in oxygen-deficient or immediately dangerous to life or health (IDLH) atmospheres. MSHA proposed to incorporate by reference ASTM F3387–19 because it is the most recent consensus standard developed by experts in government and professional associations on the selection, use, and maintenance for respiratory equipment.

AEMA stated that the final rule should clarify whether a specific written respiratory protection program is required and under what standards (Document ID 1424). MSHA's response to these comments is discussed in detail in *Section VIII.B.7. Section 60.14—Respiratory protection.* Also, the Agency provides a detailed description of each of the requirements for the respiratory protection program in *Section VIII.D.1. Respiratory Protection Program Requirements.*

In response to comments, MSHA has modified the language in paragraph (b) in the final rule compared to the proposal. The modifications include: the removal of ''as applicable''; clarification that a respiratory protection program must be in writing, and one non-substantive edit in the introductory clause. These changes clarify what the requirements are for MNM mine operators' respiratory protection programs.

MNM mine operators do not have to create a written respiratory protection program under each of 30 CFR parts 56, 57, and 60 where ASTM F3387–19 is incorporated by reference. Operators may create one single program that is applicable to respirable crystalline silica hazards (part 60) and other airborne contaminants (parts 56 and 57). However, as required by ASTM F3387–19 and MSHA standards, the respiratory protection program must assess the potential respiratory hazard or hazards and the mine operator must then select approved respirators which are appropriate for the airborne hazard(s) encountered. The final rule provides MNM mine operators additional time for compliance, which MSHA believes should give them sufficient time to prepare and develop written respiratory protection programs, if necessary, that are based on the final rule's requirements.

Consistent with the proposal, MSHA is changing paragraph (c) to require the presence of at least one other person with backup equipment and rescue capability when respiratory protection is used in atmospheres that are IDLH. This change is needed to conform to language in the proposed incorporation by reference of ASTM F3387–19, which defines the term IDLH as ''any atmosphere that poses an immediate hazard to life or immediate irreversible debilitating effects on health'' (ASTM International, 2019).

As described above in *Section VIII.C. Conforming Amendments,* 60 days after publication of the final rule, a new temporary section with the suffix ''T'' will be added for the conforming amendments in part 57. Then, 720 days after publication of the final rule, the existing section for the conforming amendments in part 57 will be removed and the temporary section will be redesignated without the ''T'' to replace the removed section. The result of these technical changes is that mine operators must comply with the existing standards until the compliance dates in part 60.

c. Part 72—Health Standards for Coal Mines

Section 72.710—Selection, Fit, Use, and Maintenance of Approved Respirators

Final § 72.710 includes two changes from the proposal. The final rule requires that approved respirators be selected, fitted, used, and maintained in accordance with the provisions of a written respiratory protection program consistent with the requirements of ASTM F3387–19. In the NPRM, MSHA proposed an editorial change to the introductory statement to § 72.710 and that approved respirators must be selected, fitted, used, and maintained in accordance with the requirements of ASTM F3387–19 ''as applicable.''

MSHA proposed to update the Agency's existing respiratory protection standard to help safeguard the life and health of coal miners when exposed to respirable airborne contaminants such as respirable coal dust while wearing respirators. The ASTM F3387–19 standard includes provisions for selection, fitting, use, and care of respirators used to remove airborne contaminants from the air using filters, cartridges, or canisters, as well as respirators that protect in oxygen-deficient or immediately dangerous to life or health (IDLH) atmospheres. MSHA proposed to incorporate by reference ASTM F3387–19 because it is the most recent consensus standard developed by experts in government and professional associations on the selection, use, and maintenance for respiratory equipment.

AEMA stated that the final rule should clarify whether a specific written respiratory protection program is required and under what standards (Document ID 1424).

MSHA's response to these comments is discussed in detail in *Section VIII.B.7. Section 60.14—Respiratory protection.* Also, the Agency provides a detailed description of each of the requirements for the respiratory protection program in *Section VIII.D.1. Respiratory Protection Program Requirements.*

In response to comments, MSHA has modified the language to remove as ''as applicable'' and to clarify that the respiratory protection program must be in writing and must be consistent with ASTM F3387–19. This change clarifies what the requirements are for coal mine operators' respiratory protection programs.

Coal mine operators do not have to create a separate written respiratory protection program under 30 CFR parts 60 and 72 part where ASTM F3387–19 is incorporated by reference. Operators may create a single program that is applicable to respirable crystalline silica hazards (part 60) and other airborne contaminants (part 72). However, as required by ASTM F3387–19 and MSHA standards, the respiratory protection program must assess the potential respiratory hazard or hazards and the mine operator must select approved respirators which are appropriate for the airborne hazard(s) encountered. MSHA believes the final rule provides coal mine operators with sufficient time to prepare and develop written respiratory protection programs that are based on the rule's requirements.

As described above in *Section VIII.C. Conforming Amendments,* 60 days after publication of the final rule, a new temporary section with the suffix ''T'' will be added for the conforming amendments in part 72. Then, 360 days after publication of the final rule, the existing section for the conforming amendments in part 72 will be removed and the temporary section will be redesignated without the ''T'' to replace the removed section. The result of these technical changes is that mine operators must comply with the existing standards until the compliance dates in part 60.

IX. Summary of Final Regulatory Impact Analysis and Regulatory Alternatives

A. Introduction

Executive Order (E.O.) 12866, as amended by E.O. 14094, and E.O. 13563 direct agencies to assess all costs and benefits of available regulatory alternatives and, if regulation is necessary, to select regulatory approaches that maximize net benefits (including potential economic, environmental, public health and safety effects, distributive impacts, and equity).[77] E.O. 13563 emphasizes the importance of quantifying both costs and benefits, of reducing costs, of harmonizing rules, and of promoting flexibility. E.O.s 12866 and 13563 require that regulatory agencies assess both the costs and benefits of regulations.

Under E.O. 12866 (as amended by E.O. 14094), the Office of Management and Budget (OMB)'s Office of Information and Regulatory Affairs (OIRA) determines whether a regulatory action is significant and, therefore, subject to the requirements of the E.O. and review by OMB. 58 FR 51735, 51741 (1993). As amended by E.O. 14094, section 3(f) of E.O. 12866 defines a ''significant regulatory action'' as a regulatory action that is likely to result in a rule that may: (1) have an annual effect on the economy of $200 million or more; or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, territorial, or tribal governments or communities; (2) create a serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) materially alter the budgetary impact of entitlements, grants, user fees or loan programs or the rights and obligations of recipients thereof; or (4) raise legal or policy issues for which centralized review would meaningfully further the President's priorities or the principles set forth in the E.O. OIRA has determined that this final rule is a significant regulatory action under section 3(f)(1) of E.O. 12866, and accordingly it has been reviewed by OMB. Pursuant to Subtitle E of the Small Business Regulatory Enforcement Fairness Act of 1996, also known as the Congressional Review Act (5 U.S.C. 801 *et seq.*), OIRA has determined that this rule meets the criteria set forth in 5 U.S.C. 804(2).

E.O. 13563 directs agencies to propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs; the regulation is tailored to impose the least burden on society, consistent with achieving the regulatory objectives; and in choosing among alternative regulatory approaches, the agency has selected those approaches that maximize net benefits. E.O. 13563 recognizes that some benefits are difficult to quantify and provides that, where appropriate and permitted by law, agencies may consider and discuss qualitative values that are difficult or impossible to quantify, including equity, human dignity, fairness, and distributive impacts.

To comply with E.O.s 12866 and 13563, MSHA has prepared a final regulatory impact analysis (FRIA) for the final rule. The purpose of the FRIA is to:

• Profile the mining industry impacted by the final rule;

• Estimate the monetized societal benefits attributable to the new PEL resulting from reductions in fatal cases of lung cancer, non-malignant respiratory disease, end-stage renal disease, and both fatal and non-fatal cases of silicosis;

• Identify additional non-quantified benefits expected from the final rule;

• Estimate the costs that the mining industry will incur to achieve compliance with the final rule;

• Assess the economic feasibility of the final rule for the mining industry; and

• Evaluate the principal regulatory alternatives to the final rule that MSHA has considered.

MSHA estimates the final rule will have an annualized cost of $90.3 million in 2022 dollars at a discount rate of 3 percent. The breakdown of this total cost value by compliance cost for each provision is as follows: approximately 59 percent is attributable to exposure monitoring; 21 percent to medical surveillance; 15 percent to exposure controls (engineering, improved maintenance and repair, and administrative controls); 5 percent to respiratory protection and incorporating ASTM F3387–19. Of the annualized compliance cost of $90.3 million, the MNM sector will incur $82.1 million (approximately 91 percent) and the coal sector will incur $8.2 million (approximately 9 percent).

Under a discount rate of 3 percent, the total monetized benefits of the new respirable crystalline silica final rule from avoided deaths and morbidity cases, including the benefits of avoided morbidity preceding mortality, are $246.9 million per year in 2022 dollars. The net quantified benefits of the final rule are calculated as the difference between the estimated benefits and costs. MSHA estimates that the net annualized benefits of the final rule, using a discount rate of 3 percent, is $156.6 million.

In addition to these quantified benefits, there are unquantified benefits. MSHA believes that the medical surveillance program will help miners to detect silica-related diseases early. Early detection of illness often leads to early intervention and treatment, which may slow disease progression and/or improve health outcomes. However, MSHA lacks data to quantify these additional benefits. Furthermore, MSHA expects that there will be additional benefits from replacing ANSI Z88.2–1969 with ASTM F3387–19. The ASTM standard reflects developments in respiratory protection since the time in which MSHA issued its existing standards. The updated standard will play a critical role in safeguarding the health of miners, reducing their exposures to respirable crystalline silica and other airborne contaminants. Again, due to a lack of data, MSHA did not quantify the expected additional benefits that would be realized by requiring respiratory protection

[77] Executive Order 12866 of September 30, 1993: Regulatory Planning and Review. 58 FR 51735. October 4, 1993. *https://www.archives.gov/files/federal-register/executive-orders/pdf/12866.pdf* (last accessed Jan. 10, 2024).

Executive Order 14094 of April 6, 2023: Modernizing Regulatory Review. 88 FR 21879. April 11, 2023. *https://www.federalregister.gov/documents/2023/04/11/2023-07760/modernizing-regulatory-review* (last accessed Jan. 10, 2024).

Executive Order 13563 of January 18, 2011: Improving Regulation and Regulatory Review. January 18, 2011. *https://www.regulations.gov/document/EPA-HQ-OA-2018-0259-0005* (last accessed Jan. 10, 2024).

programs consistent with the ASTM F3387–19 standard.

The standalone FRIA contains detailed supporting data and discussions for the summary materials presented here, including the profile of the mining industry, estimated costs and benefits attributable to the final rule, the assessment of the economic feasibility of the final rule for the mining industry, and the evaluation of regulatory alternatives. The standalone FRIA is placed in the rulemaking docket at *www.regulations.gov,* docket number MSHA–2023–0001. The summary of the standalone FRIA is presented below.

The FRIA includes several revisions made since the PRIA. In response to public comments on the proposed rule and PRIA, MSHA revised its cost and benefit estimates. The revisions increased both the estimated costs and benefits.

Four types of changes were made to the cost and benefit estimates. First, the final rule includes several changes from the proposed rule, and these changes affected estimated costs. The changes include: additional time provided by MSHA for mine operator compliance; revisions to exposure monitoring requirements including removal of the use of objective data and historical sample data to discontinue sampling; the requirement for mine operators to immediately report all exposures above the PEL from operator sampling to the MSHA District Manager or other designated office; revisions to the requirement for periodic evaluations to include additional evaluations whenever changes are made; the requirement of respiratory protection for MNM mines when engineering controls are being developed and implemented, or it is necessary by the nature of the work performed; and changes to the medical surveillance requirements for MNM operators related to the compliance date and a new requirement for reporting miners' chest X-ray results to NIOSH.

Second, MSHA revised the FRIA methodology to annualize compliance costs over 60 years, which is the regulatory time horizon for this analysis. The 60-year analysis period starts with the first day of compliance for the coal sector (12 months after publication of the final rule). Coal mine operators incur compliance costs beginning 12 months after publication of the final rule. MNM mine operators incur compliance costs beginning 24 months after publication of the final rule. The analysis period ends 60 years after the first day of compliance for the coal sector, thus 60 years of compliance costs for coal mine operators and 59 years of compliance costs for MNM mine operators are included in the analysis. MSHA also updated both compliance costs and benefits to reflect 2022 dollars using the GDP implicit price deflator.

Third, MSHA made several changes to the PRIA cost estimation methodology; for example, the Agency modified its assumption about the proportion of the miner workforce that would be sampled in larger mines, as well as its assumption about the number of corrective actions, to account for circumstances in which multiple corrective actions may be necessary to reduce miners' exposure to below the PEL. MSHA also revised estimates of maintenance and repair and administrative control costs each year.

Lastly, MSHA made some changes to the PRIA benefit estimation methodology. Changes were also made to the benefit estimates. As discussed in *Section VI. Final Risk Analysis Summary,* the PRA underestimated benefits from the proposed rule by excluding future retired miners from the number who would benefit. Both the FRA and the FRIA are updated to account for benefits for working miners and future retired miners. It is important to note that the FRIA only monetizes benefits to *future* retired miners—*i.e.,* retired individuals who were employed as miners at least one year after the start of implementation. The FRIA methodology does not attribute any health benefits to individuals who retired *before* the start of implementation of the final rule. The FRIA reflects the fact that the number of future retired miners increases gradually after the start of implementation. For example, in the first year after the start of implementation, there will be no retired miners who benefit from the rule. In the second year after the start of implementation, there will be one cohort of retired miners who benefit from the rule (*i.e.,* those in their final year of mining when implementation began). In this way, the FRIA monetizes benefits to future retired miners while accounting for the fact that future retired miners who benefit from the rule increase in size gradually during the 60-year analysis period.

B. Miners and Mining Industry

This section provides information on the characteristics of the MNM and coal mining sectors, including their estimated revenues, number of mines in each sector, commodities the industry produces, and employment sizes. In addition, this section provides the respirable crystalline silica exposure profiles for miners across different occupational categories in the MNM and coal sectors. These data come from the U.S. Department of the Interior (DOI), U.S. Geological Survey (USGS); U.S. Department of Labor (DOL), Mine Safety and Health Administration (MSHA), Educational Policy and Development and Program Evaluation and Information Resources; DOL, Bureau of Labor Statistics (BLS), Occupational Employment and Wage Statistics (OEWS); U.S. Census Bureau, Statistics of U.S. Businesses (SUSB); and the Energy Information Administration (EIA).

In general, economic profiles were developed using 2019 data because this was the most recent year available that was not impacted by temporary changes resulting from the COVID–19 pandemic. To estimate the current number of miners, MSHA used the 2019 Quarterly Employment Production Industry Profile (MSHA, 2019a) and the 2019 Quarterly Contractor Employment Production Report (MSHA, 2019b). MSHA estimated the number of and type of mines using 2019 data from the Mine Data Retrieval System, including the Mines database, (MSHA, 2022d) and the 2019 employment data (MSHA, 2019a,b).

The size of the mining industry is difficult to forecast given the uncertainties in future demand for various mined commodities, as well as uncertainties about technological changes. MSHA assumed the current mining workforce and the current number of mines would not change during the 60 years following implementation of the final rule. If the industry were to contract or expand in the future, the relative ratio of benefits to costs would remain roughly the same because both the benefits and costs of the final rule are in proportion to the size of the industry.

1. Structure of the Mining Industry

The mining industry can be divided into two major sectors: (1) MNM mines and (2) coal mines, with further distinction made regarding type of operation (*i.e.,* underground mines or surface mines) and commodity. The MNM mining sector is made up of metal mines (*e.g.,* copper, iron ore, gold, silver, etc.) and nonmetal mines. Nonmetal mines can be further categorized into four commodity groups: (1) nonmetal (mineral) materials such as clays, potash, soda ash, salt, talc, and pyrophyllite; (2) stone, including granite, limestone, dolomite, sandstone, slate, and marble; (3) crushed limestone; and (4) sand and gravel, including industrial sands.

MSHA categorizes mines by size based on employment. For purposes of this industry profile and the FRIA analyses, MSHA categorized mines into the following four size groups: [78] (1) 1 to 20 miners; (2) 21 to 100 miners; (3) 101 to 500 miners; and (4) 501 or more miners.

MSHA tracks mine characteristics and maintains a database containing the number of mines by mine type and size, number of employees, and employee hours worked. MSHA also collects data on the number of independent contractor firms who provide miners to the industry, the number of contract miners they employ, and their employed contract miners' hours worked. Contract miners may work at any mine.

Table IX–1 presents an overview of the mining industry, including the number of MNM and coal mines, their employment (excluding contract miners), and their estimated revenues by commodity and size. As mentioned above, all data regarding the number of miners and mines are current in reference to the year 2019 and are assumed to remain constant during the 60 years following the implementation of the final rule. Estimated revenues are also based on 2019 data but have been inflated to 2022 dollars using the GDP implicit price deflator (U.S. Bureau of Economic Analysis, 2023).

The MNM mining sector is comprised of an estimated 11,525 mines which employ an estimated 169,070 individuals, of which 150,928 are miners (excluding contract miners) and 18,142 are office workers. In addition, contract miners work an estimated 71.3 million hours in MNM mines each year.

The coal mining sector is comprised of an estimated 1,106 mines that employ an estimated 52,966 individuals, of which 51,573 are miners (excluding contract miners) and 1,393 are office workers. In addition, contract miners work an estimated 28.0 million hours in coal mines each year.

A further breakdown of MNM mines and coal mines by mine commodity and mine size is provided below.

BILLING CODE 4520–43–P

[78] Miner employment is based on the information submitted quarterly through the MSHA Form 7000–2, excluding Subunit 99—Office (professional and clerical employees at the mine or plant working in an office); *https://www.msha.gov/sites/default/files/Support_Resources/Forms/7000-2_0.pdf* (last accessed Jan. 10, 2024).

Table IX-1: Profile of MNM and Coal Mines, by Mine Size

Mine Commodity	Mine Size by Miner Employment	Estimated Revenues[1]		Number of Mines[2]		Miners Excluding Contract Miners[2]		Production Hours (thousands)[2]		Total Employment[2]	
		Millions in 2022 dollars	*Percent*	No.	*Percent*	No.	*Percent*	No.	*Percent*	No.	*Percent*
Metal	Emp <= 20	$572.6	*1.9%*	157	*56.1%*	851	*2.3%*	1,433.8	*1.9%*	999	*2.5%*
Metal	20 < Emp <= 100	$1,566.1	*5.1%*	39	*13.9%*	1,947	*5.3%*	3,921.3	*5.1%*	2,251	*5.6%*
Metal	100 < Emp <= 500	$12,817.5	*42.0%*	62	*22.1%*	15,060	*40.7%*	32,094.2	*42.0%*	16,508	*40.7%*
Metal	500 > Emp	$15,561.6	*51.0%*	22	*7.9%*	19,168	*51.8%*	38,965.3	*51.0%*	20,771	*51.2%*
Metal	***Total***	***$30,517.8***	***100.0%***	***280***	***100.0%***	***37,026***	***100.0%***	***76,414.7***	***100.0%***	***40,529***	***100.0%***
Non-Metal	Emp <= 20	$3,651.5	*14.4%*	645	*71.9%*	3,694	*16.3%*	6,397.5	*14.4%*	4,237	*16.6%*
Non-Metal	20 < Emp <= 100	$10,162.4	*40.1%*	207	*23.1%*	8,921	*39.3%*	17,805.0	*40.1%*	10,065	*39.3%*
Non-Metal	100 < Emp <= 500	$9,412.6	*37.1%*	42	*4.7%*	8,220	*36.2%*	16,491.4	*37.1%*	9,163	*35.8%*
Non-Metal	500 > Emp	$2,124.2	*8.4%*	3	*0.3%*	1,845	*8.1%*	3,721.6	*8.4%*	2,134	*8.3%*
Non-Metal	***Total***	***$25,350.6***	***100.0%***	***897***	***100.0%***	***22,680***	***100.0%***	***44,415.4***	***100.0%***	***25,599***	***100.0%***
Stone	Emp <= 20	$4,144.7	*28.5%*	2,002	*83.1%*	11,198	*31.7%*	20,035.5	*28.5%*	12,563	*31.5%*
Stone	20 < Emp <= 100	$6,380.2	*43.8%*	339	*14.1%*	14,779	*41.9%*	30,842.4	*43.8%*	16,824	*42.2%*
Stone	100 < Emp <= 500	$3,808.7	*26.2%*	67	*2.8%*	8,762	*24.8%*	18,411.6	*26.2%*	9,896	*24.8%*
Stone	500 > Emp	$227.3	*1.6%*	1	*0.0%*	539	*1.5%*	1,098.8	*1.6%*	602	*1.5%*
Stone	***Total***	***$14,560.9***	***100.0%***	***2,409***	***100.0%***	***35,278***	***100.0%***	***70,388.3***	***100.0%***	***39,885***	***100.0%***
Crushed Limestone	Emp <= 20	$6,621.2	*45.8%*	1,555	*83.5%*	11,771	*48.8%*	22,834.9	*45.8%*	13,495	*49.7%*
Crushed Limestone	20 < Emp <= 100	$6,569.2	*45.5%*	293	*15.7%*	10,480	*43.5%*	22,655.5	*45.5%*	11,641	*42.9%*
Crushed Limestone	100 < Emp <= 500	$1,250.7	*8.7%*	14	*0.8%*	1,856	*7.7%*	4,313.4	*8.7%*	2,002	*7.4%*
Crushed Limestone	500 > Emp	$0.0	*0.0%*	0	*0.0%*	0	*0.0%*	0.0	*0.0%*	0	*0.0%*
Crushed Limestone	***Total***	***$14,441.1***	***100.0%***	***1,862***	***100.0%***	***24,107***	***100.0%***	***49,803.8***	***100.0%***	***27,138***	***100.0%***
Sand and Gravel	Emp <= 20	$7,110.5	*69.7%*	5,879	*96.7%*	23,887	*75.0%*	39,673.3	*69.7%*	27,262	*75.9%*
Sand and Gravel	20 < Emp <= 100	$2,591.5	*25.4%*	188	*3.1%*	6,703	*21.1%*	14,459.5	*25.4%*	7,320	*20.4%*
Sand and Gravel	100 < Emp <= 500	$497.8	*4.9%*	10	*0.2%*	1,247	*3.9%*	2,777.6	*4.9%*	1,337	*3.7%*
Sand and Gravel	500 > Emp	$0.0	*0.0%*	0	*0.0%*	0	*0.0%*	0.0	*0.0%*	0	*0.0%*
Sand and Gravel	***Total***	**$10,199.8**	***100.0%***	***6,077***	***100.0%***	***31,837***	***100.0%***	***56,910.5***	***100.0%***	***35,919***	***100.0%***
MNM Total	**Emp <= 20**	**$22,100.4**	***23.2%***	**10,238**	***88.8%***	**51,401**	***34.1%***	**90,375.0**	***30.3%***	**58,556**	***34.6%***
MNM Total	**20 < Emp <= 100**	**$27,269.4**	***28.7%***	**1,066**	***9.2%***	**42,830**	***28.4%***	**89,683.7**	***30.1%***	**48,101**	***28.5%***
MNM Total	**100 < Emp <= 500**	**$27,787.4**	***29.2%***	**195**	***1.7%***	**35,145**	***23.3%***	**74,088.3**	***24.9%***	**38,906**	***23.0%***
MNM Total	**500 > Emp**	**$17,913.1**	***18.8%***	**26**	***0.2%***	**21,552**	***14.3%***	**43,785.7**	***14.7%***	**23,507**	***13.9%***
MNM Total	***Total***	***$95,070.2***	***100.0%***	***11,525***	***100.0%***	***150,928***	***100.0%***	***297,932.6***	***100.0%***	***169,070***	***100.0%***
Coal	Emp <= 20	$1,143.0	*3.9%*	707	*63.9%*	4,358	*8.5%*	9,077.4	*7.7%*	4,611	*8.7%*
Coal	20 < Emp <= 100	$3,659.4	*12.6%*	271	*24.5%*	11,814	*22.9%*	27,591.7	*23.5%*	12,145	*22.9%*
Coal	100 < Emp <= 500	$16,353.5	*56.2%*	116	*10.5%*	26,145	*50.7%*	59,897.7	*51.0%*	26,818	*50.6%*
Coal	500 > Emp	$7,943.3	*27.3%*	12	*1.1%*	9,256	*17.9%*	20,962.2	*17.8%*	9,392	*17.7%*
Coal	***Total***	***$29,099.2***	***100.0%***	***1,106***	***100.0%***	***51,573***	***100.0%***	***117,529.0***	***100.0%***	***52,966***	***100.0%***

Notes:

1. Coal Revenues were calculated using MSHA Production Figures in Short Tons by Rank: 650.3 million tons Bituminous Coal, 53.2 million tons Lignite Coal, 2.6 million tons Anthracite Coal; and EIA price's per short ton by Coal Rank: EIA Annual Coal Report 2019; Table 31 Average Sales Price of Coal by State And Rank, 2019; US Total: $58.93/ton Bituminous Coal, $19.86/ton Lignite Coal, $102.22/ton Anthracite Coal; https://www.eia.gov/coal/annual/archive/0584_2019.pdf (last accessed Jan. 11, 2024). The revenues for MNM commodities are calculated by applying the proportion of revenues represented by each commodity among all MNM commodities in the 2017 SUSB data and applying that proportion to the 2019 production value for all industrial minerals reported by USGS. Revenues were inflated to 2022 dollars using the Bureau of Economic Analysis (BEA) GDP Implicit Price Deflator, available at: https://fred.stlouisfed.org/series/GDPDEF#0 (last accessed October 26, 2023).
2. The estimated current and future number of mines, miners, and production hours are based on 2019 data and are assumed to have remained constant through the 60 years following the start of implementation of the rule.

BILLING CODE 4520–43–C

a. Metal Mining

There are 24 groups of metal commodities mined in the U.S. Metal mines represent an estimated 2.4 percent (280/11,525) of all MNM mines and employ an estimated 24.5 percent of all MNM miners (excluding contract miners). Of these 280 estimated mines, 157 (56.1 percent) employ 20 or fewer miners and 22 (7.9 percent) employ greater than 500 miners. Additionally, MSHA data show that there is an estimated total of 13,792 contract miners in the metal mining industry with an estimated 18.9 million reported production hours in a year.

b. Non-Metal (Mineral) Mining

There are 35 non-metal commodities mined in the U.S., not including stone and sand and gravel. Non-metal mines represent an estimated 7.8 percent (897/

11,525) of all MNM mines and employ an estimated 15 percent of all MNM miners (excluding contract miners). The majority of non-metal mines (71.9 percent) employ fewer than 20 miners and less than 1 percent employ more than 500 miners. According to MSHA data, there are an estimated 11,346 contract miners in the non-metal mining industry with an estimated 14.5 million reported production hours in a year.

c. Stone Mining

The stone mining subsector includes eight different stone commodities. Of these eight, seven are further classified as either dimension stone or crushed and broken stone. Stone mines make up an estimated 20.9 percent (2,409/11,525) of all MNM mines and employ an estimated 23.4 percent of all MNM miners (excluding contract miners). The majority of these mines (83.1 percent) employ fewer than 20 miners and one mine employs over 500 miners. According to MSHA data, there are an estimated 18,559 contract miners in the stone mining industry with an estimated total of 18.8 million reported production hours in a single year.

d. Crushed Limestone

Crushed limestone mines make up an estimated 16.2 percent (1,862/11,525) of all MNM mines and are estimated to employ about the same percentage (16.0 percent) of all MNM miners (excluding contract miners). Of the 1,862 crushed limestone mines, the vast majority (83.5 percent) employ fewer than 20 miners; none employ over 500 miners. Additionally, MSHA data show that there are an estimated 9,065 contract miners in the crushed limestone mining industry with an estimated total of 10.2 million reported production hours in a single year.

e. Sand and Gravel Mining

Sand and gravel mines account for an estimated 52.7 percent (6,077/11,525) of all MNM mines and employ an estimated 21.1 percent of all MNM miners (excluding contract miners). Nearly all (96.7 percent) employ fewer than 20 employees; none employ over 500 miners. MSHA data show that there are an estimated 7,512 contract miners in the sand and gravel mining industry with an estimated 8.9 million production hours in a single year.

f. Coal

Of the estimated 1,106 total coal mines, an estimated 63.9 percent (707/1,106) employ fewer than 20 miners and 1.1 percent employ more than 500 miners. Overall coal mine employment is estimated to be 52,966, of which 51,573 are miners (excluding contract miners) and the remaining 1,393 are office workers. Additionally, there are an estimated total of 22,003 contract miners in the coal mining industry with an estimated 28.0 million reported production hours in a single year.

2. Economic Characteristics of the Mining Industry

The value of all MNM mining output in 2022 dollars was estimated at $95.1 billion (U.S. Department of Interior, 2019). Metal mines, which include iron, gold, copper, silver, nickel, lead, zinc, uranium, radium, and vanadium mines, contributed $30.5 billion. In the USGS Mineral Commodity Summaries, production values for nonmetals, stone, sand and gravel, and crushed limestone are combined into one commodity group titled ''industrial minerals.'' Therefore, MSHA estimated the production value of each individual commodity by taking the proportion of revenues for the commodity in question among all commodities in the 2017 SUSB and applying that proportion to the 2019 production value for all industrial minerals reported by USGS. This approach yields the following estimates: non-metal production is valued at an estimated $22.3 billion, stone mining at $14.6 billion, crushed limestone at $14.4 billion, and sand and gravel at $10.2 billion.

The U.S. coal mining sector is made up of three major commodity groups: bituminous, anthracite, and lignite. According to MSHA data, bituminous operations represent approximately 92.1 percent of total coal production in short tons and employ 91.9 percent of all coal miners (excluding contract miners). Anthracite operations represent 0.4 percent of coal production and employ 1.9 percent of coal miners (excluding contract miners). Lignite operations represent roughly 7.5 percent of total coal production and employ 6.2 percent of coal miners (excluding contract miners).

To estimate coal revenues in 2019, MSHA combined production estimates with unit prices. Mine production data were taken from MSHA quarterly data and the coal unit prices per ton were taken from the 2019 EIA Annual Coal Report. Estimated revenues were then inflated to 2022 dollar values using the GDP implicit price deflator. As shown in Table IX–1, 2019 total coal revenues expressed in 2022 dollars totaled an estimated $29.1 billion.

3. Respirable Crystalline Silica Exposure Profile of Miners

Using the quarterly employment data submitted by mines and the Occupational Employment and Wage Statistics (OEWS) reported by the BLS, MSHA estimated the distribution of miners (excluding contract miners) across different occupational categories. For contract miners, MSHA lacked information on occupational categories. However, based on MSHA's program experience, MSHA assumed that the distribution of contract miners across the different occupational categories mirrors that of the miners (excluding contract miners) in each of the two sectors. For example, MSHA assumed that, because 1.9 percent of MNM production miners are drillers, 1.9 percent of contract miners working in MNM mines are also drillers.

As discussed in *Section VI. Final Risk Analysis Summary,* full-time equivalents (FTEs) are used to account for the fact that miners may experience more or less than 2,000 hours of exposure to respirable crystalline silica per year. MSHA calculates the number of miner FTEs by dividing the estimated total number of hours worked across all mines in a given sector by 2,000 hours. Based on these calculations, MSHA estimates 184,615 FTEs in the MNM sector of which 148,966 (81 percent) are miner FTEs (excluding contract miners) and the remaining 35,649 (19 percent) are contract miner FTEs (Table IX–2). For the coal sector, MSHA estimates 72,768 FTEs of which 58,764 (81 percent) are miner FTEs (excluding contract miners) and the remaining 14,004 (19 percent) are contract miner FTEs.

Table IX-2: Estimated Miner and Contract Miner Full-Time Equivalents (FTEs)

Parameter[1]	MNM	Coal	Total
Number of Contract Miners[2]	60,275	22,003	82,278
Number of Contract Miner Hours[2]	71,297,875	28,007,955	99,305,830
Contract Miner FTEs[3]	35,649	14,004	49,653
Number of Miners (Excluding Contract Miners)[4]	150,928	51,573	202,501
Number of Miner Hours (Excluding Contract Miners)[4]	297,932,646	117,528,968	415,461,614
Miner FTEs (Excluding Contract Miners)[5]	148,966	58,764	207,730
Miner and Contract Miner FTEs Combined[6]	184,615	72,768	257,383

Notes:

1. The estimated number of current and future miners, miner hours, and miner FTEs are based on 2019 data and are assumed to have remained constant through the 60 years following the start of implementation (MSHA, 2019a; MSHA, 2019b).
2. (Mine Safety and Health Administration, 2022a); (Mine Safety and Health Administration, 2022b)
3. The figure is calculated by dividing the total number of contract miner hours by 2,000.
4. From Table IX-1.
5. Similar to the contract miner FTEs, the figure is calculated by dividing the total number of miner hours by 2,000.
6. The figure is the sum of the calculated miner and contract miner FTEs.

MSHA's exposure data is described in *Section VI. Final Risk Analysis Summary.* In summary, MSHA used compliance data from 2005 through 2019 to estimate the current levels of exposure to respirable crystalline silica among MNM miners (MSHA, 2022b). For the coal sector, MSHA used data from 2016–2021 (MSHA, 2022a). For the coal sector, MSHA only used exposure data since 2016, by which time all provisions of the Coal Mine Dust Standard had gone into effect. MSHA did not use earlier data so that the benefits in this FRIA are clearly attributable to this final rule and not to the Coal Mine Dust Standard.

MSHA distributed the respirable dust samples in its MNM and coal exposure datasets by occupational category and exposure interval. Because exposure data associated with individual miners are not available, MSHA derived the imputed exposure profile of miners and miner FTEs stratified by occupational category and exposure interval. Based on this imputation, MSHA found that, in the MNM sector, an estimated 13,242 miners (6 percent), including contract miners, currently have respirable crystalline silica exposures above the existing PEL of 100 μg/m³, an estimated 37,966 (18 percent) have exposures above the new PEL of 50 μg/m³, and an estimated 77,736 (37 percent) have exposures at or above the action level of 25 μg/m³. On an FTE basis, an estimated 11,579 miner FTEs (6 percent), including contract miner FTEs, have respirable crystalline silica exposures above the existing PEL of 100 μg/m³, an estimated 33,146 (18 percent) have exposures above the new PEL of 50 μg/m³, and an estimated 67,946 (37 percent) have exposures at or above the action level of 25 μg/m³.

In the coal sector, an estimated 1,406 miners (2 percent), including contract miners, currently have respirable crystalline silica exposures above the existing PEL of 85.7 μg/m³, an estimated 4,080 (6 percent) have exposures above the new PEL of 50 μg/m³, and an estimated 13,971 (19 percent) have exposures at or above the action level of 25 μg/m³. On an FTE basis, the figures are similar with an estimated 1,391 miner FTEs (2 percent), including contract miner FTEs, having respirable crystalline silica exposures above the existing PEL of 85.7 μg/m³, an estimated 4,035 (6 percent) having exposures above the new PEL of 50 μg/m³, and an estimated 13,818 (19 percent) having exposures at or above the action level of 25 μg/m³.

C. Cost Analysis

The FRIA assesses the costs in the MNM and coal sectors of reducing miners' exposures to silica to 50 μg/m³ for a full-shift exposure, calculated as an 8-hour TWA and the costs of complying with the final rule's other requirements.

Under the final rule, mine operators are required to: implement exposure controls (§ 60.11); conduct exposure monitoring and report all samples over the PEL to MSHA (§ 60.12); take immediate corrective actions and provide miners with respirators when a sampling result indicates that miner exposure exceeds the PEL (§ 60.13); respiratory protection is required as a temporary measure for all MNM miners when MNM miner exposure exceeds the PEL while engineering controls are being developed and implemented or when it is necessary by the nature of work involved (for example, occasional entry to hazardous atmospheres to perform maintenance or investigation) (§ 60.14)(a); make periodic medical examinations available to MNM miners and ensure certain medical results are reported to NIOSH (§ 60.15); develop or revise existing respiratory protection programs and practices in accordance with the ASTM F3387–19 (§§ 56.5005, 57.5005, and 72.710); and retain records for the specified durations (§ 60.16).

MSHA estimates the annualized costs of the final rule range from $88.8 million to $92.4 million, depending on the discount rate used (Table IX–3). Of this total, about 91 percent will be incurred by mine operators in the MNM sector and 9 percent by mine operators in the Coal sector. The difference in cost between the MNM and coal sectors is driven by the much larger number of MNM mines, as well as differences in mine size and the extent to which current exposures are already below 50 μg/m³. In addition, MNM mine operators will incur costs to meet the medical surveillance requirements which further drives the difference in total costs between the MNM and coal sectors.

Table IX-3: Summary of Estimated Annualized Compliance Costs by Sector (in millions of 2022 dollars)

Sector	Number of Mines[1]	0 Percent Discount Rate		3 Percent Discount Rate		7 Percent Discount Rate	
		Annualized Cost	Percent	Annualized Cost	Percent	Annualized Cost	Percent
Total, All Mines	***12,631***	***$88.77***	***100.0%***	***$90.28***	***100.0%***	***$92.39***	***100.0%***
Metal/ Nonmetal, Total	11,525	$80.75	91.0%	$82.06	90.9%	$83.84	90.7%
Coal, Total	1,106	$8.02	9.0%	$8.22	9.1%	$8.55	9.3%

Note: 1. The estimated number of current and future mines are based on 2019 data (MSHA, 2022d) and are assumed to have remained constant through the following the start of implementation of the final rule.

For the PRIA, MSHA estimated annualized costs would range from $56.2 million (0 percent discount rate) to $60.0 million (7 percent discount rate). However, the estimated compliance costs for the PRIA were calculated in 2021 dollars. To compare PRIA and FRIA costs on an equivalent basis, MSHA inflated estimated PRIA compliance costs from 2021 dollars to 2022 dollars, which increases PRIA costs by about 7 percent. In 2022 dollars, estimated PRIA costs range from $60.1 million (0 percent discount rate) to $64.2 million (7 percent discount rate). Annualized estimated FRIA compliance costs exceed PRIA costs by about $28.2 to $28.7 million per year.

After accounting for the inflation to 2022 dollars, the remaining difference in estimated compliance costs between the PRIA and FRIA are attributable to several changes to the proposed rule, including:

- A longer phase-in implementation is provided for both coal and MNM mines.
- Objective data and historical sample data may no longer be used to demonstrate compliance with exposure monitoring requirements.
- Sample results exceeding the PEL must be reported to the MSHA district manager or other designated office.
- Periodic evaluations must be conducted at least every 6 months or whenever there is a change in: production; processes; installation or maintenance of engineering controls; installation or maintenance of equipment; administrative controls; or geological conditions.
- Limited temporary use of respirators is permitted in MNM mines only.
- For medical surveillance, the first medical examination offered to all MNM miners must be within 12 months of the compliance date. Also, chest X-ray results must be reported to NIOSH.

Under the FRIA, annualized costs are attributable to the following provisions of the final rule:

- Exposure Monitoring ($53.2 million, 59 percent of total)
- Exposure Controls ($13.7 million, 15 percent of total)
- Respiratory Protection ($3.3 million, 4 percent of total)
- Medical Surveillance ($18.8 million, 21 percent of total), and
- ASTM Update ($1.2 million, 1 percent of total).

Nearly two-thirds of the increase in estimated compliance costs ($19.0 million) is attributable to the exposure monitoring requirements under the final rule. The remainder is largely attributable to increased estimates for exposure controls ($7.5 million) and respiratory protection ($2.2 million). MSHA expects that the amount of sampling performed by mine operators will increase because the final rule does not allow mine operators to use objective data and historical sample data (operator and MSHA sample data from prior 12 months) to demonstrate compliance with exposure monitoring requirements. Below the estimate of each cost component is discussed in more detail.

1. Costs for Exposure Monitoring

There are five types of exposure monitoring required under the final rule:

- First-time sampling and second-time sampling based on a representative fraction of miners (§ 60.12(a)). First-time sampling occurs starting by the rule's respective compliance dates for coal mines and MNM mines. Second-time sampling occurs within three months of first-time sampling.
- Above-action-level sampling of a representative fraction of miners. If the most recent sampling results are at or above the action level (§ 60.12(a)), above-action-level sampling starts three months after the most recent sampling and continues until two consecutive samples demonstrate that miners' exposures are below the action level.
- Corrective actions must be performed for samples over the PEL. The mine operator must take corrective actions to reduce exposure and conduct corrective actions sampling until sample results are at or below the PEL (§ 60.12(b)). All corrective actions sample results exceeding the PEL must be immediately reported to the MSHA District Manager or other office designated by the District Manager.
- Periodic evaluations (qualitative monitoring) must be performed at least every 6 months, or whenever there is a change in production, processes, engineering or administrative controls, or geological conditions that may reasonably be expected to result in new or increased respirable crystalline silica exposures to ensure that any change will not have increased miners' exposures (§ 60.12(c)).
- If the periodic evaluations conducted under § 60.12(c) determine that increased exposures are likely, post-evaluation sampling must be conducted to ensure exposures remain at or above the action level (§ 60.12(d)).

For quantitative monitoring, MSHA estimates total sampling costs as a function of several factors: the unit cost of sampling, made up of labor costs (miners' and external consultants' time and hourly wage), laboratory costs for analyzing the samples, and clerical costs for recording the results; the number of samples that constitutes the required representative fraction each time the operator conducts sampling; and the frequency with which operators are assumed to carry out different types of monitoring (samplings and evaluation). MSHA assumes that regardless of the type of sampling, the unit cost of sampling does not vary, since the process of collecting a dust sample and analyzing for respirable crystalline silica is relatively similar at different mines. For the qualitative monitoring, MSHA estimates periodic evaluation costs as a function of labor costs and the frequency of evaluation. The calculation of each of these factors is discussed below.

Labor Costs of Exposure Monitoring

The most important component of sampling and evaluation cost is the time required to conduct the activities. For sampling, this includes the time needed to prepare for sampling, take the samples, and perform recordkeeping tasks on the results. Sampling takes time, which is valued at the hourly wage of the person wearing the sampling equipment and the person conducting the sampling. To err on the side of overestimates, MSHA assumed that in MNM mines, sample preparation and collection is performed by an industrial hygienist (IH).[79] The IH may be an in-house specialist or an external consultant. For coal mines, miners certified to perform sampling under 30 CFR 70.202, 71.202, and 90.202 can conduct the sampling required under the final rule.

In addition, MSHA assumed the personnel conducting sampling can collect 2, 3, and 4 samples per day at small, medium, and large mines, respectively. This determines the number labor hours needed to complete sampling at a mine, and therefore directly affects labor costs.

Sampling labor costs: For coal mines, MSHA estimates sampling labor cost at $398 per sample at mines with 20 or fewer employes; $264 per sample at mines with 21 to 500 employees; and $248 per sample at mines with more than 500 employees. For metal mines, MSHA estimates sampling labor cost at $747 per sample for mines with 20 or fewer employes; $380 per sample at mines with 21 to 500 employees; and $334 per sample for mines with more than 500 employees. For nonmetal mines, MSHA estimates sampling labor cost at $772 per sample at mines with 20 or fewer employees; $366 per sample at mines with 21 to 500 employees; and $322 per sample at mines with more than 500 employees. These figures include the recordkeeping costs specified below.

Evaluation labor costs: MSHA estimates that a periodic evaluation will typically require two hours of time for an IH. Thus, the cost ranges from $131 to $162 per evaluation.

Laboratory Analysis Costs of Sampling

MSHA estimates that laboratory analysis will cost the mine operator $150 per sample. This includes the cost of packing and shipping the sample to the lab, the laboratory analysis, and reporting sample results to the operator.

Recordkeeping Cost of Sampling

The labor time required for recording results of sampling is estimated at 17 minutes and is valued at the loaded hourly wage of an industrial hygienist. Thus, costs for recordkeeping time due to sampling range from $19 to $23 per sample.

Number of Samples—Representative Sampling

While the cost of labor time and laboratory analysis are the primary components of cost per sample, a second major determinant of sampling cost at any mine is the number of samples required each time sampling occurs. Where several miners perform the same tasks on the same shift and in the same work area, the mine operator may sample a representative fraction (*i.e.,* at least two) of these miners to meet the sampling requirements. The final rule requires that mine operators sample a representative fraction of miners who are expected to have the highest exposure to respirable crystalline silica. MSHA estimated the number of miners considered a representative sample based on the size of the mine. In small mines that employ 20 or fewer miners (including contract miners), MSHA assumes that a sample comprising at least 50 percent of miners will be necessary to collect a representative sample. In medium-sized mines with 20 to 100 miners, the assumption is that a minimum 25 percent of miners will need to be sampled for the sample to be representative. In large mines with 100 or more miners, the Agency assumes that a minimum 15 percent of miners will need to be sampled for the sample to be representative.

Frequency of Exposure Monitoring—Number of Samples and Evaluations

The third component of sampling cost is the frequency with which it must be performed. Sampling frequency depends on sample results, as specified by MSHA's exposure monitoring requirements.

First-time and second-time sampling. First-time and second-time sampling is performed by all mine operators. First-time sampling occurs by the relevant compliance date for existing mines. Second-time sampling occurs within 3 months following first-time sampling. First-time and second-time sampling is representative sampling. The number of samples taken at a mine will depend on the size of the mine. After the first-time sampling is completed, each operator will determine the next action based on the first sample result. If that result is below the action level, the mine operator will have to conduct the second sampling. If the results from both samplings are below the action level, no further sampling is required, unless there are changes identified by periodic evaluations that may reasonably be expected to result in new or increased respirable crystalline silica exposures. (Periodic evaluations are further discussed below.) The second-time sampling must be taken after the operator receives the results of the first-time sampling but no sooner than 7 days after the prior sampling was conducted.

Above-action-level sampling. Sampling above the action level is also representative. Unlike first- and second-time sampling, this type of sampling will not be required of all mines, but only of those mines showing exposure levels at or above the action level of 25 $\mu g/m^3$. This sampling continues as long as the most recent sample results demonstrate exposure at a mine is at or above the action level of 25 $\mu g/m^3$ but below the new PEL of 50 $\mu g/m^3$.

MSHA estimated the percent of samples exceeding the action level in Year 1 based on its exposure profile developed using the Agency's compliance sampling data. MSHA assumed that mine operators will reduce the percentage of samples exceeding the action level from their current level of 31 percent to about 15 percent of samples by Year 7.

Corrective Actions Sampling. Corrective actions sampling is required when a sample result exceeds the new PEL. A sample result above the PEL requires the mine operator to take corrective actions and conduct corrective actions sampling to determine if the actions reduced exposures to the PEL. MSHA uses the estimated number of samples exceeding 50 $\mu g/m^3$ to estimate the number of corrective actions taken. Each sample result above the PEL requires a corrective action and an additional sample to ensure that the corrective action was effective. Not all corrective actions may be effective in reducing exposures below the PEL. Therefore, MSHA increased the number of samples exceeding the new PEL by 25 percent to account for situations requiring more

[79] In reality, some MNM mines may train their miners or other in-house employees to conduct sampling. In such scenarios, an IH would not be used and the labor cost of sampling would be based on the loaded hourly wage for the participating employee.

than one corrective action taken by mine operators.

Periodic Evaluation. MSHA assumed that mines operating only two quarters or less per year will conduct this evaluation once per year, while mines operating more than two quarters per year will perform this evaluation twice per year.

However, because the rule requires periodic evaluation whenever factors change that may affect exposures, some mines, such as portable mines, will likely have to conduct evaluations more frequently than semi-annually. Therefore, MSHA increased its estimate of the number of periodic evaluations by 20 percent (*i.e.,* annual periodic evaluations are equal to 2.4 times the number of mines) to account for mines that will need to perform evaluations more than twice per year.

Post-Evaluation Sampling. Periodic evaluation may lead to sampling performed for purposes of evaluating whether exposure levels might have changed or if they remain below the action level. MSHA assumed that post-evaluation sampling comprises 2.5 percent of miners. This percentage is relatively small because mine operators are already collecting sample data which can be used for these purposes. However, MSHA estimated that some additional sampling might be needed and included additional post-evaluation sampling costs.

Table IX–4 summarizes how the costs of each type of monitoring measures are estimated.

BILLING CODE 4520–43–P

Table IX-4: Exposure Monitoring Calculation

Exposure Monitoring Requirement[1]	Determination of Cost per Sample or Evaluation[1, 2]	Number of Samples or Evaluations[1]	Condition for Exposure Monitoring Requirement and Frequency[1]
First-time and second-time sampling	Sampling labor cost + lost work time + recording time + laboratory fees	Representative sample of all miners who may reasonably be expected to be exposed to respirable crystalline silica, by mine size	All mines Twice
Above-action-level sampling	Sampling labor cost + lost work time + recording time + laboratory fees	Miners that meet condition for periodic sampling × percent of miners needed for representative sample, by mine size	Miners at or above the action level (≥25 µg/m³) but at or below the PEL (≤ 50 µg/m³) Number of quarters mine is in operation. Three months after sampling results at or above the action level and continues until two consecutive samples demonstrate that miners' exposures are below the action level
Corrective actions sampling	Sampling labor cost + lost work time + recording time + laboratory fees	Sample results above the PEL (> 50 µg/m³) × 1.25	Samples taken because first-time or second-time samples, above-action-level samples, or post-evaluation samples showed results above the PEL; multiple samples might be necessary to demonstrate post-corrective action exposure level is below the PEL.
Post-evaluation sampling	Sampling labor cost + lost work time + recording time + laboratory fees	2.5 percent of all miners × percent of miners needed for representative sample, by mine size	If evaluation shows exposure level may exceed PEL, sampling performed to determine if exposure level is above PEL or action level
Periodic evaluation	Hours per evaluation × in-house loaded industrial hygienist wage	Number of mines × frequency of evaluation × 1.2	All mines Every 6 months, or when there is a change in production, processes, engineering or administrative controls, or other factors that may reasonably be expected to result in new or increased respirable crystalline silica exposures.

Notes:
1. Throughout this table, miners refer to both miners (excluding contract miners) and contract miners.
2. Lost work time, recording time, and laboratory cost fees as presented in FRIA Table 4-3 are constant within each commodity type (coal, metal, nonmetal) across all mine sizes. Sampling labor cost are constant within each commodity but vary by mine size because there is a fixed component (e.g., the cost of an IH) that is spread over more samples as mine size increases.

Table IX–5 below presents the estimated number of samples by sampling type and by commodity sector in the first 7 years of the analysis because MSHA expects a long-run average to be reached in Year 7. MSHA projects that in the first 2 years (following the coal and MNM compliance dates), 259,059 samples will be taken compared to 92,663 per year in Years 7 through 60. This is a result of: (a) declines in first-time and second-time sampling after the first year of compliance, and (b) declines in above-action-level and corrective actions sampling as mine operators become more experienced in developing and implementing new controls.

First-time and second-time sampling. Of the 259,059 samples expected to be taken in the first 2 years following the coal and MNM compliance dates, MSHA projects that approximately 60 percent (154,680/259,059) will be from first-time and second-time sampling. After Year 1 for Coal, and Year 2 for MNM, all first-time and second-time sampling will only be performed by new mines. MSHA projects that about 2 percent of mines in any given year will be new entrants to the mining industry, although the total number of mines in each year remains roughly constant.

Table IX-5: Estimated Number of Samples and Evaluations Taken by Type and Year

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Years 7 - 60
	All Mines							
	Sample Totals, All Mines							
All Types		***41,599***	***217,460***	***146,009***	***131,783***	***117,558***	***103,332***	***92,663***
	First-time and second-time sampling[1]							
Mines		1,106	11,547	253	253	253	253	253
Miners		73,576	212,675	5,696	5,696	5,696	5,696	5,696
Samples		29,796	124,884	3,082	3,082	3,082	3,082	3,082
	Sampling with results exceeding the action level[2]							
Mines[3]		-	-	-	-	-	-	-
Miners		13,727	92,941	146,671	130,341	114,011	97,681	85,434
Samples[4]		5,423	48,275	79,062	69,948	60,834	51,720	44,885
	Corrective actions sampling							
Mines[3]		-	-	-	-	-	-	-
Miners		4,031	40,664	67,967	60,816	53,665	46,513	41,246
Samples[4]		1,991	27,348	46,912	41,800	36,689	31,577	27,743
	Periodic evaluations							
Mines		*1,106*	*12,631*	*12,631*	*12,631*	*12,631*	*12,631*	*12,631*
Evaluations		*2,449*	*28,308*	*28,308*	*28,308*	*28,308*	*28,308*	*28,308*
	Post-evaluation sampling							
Mines[3]		-	-	-	-	-	-	-
Miners		3,679	14,239	14,239	14,239	14,239	14,239	14,239
Samples[4]		4,390	16,953	16,953	16,953	16,953	16,953	16,953
	Metal/Nonmetal							

	Sample Subtotals, MNM Mines							
All Types		-	*197,985*	*126,983*	*113,207*	*99,432*	*85,656*	*75,324*
	First-time and second-time sampling[1]							
Mines		-	11,525	231	231	231	231	231
Miners		-	211,203	4,224	4,224	4,224	4,224	4,224
Samples		-	124,288	2,486	2,486	2,486	2,486	2,486
	Sampling with results exceeding the action level[2]							
Mines[3]		-	-	-	-	-	-	-
Miners		-	66,222	120,930	105,578	90,227	74,875	63,361
Samples[4]		-	37,719	68,892	60,165	51,437	42,710	36,165
	Corrective actions sampling							
Mines[3]		-	-	-	-	-	-	-
Miners		-	32,698	60,129	53,106	46,083	39,060	33,792
Samples[4]		-	23,414	43,041	37,993	32,944	27,896	24,110
	Periodic evaluations							
Mines		-	*11,525*	*11,525*	*11,525*	*11,525*	*11,525*	*11,525*
Evaluations		-	*25,859*	*25,859*	*25,859*	*25,859*	*25,859*	*25,859*
	Post-evaluation sampling							
Mines[3]		-	-	-	-	-	-	-
Miners		-	10,560	10,560	10,560	10,560	10,560	10,560
Samples[4]		-	12,564	12,564	12,564	12,564	12,564	12,564
	Coal							
	Sample Subtotals, Coal Mines							
All Types		*41,599*	*19,475*	*19,025*	*18,576*	*18,126*	*17,676*	*17,339*
	First-time and second-time sampling[1]							
Mines		1,106	22	22	22	22	22	22
Miners		73,576	1,472	1,472	1,472	1,472	1,472	1,472
Samples		29,796	596	596	596	596	596	596
	Sampling with results exceeding the action level[2]							
Mines[3]		-	-	-	-	-	-	-
Miners		13,727	26,719	25,741	24,763	23,785	22,806	22,073
Samples[4]		5,423	10,556	10,170	9,783	9,397	9,010	8,720
	Corrective actions sampling[5]							
Mines[3]		-	-	-	-	-	-	-
Miners		4,031	7,966	7,838	7,710	7,582	7,454	7,454
Samples[4]		1,991	3,934	3,871	3,807	3,744	3,681	3,633
	Periodic evaluations							
Mines		*1,106*	*1,106*	*1,106*	*1,106*	*1,106*	*1,106*	*1,106*
Evaluations		*2,449*	*2,449*	*2,449*	*2,449*	*2,449*	*2,449*	*2,449*
	Post-evaluation sampling							
Mines[3]		-	-	-	-	-	-	-
Miners		3,679	3,679	3,679	3,679	3,679	3,679	3,679
Sample[4]		4,390	4,390	4,390	4,390	4,390	4,390	4,390

Notes:

1. For years 2 – 60 for Coal mines, and years 3 – 60 for MNM mines, MSHA assumes that 2 percent of mines will be new and therefore undertake first-time and second-time sampling, but with no net growth, the total number of mines will remain constant.

2. This includes above--action-level sampling (≥ 25 μg/m^3 but ≤ 50 μg/m^3) and results that exceed new PEL (> 50 μg/m^3) thus requiring corrective actions. Above--action-level sampling is expected to decline linearly from current exposure levels from year 1 to the start of year 7, after which time the frequency of sampling at or above the action level will be constant. Sample results exceeding the new PEL are also expected to decline linearly from current exposure levels in year 1 to the start of year 7, after which time the frequency of sampling will be constant.

3. The calculations for above-action-level, corrective actions, and post-evaluation sampling are based on the number of miners rather than the number of mines. Because MSHA requires representative sampling, it expects that in general the number of samples taken will be less than the number of miners.

4. Half a year of sampling above-action-level and corrective actions sampling occurs in Year 1 for Coal mines and Year 2 for Metal/Nonmetal mines.

5. When the most recent sample results exceed the PEL, corrective actions sampling is performed to ensure that the post-corrective actions exposure level is below the PEL.

6. If a periodic evaluation shows that the exposure level may be at or above the action level, post-evaluation sampling is performed to assess if the exposure level is, in fact, at or above the action level.

Above-action-level sampling. MSHA projects that the number of above-action-level samples will increase from 5,423 in Year 1 to 48,275 in Year 2 and to 79,062 in Year 3 as more mines start their above-action-level sampling. This type of sampling is projected to decline starting from Year 4, due to the implementation of engineering controls, maintenance and repair of controls, and implementation of administrative controls, all of which will result in fewer miners and contract miners with exposure levels at or above the action level. MSHA projects that by Year 7, about 45,000 samples per year will be taken.

Corrective actions sampling. MSHA also projects that the number of corrective actions samples—those taken after corrective actions, to ensure exposures have been reduced to below the new PEL—will be 46,912 in Year 3. This figure is also projected to decline over time, to 27,743 by Year 7.

Evaluations. MSHA projects that starting with Year 2 following implementation, 12,631 mines will take about 28,308 evaluations per year.

Post-evaluation sampling. Similarly, post-evaluation sampling remains constant at approximately 16,953 samples per year since these samples are independent of the above-action-level sampling.

Total Annualized Exposure Monitoring Costs

Table IX–6 below presents estimated total annualized exposure monitoring costs by type of monitoring and mining sector. The five types of exposure monitoring (samplings and evaluation) are projected to cost mine operators an average of about $53.2 million (3 percent discount rate) per year over 60 years. The first-time and second-time sampling ($4.2 million per year) account for about 8 percent of exposure monitoring costs; above-action-level sampling ($23.5 million) accounts for 44 percent; corrective actions sampling ($14.9 million) accounts for 28 percent; and periodic evaluations and post-evaluation sampling ($10.7 million) together account for about 20 percent. Of the total exposure monitoring costs, about 89 percent are expected to be incurred by MNM mines and the remaining 11 percent by coal mines.

Table IX-6: Total Annualized Exposure Monitoring Costs by Sector (in millions of 2022 dollars)

Cost Type	Total Cost over 60 Years	Annualized Costs			Percent Annualized Costs[1]
		0% Discount Rate	3% Discount Rate	7% Discount Rate	
All Mines					
First-time and second-time sampling	$170.2	$2.8	$4.2	$6.3	7.8%
Above-action-level sampling	$1,390.4	$23.2	$23.5	$23.9	44.2%
Corrective actions sampling	$884.0	$14.7	$14.9	$15.0	27.9%
Post-evaluation sampling	$426.3	$7.1	$7.0	$6.8	13.1%
Periodic evaluations	$225.0	$3.8	$3.7	$3.6	6.9%
Total	***$3,095.9***	***$51.6***	***$53.2***	***$55.6***	***100.0%***
Metal/Nonmetal					
First-time and second-time sampling	$151.3	$2.5	$3.7	$5.6	6.9%
Above-action-level sampling	$1,239.1	$20.7	$21.0	$21.4	39.4%
Corrective actions sampling	$821.4	$13.7	$13.8	$14.0	26.0%
Post-evaluation sampling	$354.6	$5.9	$5.8	$5.6	10.9%
Periodic evaluations	$201.2	$3.4	$3.3	$3.2	6.2%
Subtotal	***$2,767.6***	***$46.1***	***$47.6***	***$49.7***	***89.4%***
Coal					
First-time and second-time sampling	$18.8	$0.3	$0.5	$0.7	0.9%
Above-action-level sampling	$151.3	$2.5	$2.5	$2.5	4.8%
Corrective actions sampling	$62.6	$1.0	$1.0	$1.0	2.0%
Post-evaluation sampling	$71.7	$1.2	$1.2	$1.2	2.2%
Periodic evaluations	$23.9	$0.4	$0.4	$0.4	0.7%
Subtotal	***$328.2***	***$5.5***	***$5.6***	***$5.9***	***10.6%***

Note: 1. At the 3 percent discount rate.

BILLING CODE 4520–43–C

Several commenters disagreed with MSHA's estimates for sampling costs (Document ID 1419; 1441; 1442; 1448) in the PRIA. For example, a mining trade association NSSGA provided estimates from several mine operators that exposure monitoring costs would be substantially higher than those reported in MSHA's PRIA (Document ID 1448). This commenter provided sampling costs ranging from a low of $139 to a maximum of $1,800 per sample, with a median of $650 per sample, that would increase costs by $34 million to $162 million for 250,000 MNM miners. This commenter further stated that sampling costs vary according to the number of miners sampled: $2,866 for one miner, but $3,247 for 3 miners (approximately $1,082 per miner). A second commenter, a MNM mine operator/owner Vanderbilt Minerals, LLC, listed costs in excess of $11,000 for a single 3-day sampling event (Document ID 1419). A third commenter, an industry trade association EMA, stated that 400 of its 446 employees would require 1,200 individual samples over the course of one year to meet the sampling requirements (Document ID 1442). A fourth commenter, NVMA, stated that one of its members estimated sampling costs would increase by $1.2 million for its 7,000 employees (Document ID 1441).

MSHA acknowledges that the range of costs per sample provided by commenters likely exceeds MSHA's own estimates. As explained earlier, and in greater detail in Section 4 of the standalone FRIA document, MSHA's calculations of the average unit costs of sampling, sample analysis, and evaluation take into account the labor cost of time spent sampling, laboratory fees for sample analysis, lost work time due to sampling, recordkeeping time, plus the cost of performing periodic evaluations. MSHA assumes that the labor cost of sampling varies by commodity and mine size. MSHA estimates that mine operators will take 5.76 million samples at a cost of $3.09 billion over the 60-year analysis period. MSHA estimated the weighted average (mean) cost at $500 per sample, with costs ranging from $250 per sample (for coal mines with more than 500 employees) to $750 per sample (for metal mines with 20 or fewer employees). A direct comparison with the cost estimates provided by the above commenter (NSSGA) is not possible because NSSGA presents the median but not the mean cost per sample from the organization's members who provided data. Because the distribution of costs provided by this commenter is skewed towards higher values, the mean cost is likely to exceed the median value. Thus, these data suggest the sampling costs provided by the commenter are probably falling within the range of MSHA's estimates.

However, MSHA estimates sampling costs of a ''typical'' mine for the purpose of this analysis.[80] NSSGA presented costs of $1,800 per sample, $2,866 for sampling one miner, and $3,247 for sampling 3 miners are not necessarily inconsistent with MSHA's cost estimates. For example, the operator who lists costs exceeding $11,000 for a 3-day sampling episode did not provide the number of miners sampled or the number of samples taken in that sampling episode. Using MSHA's lowest estimate of $330 per sample for a mine with more than 500 miners, this estimate is equivalent to about 33 samples, which is not unreasonable for three, 10-hour days of sampling. The commenter's cost estimate of $11,000 over 3 days is consistent with MSHA's estimate.

MSHA acknowledges that some mine operators will incur higher sampling costs than the operator of a ''typical'' mine. MSHA believes that some small mine operators may experience higher sampling costs than MSHA estimates due to operating in remote areas where it may be more difficult to procure sampling services, and to the size of the mine. MSHA estimates the labor cost per sample at a small MNM mine will be nearly twice the cost per sample at larger MNM mines. Under MSHA estimates, the percentage of miners needed to achieve representative sampling (50 percent) is twice as large as the percentage at larger mines (25 percent or less).

MSHA was unable to determine from the information provided by commenters, how they determined a representative sample and the frequency of samples taken. For example, the range of values provided by the NSSGA was based on ''more than 20 companies.'' However, there are more than 6,000 sand and gravel mines affected by the rule, and it is unclear whether this cost data represents the whole sector.

MSHA's estimated cost per sample is largely influenced by a mine's need to hire a sampling professional. Some mines might perform their own sampling, others may hire a sampling professional (*e.g.,* industrial hygienist); and others may use a combination of the two, based on sample timing, numbers of samples, and mine location. In estimating sampling costs, MSHA assumed half of the MNM samples would be collected in house and half collected by a sampling professional. MSHA considers that mine operators (or controllers) will evaluate the costs of options and make the most cost-effective decision. The Agency's estimated average cost per sample collected by a contracted industrial hygienist is nearly equivalent to the high-end cost examples provided by some commenters. Differences are attributable assumptions made on travel time and expense, numbers of samples collected per day, numbers of days per trip (over which travel time and expense are averaged). To the extent that more remote mines are able to coordinate through a local, state, or national industry association, insurance carrier, their common mine controller, or other affiliation, these costs can be reduced by coordinating sampling dates. In addition, organizations and associations provide training on conducting air sampling. A trained technician working under an experienced industrial hygienist can reduce sampling costs.

Estimated total sampling costs from some commenters are much higher than MSHA's estimates because they assume more miners would have to be sampled than MSHA estimated under the proposed rule. For example, NSSGA estimated that at a cost per sample of $139 per sample, industry costs will increase by $34 million, while its median cost of $650 per sample will increase industry cost by $162 million (Document ID 1448). This commenter appears to have multiplied the cost per sample by its estimated number of affected miners, 250,000. Similarly, EMA mentioned an operator who assumes that 400 of 446 employees would be sampled (Document ID 1442), while a member mentioned by the NVMA appears to assume that all, or at least the vast majority of its 7,000 employees would be sampled (Document ID 1441).

In response to public comments, MSHA increased its estimate of the number of samples operators would need to take to meet the sampling requirements of the final rule by increasing the number of samples that constitutes the required representative fraction (or sampling representativeness) and frequency of sampling and evaluation. For example, over the first six years starting from the start of implementation, MSHA now estimates 758,000 samples of all types will be taken (Table IX–5), compared to 499,000 under the proposed rule.

Based on exposure profiles for the MNM and coal mining industries and MSHA's experience and knowledge of the mining industry, MSHA expects that on average the ratio of samples to miners sampled will be smaller than estimated by commenters. The final rule allows mine operators to sample a representative fraction of miners to meet the rule requirement. That is, a mine operator would be required to sample a minimum of two miners where several miners perform the same tasks on the same shift and in the same work area, so not all miners working in the same mine need to be sampled. Additionally, this sampling will stop when sampling results demonstrate exposure at a mine is below the action level. In Section 8.2.2 of the standalone FRIA document, MSHA provides two examples of how representative sampling will reduce the number of samples required based on MSHA experience in exposure sampling at mines and occupation categories.

MSHA has determined that exposure monitoring requirements in the final rule are necessary to maintain exposure levels at a safe level to ensure miners' health. The exposure monitoring requirements are also consistent with the Mine Act's statutory purpose to provide improved health protection for miners. Section 8.2.2 of the standalone FRIA document outlines a number of steps mine operators can take to reduce their monitoring cost.

2. Costs for Exposure Controls

To estimate the installation cost and to determine which mines will likely incur exposure control costs to reach compliance with the new PEL, MSHA analyzed the most recent 5 years of data on silica exposure (2015–2019 for MNM and August 2016–July 2021 for coal). As a starting point, it assumed that a mine will incur costs to meet the new PEL if it had a single sample result that exceeded the new PEL from the most recent day for which sample results were available. Analysis of the data yielded an initial estimate that 9.7 percent of all mines would incur costs, as reported in the PRIA. In response to public comments, MSHA updated this estimate to reflect the likelihood that more mines would incur additional costs of exposure controls. Based on its analysis and experience, MSHA projects in this FRIA that each year, about 20 percent of mines will incur some type of exposure control costs under the final rule.

MSHA estimated three types of exposure control costs, as described in the following sections:

- Installation costs, consisting of the costs of purchasing new engineering control equipment and installing it or

[80] Industry-wide, a ''typical'' mine is considered as a small surface mine, most likely to produce MNM commodity. Such a mine: would likely have a small number of buildings, such as a maintenance shop, an office, and a couple of storage; might employ up to 50 miners plus managerial and office staff; and would likely have a crusher and screening plant, a conveyor, and several pieces of heavy equipment and haulage vehicles.

purchasing new services to clean or ventilate dust from work areas.

• Maintenance and repair costs, to ensure proper use of existing engineering controls with increased frequency of dust control maintenance and repair.

• Costs of administrative controls to reduce dust exposure (for example, the costs of training or posting signage regarding new policies).

Breaking down the total by type of cost, each year 5 percent of mines are expected to incur additional amortized installation costs, while 20 percent (that 5 percent plus an additional 15 percent) are expected to incur additional maintenance and repair costs and costs for administrative controls.

Costs for New Engineering Controls

Some affected mines will incur installation costs because they will need to implement additional engineering control measures to reduce exposure levels. Using historical data and institutional knowledge, MSHA estimates the number of mines, by size, that will require additional engineering controls to meet the new PEL and the estimated level of capital investment (*i.e.,* minimal, moderate, and large) needed. It projects that 580 mines—or a little under half of those with exposures above the new PEL at the time of their most recent sampling—will require these additional engineering controls, with a large majority requiring minimal capital expenditure. (Table IX–7).

Table IX-7: Affected Mines by Employment Size and Control Category Incurring Additional Engineering Controls, 2019

	Mine Employment Size[1]			
Control Category	**Small Mines (<= 20 miners)**	**Medium Mines (20 < miners <= 100)**	**Large Mines (> 100 miners)**	**Total Mines**
Engineering controls– Minimal capital expenditure	399	50	9	458
Engineering controls– Moderate capital expenditure	50	25	9	84
Engineering controls– Larger capital expenditure	20	8	9	38
Total	***469***	***83***	***28***	***580***

Notes: Due to rounding, some totals do not exactly equal the sum of the corresponding individual entries.
Controls categorized under minimal capital expenditure are relatively simple fixes with initial capital costs less than $2,000; controls with moderate capital expenditure range from roughly $2,000 to $16,000 in capital costs, while large capital control expenditures exceed $20,000.
1. Production miners and contract miners.

MSHA estimates an average cost for engineering controls based on NIOSH evaluation of the dust controls used in the mining industry. MSHA assumed operating and maintenance (O&M) costs to be 35 percent of initial capital expenditure and assumed that installation cost, when appropriate, will be equal to initial capital expenditure. MSHA assumed most controls will have a 10-year service life, with exceptions for some equipment. For example, heavy haulage and excavating machinery are assumed to have a 15-year service life, and new or substantially renovated structural ventilation systems are assumed to have a 30-year service life. Within each category of capital expenditures, MSHA takes an average of the engineering control costs, inclusive of installation, maintenance, capital, and replacements costs over the 60-year analysis period and annualized the costs. Each affected mine is assigned the average value for its capital expenditure category. At a 3 percent discount rate, annualized costs range from $556 per mine for the lowest cost tier of capital equipment to $24,345 per mine for the highest cost tier. The annualized cost is $2,573 per mine per year when averaged across all mines.

Table IX–8 presents total annualized engineering costs calculated at $1.43 million (0 percent) to $1.58 million (7 percent) over 60 years.

Table IX-8: Estimated Total Annualized Engineering Costs (in thousands of 2022 dollars) by Control Category, 2022

Control Category	Number of Mines	Annualized Engineering Control Cost at Specified Discount Rate			
		0 Percent	3 Percent	7 Percent	Percentage of Total Costs[1]
All Engineering Controls					
Total -- All	***580***	***$1,431***	***$1,492***	***$1,575***	***100.0%***
Metal/Nonmetal	518	$1,186	$1,231	$1,290	82.5%
Coal	62	$246	$262	$285	17.5%
Minimal capital expenditure					
Subtotal -- Minimal	***458***	***$251.2***	***$254.6***	***$258.0***	***100.0%***
Metal/Nonmetal	417	$228.6	$231.1	$233.4	90.8%
Coal	41	$22.7	$23.5	$24.5	9.2%
Moderate capital expenditure					
Subtotal -- Moderate	***84***	***$308.1***	***$320.8***	***$337.2***	***100.0%***
Metal/Nonmetal	71	$258.2	$267.8	$279.9	83.5%
Coal	14	$49.9	$53.0	$57.3	16.5%
Larger capital expenditure					
Subtotal -- Larger	***38***	***$872.1***	***$916.8***	***$979.6***	***100.0%***
Metal/Nonmetal	30	$699.1	$731.8	$776.3	79.8%
Coal	7	$173.1	$185.1	$203.3	20.2%

Note: 1. Calculated at the 3 percent discount rate.

Costs for Maintenance & Repair of Engineering Controls

Beyond adopting more advanced engineering control infrastructure, an integral method of reducing respirable crystalline silica exposure is by increasing the frequency of maintenance and repairs for dust control systems. In MSHA experience, when there are overexposures, often engineering controls are in place but the operator has neglected maintenance and repair. MSHA has determined that, when the appropriate dust control systems are used, effective and regular maintenance and repair of such systems can help reduce respirable crystalline silica exposure below the new PEL. Maintenance and repair activities are usually conducted at the beginning of each shift (or as frequently as necessary) and can be a part of existing safety and operational checks performed on most equipment.

MSHA estimates, on average, that mine operators would spend 16 hours per quarter on additional inspection and maintenance (*i.e.,* 64 hours per year). To account for additional maintenance and repair costs that would result from using inspection checklists to cover maintenance and repair of dust suppression and control equipment, MSHA added 25 percent to the costs for maintenance and repairs. These maintenance and repair costs will be incurred every year over a 60-year analysis period, resulting annual cost of $3,389 per mine for MNM and $4,789 per mine for coal.

MSHA anticipates that additional mines will incur increased maintenance and repair costs each year to reduce exposure below the action level to avoid exposure monitoring costs. MSHA assumes that in total, these maintenance and repair costs will be incurred by 19.7 percent of mines, or 2,489 mines (2,249 MNM mines and 241 coal mines). These mines include the 4.7 percent that will incur new installation costs, plus an additional 15 percent that will incur only maintenance and repair costs and costs of administrative controls. MSHA assumes that this is the share of mines industrywide that will incur costs in each year, even as the specific mines incurring those costs may vary from year to year. Multiplying the average maintenance and repair cost per mine by the estimated 2,489 mines that will incur costs ranging from $8.65 million (0 percent discount rate) to $8.27 million (7 percent discount rate) for increased maintenance and repair (Table IX–9).

Table IX-9: Annualized Increased Maintenance and Repair Control Costs (in thousands of 2022 dollars) by Sector

Mine Sector	Total Annualized Cost at Specified Discount Rate			Percent by Sector[1]
	0 Percent	3 Percent	7 Percent	
Total	***$8,646***	***$8,506***	***$8,266***	***100.0%***
Metal/Nonmetal	$7,493.6	$7,353.3	$7,113.3	86.5%
Coal	$1,152.2	$1,152.2	$1,152.2	13.5%

Note: 1. Calculated at the 3 percent real discount rate.

Costs for Administrative Controls

Administrative controls comprise a variety of methods to reduce exposure to respirable crystalline silica dust. In general, mine operators evaluate situations in which exposure can be reduced through changes in policies and work practices, and implements those changes by informing miners through training, published announcements, procedures, instructions, and signage. Examples of administrative controls include enclosing cabs to work with doors and windows shut and setting speed limits and minimum distances for equipment operated on dusty haul roads.

While many of these examples are applications of common-sense policies, they can be circumvented either accidently or deliberately. Administrative controls are not always effective, or as effective as they could be, because unlike engineering controls, administrative controls depend on miners' adherence to the policies and work practices. Administrative controls rank lower than engineering controls in the hierarchy of effectiveness.

The cost of administrative controls is composed of labor hours. MSHA believes that 2,489 mines will spend, on average, 16 labor hours on administrative controls starting in Year 1 for coal and Year 2 for MNM of the 60-year analysis period. As with the estimates of additional maintenance and repair costs, this figure for number of affected mines is based on MSHA's assumption that, beyond those mines with exposures currently above the new PEL, an additional 10 percent of mines might incur increased administrative costs each year to reduce exposure to below the action level.

In addition to the time spent identifying administrative controls, mine staff need to prepare and publish training and instructional materials, and post signage and/or other informational materials to implement such controls; to account for this, MSHA increases the value of labor hours by a factor of 2.0. MSHA estimates that the additional labor costs spent on administrative controls as an average of the loaded hourly wage rate weighted by the relative employment of these occupations in the mining industry. The estimated average cost is $1,439 per affected MNM mine (Year 2—60) and $2,222 per coal mine (Year 1—60).

Table IX–10 shows the estimated number of mines and annual costs expected to be incurred in Year 1 and Years 2 through 60 for administrative controls. Additionally, Table IX–11 shows that total annualized costs range from $3.7 million (0 percent discount rate) to $3.6 million (7 percent discount rate) based on the discount rate used. The higher totals for the MNM sector are attributable to the much larger number of affected mines than the coal sector.

Table IX-10: Annual Administrative Control Costs (in thousands of 2022 dollars)

Mine Sector	Mines Needing Administrative Control	Annual Cost	Percent by Sector[1]
Incremental costs incurred in Year 1			
Total	***241***	***$534.7***	***100.0%***
Metal/Nonmetal	0	$0.0	0.0%
Coal	241	$534.7	100.0%
Incremental costs incurred in Year 2-60			
Total	***2,489***	***$3,770.9***	***100.0%***
Metal/Nonmetal	2,249	$3,236.2	85.8%
Coal	241	$534.7	14.2%

Note: 1. Calculated at the 3 percent discount rate

Table IX-11: Annualized Administrative Control Costs (in thousands of 2022 dollars)

Mine Sector	Total Annualized Cost at Specified Discount Rate			
	0 Percent	3 Percent	7 Percent	Percent by Sector[1]
Total	***$3,717.0***	***$3,657.4***	***$3,555.5***	***100.0%***
Metal/Nonmetal	$3,182.3	$3,122.7	$3,020.8	85.4%
Coal	$534.7	$534.7	$534.7	14.6%

Note: 1. Calculated at the 3 percent discount rate.

Several commenters did not agree with MSHA's exposure control estimates as applied to their mines, stating that MSHA underestimated the costs of implementing exposure controls (Document ID 1419; 1441; 1448; 1455), and/or asserted that most mine operators who meet the current PEL will need to install significant new engineering controls to meet the new PEL. For example, Nevada Mining Association, stated that estimated compliance costs for one of their members was $22.7 million for the first year and $13.6 million for each following year to retrofit mobile equipment with filtered pressurized air as well as medical surveillance and exposure sampling costs (Document ID 1441). NSSGA stated that ''[b]ased on communications with 13 member companies, costs for exposure controls will vary widely, but on average are $920,000 annually, with a median of $225,000 (Document ID 1448).'' Neither the types of controls nor the number of mines installing the controls was included with the commenter's estimate. One of NSSGA's members also stated that its 2023 budget for exposure controls is approximately equal to the MSHA annual estimate for all of MNM. Another commenter, US Silica, stated that in 2023 alone, it incurred $3.6 million in capital costs on two automated projects and multiple other projects exceeding MSHA's estimate for the industry (Document ID 1455). A fifth commenter, Vanderbilt Minerals, LLC provided expected costs of $7 million for a list of renovations to existing facilities and new equipment purchases (Document ID 1419).

Based on its analysis of the Agency's sampling database, MSHA believes roughly 90 percent of mines will be able to meet the PEL without incurring additional costs. In Section 4 of the standalone FRIA document, MSHA estimates that about 1,230 mines are expected to incur exposure control costs to meet the new PEL. Of these, a little more than 50 percent (650 mines) should be able to meet the new PEL using controls such as additional maintenance and repair, and administrative controls. The remaining 47 percent of mines (580 mines) expected to incur costs will also implement engineering controls—in addition to increased maintenance, repair, and administrative costs—to meet the new PEL.[81] The distinction between the two types of mines is related to sample data that shows compliance with the existing PEL. Additionally, MSHA includes an extra 10 percent of total mines (111 coal mines and 1,153 MNM mines) that will incur exposure control costs, including enhanced administrative controls and frequent maintenance and repair. MSHA's analysis is described in more detail in the standalone FRIA. Twenty operators commented that MSHA underestimated exposure control costs. A couple of these commenters did not provide specific evidence to support their position that many operators will incur substantial engineering control costs.

MSHA assumes that all mines are currently in compliance with the existing PEL when estimating compliance costs. Costs incurred by operators are attributed to lowering exposures from the existing PEL to the new PEL. Some mine operators have found it difficult to consistently control exposures to meet the existing PEL; any additional costs incurred by them will be more appropriately attributed to maintaining compliance with the existing PEL.

The estimated costs presented in the standalone FRIA represent the average estimated compliance costs for a typical mine. MSHA acknowledges that the exposure control costs will differ depending on the size of the mine, the current level of exposure to respirable crystalline silica, existing engineering and administrative controls, the mine layout, work practices, and other variables. MSHA's price and cost estimations are based on a variety of sources including market research and MSHA's experience and sample data.

[81] The maintenance, repair, and administrative costed for the additional 1,260 mines are not to meet the new PEL but to reduce exposures below the action level to reduce monitoring costs.

The evidence provided by the commenters was collected from members of trade organizations. It appears that at least some of the cost estimates are from either very large mines—far larger than the ''typical'' mine used for MSHA cost estimates—or may reflect an estimate for all mines controlled by an operator. For example, the comment that the ''total amount to retrofit all underground and surface mobile equipment with filtered pressurized air, medical surveys and increased sampling is $22.7 million for the first year, and $13.6 million each year after'' is from an MNM operator with 7,000 employees. If this represents a single mine, only 26 MNM mines (0.2 percent) employed more than 500 miners in 2019 (Table IX–1), if this represents multiple mines, then the anticipated compliance costs per mine would be smaller. Because the number of mines is unknown, and because the commenter includes sampling costs (provided separately as $1.2 million per year) and medical surveillance costs in the total, it is impossible to meaningfully compare this estimate with MSHA's estimates.

Similarly, US Silica presented costs exceeding $3.6 million in capital expenditures on two automated projects; totaling all projects, US Silica states it exceeded MSHA's estimate for the entire industry (Document ID 1455). However, it is unclear how many mines owned by US Silica incurred the costs. In addition, US Silica installed two automated systems. Generally, an automated bagging operation is more costly to purchase and install than a manual bagging system. The higher capital cost of an automated system also likely results in offsetting cost savings (*e.g.,* labor costs), and thus US Silica's estimated compliance costs likely include decisions made for other business reasons, not just the cost of reducing worker exposure.

Vanderbilt Minerals LLC provided expected costs of $7 million for renovations to existing facilities and new equipment purchases at a single site, including ''the purchase/ installation of such items as a new bagging system for 50-pound bags, new dust collectors for drying/milling equipment, renovation of a laboratory, office, break room, mill control office, and crusher operator booth, purchase of larger water trucks and an increase in paved haul roads (Document ID 1419).'' In this case, the costs by the commenter are clearly higher than MSHA's estimated compliance costs for a single typical mine. However, the site in question appears to be highly atypical of most of MNM mining and therefore not appropriate for extrapolating industry costs. More details are provided in Section 8 of the standalone FRIA document.

A further difficulty in evaluating commenters' estimates of engineering costs is that MSHA presents annualized costs; that is, compliance costs with initial capital and one-time costs amortized over the service life of the control. Many commenters provided first-year costs (without identifying capital, one-time, or recurring (operation and maintenance) cost components) to show that MSHA underestimated exposure control costs. The comparison of commenters' first-year costs with MSHA's annualized cost estimates is inappropriate. For example, a MNM mine operator provided $3.6 million as the first-year cost estimate without offering information about the actual service lives of these automation projects (Document ID 1455). If those costs are amortized at a 3 percent discount rate using an assumed 10-year service life (implying the system will be replaced 6 times over the course of the 60-year analysis period), the annualized capital component of their cost is about $410,000; if the expected service life is 30 years (replaced twice over 60 years), the annualized cost is about $178,000. Similarly, when amortized using a 3 percent rate, a $7 million in initial capital cost is equivalent to less than $800,000 annualized cost per year if the system has a 10-year service life, and less than $400,000 if the service life is 30 years. Thus, it is difficult to directly compare MSHA's annualized costs with first-year costs provided by commenters without service life information.

Small mine operators specifically questioned MSHA's estimates of the cost of controlling exposure to respirable silica crystalline silica dust (Document ID 1411; 1415; 1427; 1435; 1436). Water based dust suppression, especially if combined with magnesium chloride, is likely to be more expensive at some remote mines in arid regions due to the cost of obtaining and transporting water. However, these commenters did not discuss the applicability of other methods of reducing exposures presented in the FRIA and Technological Feasibility discussions. For example, operating vehicles with windows closed, reduced vehicle speed, and wider vehicle spacing have all been shown to decrease operator exposure to dust. These commenters provided the cost of cabin air filters and their preference to not use air conditioning, but it should be noted that there may be trade-offs in the choices mine operators make to reduce exposure to dust. For example, the use of air conditioning by vehicle operators will increase costs (filters, fuel use), but will decrease exposures. These increased operating costs should be offset by reduced sampling costs.

3. Costs for Respiratory Protection

The new PEL may result in an increased use of respirators by miners when compared with usage under the existing PEL. This additional usage will result from provisions § 60.13: Corrective actions and § 60.14 (a): Respiratory protection. Under § 60.13, if sampling results indicate miners' exposure exceeds the new PEL, mine operators must make approved respirators available to affected miners; ensure that miners wear respirators properly during the period of overexposure; and take corrective actions to lower the concentration of respirable crystalline silica to at or below the PEL. Section 60.14 (a) requires the temporary use of respirators by MNM miners when engineering controls are developed and implement or when necessary due to the nature of work involved (*e.g.,* entry into a hazardous atmosphere to perform maintenance). MSHA expects that additional use of respiratory protection will occur because exposure levels that were below the existing PEL will now be above the new PEL. MSHA believes that most respirator use will occur during the first few years after implementation of the rule until mine operators can consistently control sources of respirable crystalline silica dust exposure at the new PEL using engineering controls, but that the respirator use will decline as mines implement and improve additional controls. However, with little data to support an assumption concerning how quickly incremental respirator use might decline, MSHA chose to model respirator use as remaining constant over the 60-year analysis period.

Under § 60.13 MSHA believes that miners who are most likely to need incremental respirator use to perform corrective actions work in the following occupations:

- Kiln, Mill, and Concentrator Workers (MNM mines)
- Mobile Workers & Jackhammer Operators (MNM mines)
- Miners in Other Occupations (MNM mines)
- Underground Miners (Coal mines)
- Surface Miners (Coal mines)

To estimate the number of miners who might be required to use respirators under § 60.13, MSHA first uses sample data to estimate the number of miners in these occupations with respirable crystalline silica exposures between the new PEL and the existing standards (50 μg/m^3 to 100 μg/m^3 range for MNM and 50 μg/m^3 to 85.7 μg/m^3 for coal) to identify the miners most likely to increase their use of respirators as a result of the rule. MSHA then assumes that 20 percent of that total, about 2,109 miners would these miners end up using respirators as a result of the rule. MSHA thus estimates that mine operators will incur costs for increased respiratory protection by 1,984 MNM miners and 125 coal miners per year to meet the requirements of § 60.13.

Under § 60.14, MSHA uses sample data to estimate the number of MNM miners that might need to increase their use of respirators due to the rule. MSHA assumes that MNM mine operators will need to provide additional respiratory protection for 20 percent of MNM miners in all occupations with exposures between the new PEL and the existing PEL. MSHA estimates MNM operators will need to provide respiratory protection to 4,945 MNM miners to meet the requirements of § 60.14.

Under sections 60.13 and 60.14 together, mine operators are expected to increase respirator protection for approximately 7,054 miners and contract miners (6,928 MNM miners and 125 coal miners).

MSHA estimates two types of respiratory protection costs: the purchase of new respirators to be issued and the incremental cost of additional temporary respirator use. MSHA believes that given the existing respiratory protection standards, most miners have already been issued respirators to deal with intermittent, temporary circumstances where exposures exceed the existing standards. However, some mine operators with miners at low risk of exceeding the existing standard may need to purchase respirators to account for possible temporary exposures in the range between the new PEL and existing standards. It is likely that some miners newly at risk for exposure in this range will not have respirators. In addition, because respirators will be used more under the new PEL, respirators will deteriorate more quickly and need replacement. In addition to miners who did not need to wear a respirator under the existing standards but might have occasional temporary need for respiratory protection under the new PEL, some mine operators will need to replace respirators for miners more frequently due to a small increase in the need for temporary respiratory protection.

MSHA assumes that in Year 1, coal mine operators will incur costs for new respirators for 50 percent of their coal miners who are expected to increase respirator use (*i.e.,* a total of 63 new respirators) under § 60.13. In Year 2, MNM mine operators will similarly incur costs for new respirators for 50 percent of the total MNM coal miners who are expected to increase their respirator use (*i.e.,* 3,464 new respirators under § 60.13 and § 60.14 combined). In Years 2 through 60 (for coal) and Years 3 through 60 (for MNM), mine operators will incur replacement costs for 50 percent of the total number of new respirators purchased in Year 1 (for coal) and Year 2 (for MNM). Therefore, in Year 3 and onwards, coal and MNM mine operators will purchase a total of 1,763 new respirators per year. Furthermore, MSHA assumed that all new respirator purchases in any year throughout the analysis period will require fit testing and training.

MSHA assumed that mine operators will purchase tight-fitting, re-useable half-mask elastomeric respirators at a cost of $39.57 each plus $17.29 for filters.[82] In addition, MSHA assumed respirators are assigned to individuals, not shared equipment. Furthermore, miners issued new respirators will require an additional 2 hours of labor time for fit testing and training which is valued at the weighted average loaded wage of all mine workers in the given sector ($50.60 for Metal miners, $40.47 for Nonmetal miners, and $49.97 for coal miners).[83 84] The resulting annual cost per miner requiring a new respirator is estimated to be $145 for MNM miners and $157 for coal miners.

Table IX–12 presents the estimated annual costs of purchasing new respirators for respiratory protection under the new PEL for miners who did not require respiratory protection under the existing PEL. In Year 1 of compliance for coal mines, 63 coal miners (including contract miners), who occasionally perform corrective actions where they would likely be exposed to respirable crystalline silica in the range between the new PEL and the existing standards are expected to be provided with new respirators by mine operators t a cost of $9,821. In Year 1 of compliance for MNM mines (Year 2 following publication of the final rule), 3,464 MNM miners will also be provided with new respirators for corrective actions and temporary use at a cost to mine operators of $502,282. New respirator purchase costs in Year 1 of compliance for coal and MNM mine operators are estimated to total $512,103 across both sectors. In subsequent years (Years 2 through 60 for coal mines; Years 3 through 60 for MNM mines), annual costs are expected to be about half of first year costs ($256,052).

Table IX-12: Estimated Annual Cost of New Respirator Purchases (in 2022 dollars)

Mine Sector	Miners Including Contract Miners	Total Annual Cost	Percent by Sector
Year 1			
Total	***63***	***$9,821***	***100.0%***
Metal/Nonmetal	0	$0	0.0%
Coal	63	$9,821	100.0%
Year 2			
Total	***3,496***	***$507,193***	***100.0%***
Metal/Nonmetal	3,464	$502,282	99.0%
Coal	31	$4,911	1.0%
Years 3-60			
Total	***1,763***	***$256,052***	***100.0%***
Metal/Nonmetal	1,732	$251,141	98.1%
Coal	31	$4,911	1.9%

Table IX–13 summarizes the total annualized cost of new respirator purchases by sector. Overall, the new PEL is expected to lead mine operators to purchase new respirators costing an average of $256,134 (at a 0 percent discount rate) to $255,285 (at a 7 percent discount rate) per year over the 60-year analysis period.

[82] Based on online (non-discount) prices: websites for Northern Safety, 2022: $29.14/each 3MSeries 6500 half mask respirator, $10.25/pair for P100 pancake filters; and Grainger, 2022: $50.00 for MSA 420 series half mask respirator, $24.32 for P100 filter cartridges (package of 2). Prices are higher end of potential range, supplier bulk discounts available from numerous other sources.

[83] OSHA APF rulemaking (update to 29 CFR 1910.134) Unit Costs: 1 hour employee training, 1 hour employee qualitative fit testing. Alternatively, 2 hours for quantitative fit testing (from costs estimated in 2001–2006; may be reduced due to efficiency of more modern quantitative fit testing equipment currently available and widely used). MSHA assumed that worker fit testing is conducted in small groups; two to four miners are fit tested during the hour, but all remain part of the group for the full hour.

[84] MSHA assumed there will be no additional labor costs for personnel conducting fit testing or training because current respiratory protection programs already require these steps.

Table IX-13: Estimated Annualized Cost of New Respirator Purchases (in 2022 dollars)

	Total Annualized Cost at Specified Discount Rate			
Mine Sector	**0 Percent**	**3 Percent**	**7 Percent**	**Percent by Sector[1]**
Total	***$256,134***	***$255,967***	***$255,285***	***100.0%***
Metal/Nonmetal	$251,141	$250,884	$250,047	98.0%
Coal	$4,992	$5,083	$5,238	2.0%

Note: 1. Calculated at the 3 percent discount rate.

MSHA estimates the cost of additional respirator use under the new PEL for miners who did not need it under the existing standards. MSHA assumes the cost of additional respirator use starts in Year 1 (for coal mines) and Year 2 (for MNM mines) will remain constant over the 60-year analysis period. On average, MSHA believes additional respirator use will be necessary for 4 hours per week per miner, or an additional 208 hours per year (4 hours per week × 52 weeks per year). For estimating costs, if an elastomeric respirator uses two filters at a time, and the filters last eight hours before requiring replacement, then these miners will need an additional 26 pairs of filters per year (208 hours per year/8 hours per filter pair). At an average price of $17.29 per pair of filters, mine operators will spend an additional $450 per miner per year ($17.29 × 26 filter pairs) for respirator filters.

Table IX–14 and Table IX–15 present the estimated total annual and annualized cost of additional respirator usage by sector. The annual cost of additional temporary respirator use is expected to be $450 per miner per year over the 60-year analysis period (Table IX–14) and total annualized cost is expected to range from $3.12 million (0 percent discount rate) to $2.96 million (7 percent discount rate) per year (Table IX–15).

Table IX-14: Estimated Annual Cost of Additional Respirator Use by Sector (2022 dollars)

Mine Sector	**Miners Including Contract Miners**	**Annual Cost per Miner**	**Total Annual Cost**
Year 1			
Total	***125***	***$450***	***$56,312***
Metal/Nonmetal[1]	0	$0	$0
Coal[2]	125	$450	$56,312
Years 2 - 60			
Total	***7,054***	***$450***	***$3,170,895***
Metal/Nonmetal[1]	6,928	$450	$3,114,584
Coal[2]	125	$450	$56,312

Notes:

1. Annual cost for MNM in Year 2 through 60; cost is $0 in Year 1.
2. Annual cost for coal in Year 1 through 60.

Table IX-15: Annualized Cost of Additional Temporary Respirator Use by Sector (in thousands of 2022 dollars)

	Total Annualized Cost at Specified Real Discount Rate			
Mine Sector	**0 Percent**	**3 Percent**	**7 Percent**	**Percent of Total Annualized Cost[1]**
Total	***$3,119.0***	***$3,061.6***	***$2,963.6***	***100.0%***
Metal/Nonmetal	$3,062.7	$3,005.3	$2,907.2	98.2%
Coal	$56.3	$56.3	$56.3	1.8%

Note: 1. Calculated at the 3 percent discount rate.

The estimate presented in Table IX–15 may be an overestimate of the cost of respirator use. MSHA assumed respiratory use would remain constant over the 60-year analysis period, it is likely that need for additional respirator use will decline as mines implement and improve engineering and administrative controls. However, with little data to support an assumption concerning how quickly the need for additional respirators might decline, MSHA chose to model it as constant. Second, while most mines operate year-round, some mines may operate for as little as 3 months per year. This will also decrease the need for respirators use.

Some commenters provided unit cost data for respirators and filters that were greater than the unit cost estimates that used in the PRIA (Document ID 1411; 1415; 1427; 1435; 1436). First, based on their data, the replacement filter cartridges last much longer than those costed by MSHA, so that the cost of one year's use will be lower than MSHA's cost estimate due to the long life span of replacement filters used by commenters. Second, the commenters assumed all employees would require new respirators and did not account for baseline use (or availability) of respirators at the mine. The final rule requires MNM mine operator to use respiratory protection as a temporary measure when miners must work in concentrations of respirable crystalline silica above the PEL when engineering control measures are being developed and implemented or necessitated by the nature of work involved. MSHA determined that its cost assumption is more comprehensive and likely overestimates respirator protection costs.

4. Cost for Medical Surveillance

Under the final rule, MSHA will require each MNM mine operator to provide mandatory medical examinations to miners who are new to the mining industry and voluntary periodic examinations to all currently employed miners. These new medical surveillance standards extend to MNM miners the opportunity for medical surveillance that is already available to coal miners under the existing rules.

The medical examinations will be provided by a physician or other licensed health care professional (PLHCP), or by a specialist. The medical examination will include a miner's medical and work history, a physical examination, a chest X-ray, and a pulmonary function test. For those miners new to the mining industry, the first mandatory examination must take place within 60 days after beginning employment. This must be followed by a mandatory follow-up examination at 3 years. Should the follow-up examination indicate any medical issues related to lung disease, a second mandatory follow-up examination must take place in 2 years. In addition to these mandatory examinations, mine operators must also offer voluntary periodic medical examinations to all MNM miners at least every 5 years. The first periodic medical examination for existing MNM miners must be provided within 12 months of the final rule's MNM compliance date, or if a MNM mine commences operation after the compliance date, within 12 months of the mine beginning operations. All of the medical examinations must be provided at no cost to the miner.

Additionally, the MNM mine operator must ensure that, within 30 days of the medical examination, the PLHCP or specialist provides the results of chest X-ray classifications to NIOSH, once NIOSH establishes a reporting system. The cost of the x-ray includes the cost of preparing the report and transmitting those results to NIOSH.

To estimate the costs of compliance with the medical surveillance requirement, MSHA first estimated the ''unit cost'' of a single medical examination. MSHA then estimated how many examinations would occur in each year over the 60-year analysis period and multiplied the numbers of examinations by the unit cost to determine total costs in each year. MSHA summed the costs in each year to estimate a total cost over the full 60-year period.

Unit Costs

MSHA assumed that all examinations entail the same cost elements (in decreasing order of cost): the physical examination, chest X-ray, spirometry test, lost work time while being examined, lost travel time, symptom assessment and occupational history, transportation cost, and recordkeeping of the mine operator. Table IX–16 displays estimated components in 2022 dollars, which sum to a unit cost of $628.58 per examination.

Table IX-16: Estimated Cost Per Medical Examination (in 2022 dollars)

Cost Components	Cost
Physical Examination	$158.69
Chest X-Ray	$119.20
Spirometry Test	$81.89
Symptom Assessment and Occupational History	$49.90
Lost Work Time While Being Examined	$87.29
Lost Travel Time	$87.29
Transportation Cost	$26.76
Recordkeeping of Mine Operator	$17.55
Total	$628.58

To estimate the number of examinations expected per year, MSHA used the estimated number of full-time equivalent (FTE) employees in MNM mining, which is 184,615 FTE workers. MSHA assumed that the MNM employment will remain constant over the 60-year analysis period following compliance of the medical surveillance requirement.[85] MSHA estimates that the average length of employment as an MNM miner (before leaving the mining occupation) is 22 years, which is derived from a NIOSH survey that found the average mining experience of MNM miners is approximately 11 years.[86]

[85] MSHA chose to express mine employment in FTEs for the benefits analysis because health impacts would differ between part-time miners, who would experience less exposure to respirable crystalline silica dust and thus would be less likely to experience the same negative health effects in the same amount of time as miners who worked full-time or more. A similar logic applies to miners deciding whether to accept medical examinations, thus medical surveillance costs are also estimated based on FTE miners.

[86] The 2012 report by NIOSH, entitled, ''National Survey of the Mining Population: Part 1: Employees,'' includes the findings of its 2008 survey on mine operators and miners in the U.S. *https://www.cdc.gov/niosh/mining/works/coversheet776.html* (last accessed Jan. 10, 2024). Details on the survey methodology and results are available in the link. The NIOSH survey found the following mine experiences for different types of MNM mines, which average to about 11 years (11.375 to be precise): metal mines, 10.7 years; nonmetal, 12.0 years; stone, 12.5 years, and sand

Based on this estimate, MSHA assumed that each year 8,392 miners (*i.e.,* about 1/22, or 4.55 percent, of 184,615 FTE MNM miners) would leave the industry, and be replaced by the same number of new entering workers.

MSHA estimates total medical surveillance costs over the 60-year analysis period under two different scenarios due to the uncertainty of how many currently employed miners will participate in voluntary medical surveillance programs. Assuming a participation rate of 25 percent (Scenario 1), annualized costs range from $14.6 million (with a 0 percent discount) to $14.0 million (with a 7 percent discount rate) and the annualized cost per MNM miner ranges from $79 (with 0 percent discount rate) to $76 (with a 7 percent discount rate).

In scenario 2, MSHA assumed that the participation rate is 75 percent. Annualized costs range from $23.7 million (0 percent discount rate) to $23.1 million (7 percent discount rate). The annualized cost per MNM miner range from $128 (7 percent discount rate) to $125 (0 percent discount rate). A summary of estimated medical surveillance costs under the two scenarios is presented in Table IX–17.

Table IX-17: Summary of Estimated Medical Surveillance Costs for MNM Miners by Participation Rate and Discount Rate (in millions of 2022 dollars)

Cost Type	Discount Rate		
	0 percent	3 percent	7 percent
Total Costs			
25 percent participation rate	$875.0	$397.2	$196.0
75 percent participation rate	$1,383.2	$645.4	$332.4
Average of participation rates	*$1,129.1*	*$521.3*	*$264.2*
Annualized Cost			
25 percent participation rate	$14.6	$14.4	$14.0
75 percent participation rate	$23.1	$23.3	$23.7
Average of participation rates	*$18.8*	*$18.8*	*$18.8*
Annualized Cost per MNM miner			
25 percent participation rate	$78.99	$77.74	$75.61
75 percent participation rate	$124.87	$126.32	$128.25

Vanderbilt Minerals LLC stated that MSHA underestimated the cost of medical surveillance and stated its program cost approximately $9,400 per site per year, plus an additional $4,000 per site per year in employee time at 3 hours per employee (Document ID 1419). Assuming an average loaded wage of a nonmetal sector extraction worker at $40.47 per hour, $4,000 in employee time would cover 33 employees. This suggests that average medical surveillance costs would be about $406 per employee by dividing total costs of $13,400 (= $9,400 + $4,000) per site by 33 employees.[87] This is significantly lower than MSHA's estimated unit cost for medical surveillance of $629 per examination in 2022 dollars (Table IX–16).

Another commenter, National Mining Association, stated that the proposed medical surveillance requirements would impose significant costs on its members, due to the expansion to cover potentially 200,000 MNM miners at more than 11,000 mines (Document ID 1428). As mentioned above, MSHA assumes that under the final rule, operators are required to conduct medical surveillance on currently employed miners and new miners (those who start to work on the mining industry for the first time). For currently employed miners, MSHA assumes two participation rates (25 percent and 75 percent) for medical surveillance and estimates the number of tests per year as 6,700 under 25 percent participation rate and 20,200 under 75 percent participation rate tests per year at an average cost of $4.24 million to $12.7 million each year (undiscounted). Average over the two participation rates, MSHA estimates that operators will conduct an average of 13,500 tests per year on the new miners at an average cost of $8.5 million each year (undiscounted).

Commenters also shared concerns on medical surveillance costs for small mine operators (Document ID 1408; 1411; 1415; 1427; 1435; 1436). The specific issue raised by these commenters concerned the cost of hourly wages and travel expenses from remote mine locations to obtain medical examinations. Thus, their costs will be larger than estimated by MSHA. MSHA acknowledges these concerns but notes that commenters provided no specific data in support of their position.

At least two commenters, NSSGA and Illinois Association of Aggregate Producers, stated that, under the proposed rule, companies would incur millions of dollars in costs that do not benefit miners' health and safety, using as examples requiring sampling every 3 months indefinitely for exposures between 25 μg/m^3 and 50 μg/m^3, requiring that medical surveillance be offered to miners with less than 30 days a year of exposure to respirable silica at

and gravel 10.3 years. For comparison, the same survey found the average mining experience for coal miners was 16.0 years. These averages reflected the average number of years that respondent miners had worked at mines at the time the survey was conducted. MSHA considered these average mine experiences to represent approximately one half of the mining tenure these miners would have (the years in mining when they leave). Conversely, MSHA estimated miners' total expected tenure to be twice these average mining experiences.

[87] The commenter does not state whether employee time is valued at a loaded hourly rate (including benefits and overhead) or the raw hourly rate. If the latter rate is used ($24.34 per hour), then the commenter's program would cover 55 employees at a cost of $244 per employee.

or above the action level and requiring initial sampling even for facilities that have had exposure monitoring for decades (Document ID 1448; 1456). MSHA has determined that on-going sampling and periodic evaluations are necessary to ensure that exposures to respirable crystalline silica meet the new PEL and that miners' health is protected. Exposure monitoring, that includes an action level, provides mine operators and miners with necessary information to take actions to prevent miners' overexposures. Allowing mine operators to cease monitoring once exposure is maintained below the action level provides operators with the incentive to reduce and maintain exposures below the PEL. For medical surveillance, MSHA believes it is important for MNM operators to provide medical surveillance so that MNM miners will have information about their health to take necessary action early to prevent any further progression of disease.

5. Cost for ASTM Update

Under the final rule, mine operators are required to have a written respiratory protection program in accordance with the 2019 ASTM F3387–19 standard. A written respiratory protection program must include: program administration; written standard operating procedures; medical evaluations; respirator selection; training; fit testing; and maintenance, inspection, and storage. Mine operators will compare the ASTM standard to their existing respiratory protection program or practices and identify the elements of their existing respiratory protection program or practices that need to be revised. MSHA evaluated the components of the 2019 ASTM standard that have the potential to impose additional costs on mine operators.

MSHA assumes that 20 percent of MNM mines will incur costs to meet the 2019 ASTM standard each year. MSHA assumes that all coal mines are affected by the update to the 2019 ASTM standard because 30 CFR 72.700(a) requires coal mine operators to make respirators available to their miners. This should be an overestimate because it is likely that many coal mines already meet the 2019 ASTM standard. MSHA assumes that only a small subset of miners uses respirators each year. MSHA assumes about 10 percent of MNM miners and 3.7 percent of coal miners are expected to be required to use respirators each year.

Table X–18 presents the total number of mines compared to the total number of mines expected to incur compliance costs to update their respiratory protection program and practices. In Year 1, MSHA assumes that 1,106 coal mines will incur costs to update their respiratory protection program and practices to the 2019 ASTM standard, and 2,722 coal miners and contract miners are expected to wear respirators. Starting in Year 2, MSHA estimates that 3,411 mines (*i.e.,* 20 percent of the 11,525 MNM mines and 100 percent of the 1,106 coal mines) are expected to incur costs. In addition, MSHA estimates 6,946 miners and contract miners wear respirators each year, which represents less than 2.5 percent of all miners including contract miners (6,946/284,778). Respirators are worn to protect miners from airborne contaminants (including respirable crystalline silica and coal dust) at a small percentage of mines each year and only a small fraction of the miners at those mines wear respirators.

Table IX-18: Mines Incurring Incremental Costs of ASTM Update, 2019

Mine Sector	Total Mines	Affected Mines	Miners Including Contract Miners in Affected Mines		Average Miners per Affected Mine	
			Total Miners	Miners Wearing Respirators	Miners	Miners Wearing Respirators
All Mines	***12,631***	***3,411***	***115,817***	***6,946***	***34.0***	***2.0***
Metal/Nonmetal	11,525	2,305	42,241	4,224	18.3	1.8
Coal	1,106	1,106	73,576	2,722	66.5	2.5

Note: Due to rounding, some totals do not exactly equal the sum of the corresponding individual entries.

MSHA evaluates the components of the 2019 ASTM standard that may impose additional costs on mine operators, and the assumptions in estimating those costs.

Approved Respirators. Mine operators are familiar with MSHA's existing requirements for using NIOSH-approved respirators, and this analysis assumed that mine operators will not incur additional costs for these requirements. MSHA assumed recordkeeping primarily results in labor costs.

Program Audit. Program costs for an annual review and written report by the program administrator are included with the annual labor time. A program administrator will perform the review and prepare the report. A second review in the form of an outside audit is conducted by a person not involved in the respirator program. The audit is to be repeated at a frequency determined by the complexity of the program.

Written Standard Operating Procedures. MSHA assumes that most mines have established written Standard Operating Procedures (SOPs) that comply with the ASTM standard. MSHA assumed that 50 percent of affected mine operators will prepare new or updated SOPs at the start of implementation. Following this initial period, these costs will be incurred only by new mines.

Medical Evaluations. Under this provision, mine operators would update the information provided to the PLHCP concerning each miner's work area, type and weight of respirator, duration and frequency of respirator use, work activities and environmental conditions, hazards, and other PPE worn. This information is assumed to be part of the miner's job description and personnel records (*e.g.,* fit-test results) and is likely available electronically at most mines. As a result, the cost of this provision is associated with the requirement to document this information in the miner's records and transmit it to the PLHCP.

Respirator Selection. The provisions for respirator selection in the 2019 ASTM standard reflect the current standard of care for respirator use in the U.S. In this analysis, MSHA assumed that mine operators are already using these criteria for selecting respiratory protection. MSHA assumed that mine operators will not incur additional costs for this provision.

Mine Operator Responsibilities. The 2019 ASTM standard provides that mine operators allow miners wearing respirators to leave a hazardous atmosphere for any reason related to the respirator. The mine operator will also investigate the cause of respirator failures and communicate with the respirator manufacturer and government agencies about defects. Respirator failures or defects are considered rare events. To account for the potential time involved should defective respirators be encountered, this analysis adds a minimal amount of labor time.

Training the "Respirator Trainer". Under the 2019 ASTM standard, the respirator trainer will provide training to others with responsibilities for implementing the mine operator's respirator program, and therefore, this person must have an appropriate training or experience. For existing mines, this cost is unlikely to recur except when a respirator trainer leaves the mine operator's employment. However, it is likely to be incurred by the 2 percent of new mines entering the market in any given year.

Training for the Mine Operator/Supervisor and the Person Issuing Respirators. The mine operator or supervisor of any miner who must wear a respirator must receive training on the elements of the respiratory protection program in the SOPs and related topics. The cost in the first year of compliance will also be incurred in subsequent years by—at a minimum—new mines entering the market.

Miner Training. Miners required to use respirators already receive training each year under the 1969 ANSI standard and under 30 CFR part 46 and Part 48. Most mines incorporate this into their existing annual health and training plan, and therefore MSHA estimates that there are no incremental costs attributable to this provision.

Fit Testing Frequency. The 2019 ASTM standard provides for annual respirator fit testing to ensure that the make, model, and size of the respirator issued to the miner are appropriate and the miner is still able to achieve a good face seal. MSHA assumed that, on average, miners receive annual fit testing under existing training standards. A provision under the 2019 ASTM standard is that the fit testing must be overseen by a trained technician or supervisor. The time of the trained supervisor is an additional cost incurred under this provision.

Maintenance, Inspection, and Storage. The provisions for respirator selection in the 2019 ASTM standard reflect the current standard of care for respirator use in the U.S. In this analysis, MSHA assumed that mine operators are already using these criteria for maintaining, inspecting, and storing respirators. Therefore, MSHA assumed that mine operators will not incur additional costs for this provision.

Table IX–19 presents average compliance costs per mine by sector. In Year 1, compliance costs average about $1,700 for coal mines. In Year 2, compliance costs average about $1,200 for MNM mines and $500 for coal mines. In Years 3 and following, average compliance costs per mine are smaller, ranging from $262 for MNM mines to $479 for coal mines, with an overall average of $332 per mine.

MSHA assumes that all mines are affected by the requirement to have a written respiratory protection program that meets the ASTM standard but not all mines are expected to incur costs for this requirement. MSHA estimates, in Year 1 (for coal mines) and Year 2 (for MNM mines), only 50 percent of affected mines are expected to incur costs under provision 2 (SOPs) because many mines already have SOPs that comply with the ASTM. In Years 2 through 60 (for coal) and Years 3 through 60 (for MNM), the number of affected mines that would incur costs is smaller than in Years 1 and 2 because following Year 1 (for coal) and Year 2 (for MNM), additional compliance costs are expected to be incurred primarily by new mines entering the industry. For example, provisions related to written SOPs, Training for the Respirator Trainer, and Training for the Mine Operator and Person Responsible for Issuing Respirators are initial costs incurred in the first year of compliance. In subsequent years, those costs would generally be incurred only by the 2 percent of new mines entering the industry.

Table IX-19: Respiratory Protection Practices Costs Related to ASTM Update per Mine (in 2022 dollars)

Mine Sector	Number of Mines Incurring Costs	Total Cost	Cost per Mine
Incremental Cost in Year 1			
Total	***1,106***	***$1,911,502***	***$1,728***
Metal/Nonmetal	0	$0	--
Coal	1,106	$1,911,502	$1,728
Incremental Cost in Year 2			
Total	***3,411***	***$3,237,436***	***$949***
Metal/Nonmetal	2,305	$2,707,811	$1,175
Coal	1,106	$529,625	$479
Incremental Cost in Year 3-60			
Total	***3,411***	***$1,132,441***	***$332***
Metal/Nonmetal	2,305	$602,816	$262
Coal	1,106	$529,625	$479

Below in Table IX–20 are the annualized costs associated with the ASTM requirement. The total annualized cost to the mining industry ranges from $1.18 million (0 percent discount rate) to $1.32 million (7 percent discount rate), with 53 percent of those costs attributable to MNM mines and 47 percent attributable to coal mines.

Table IX-20: Respiratory Protection Practices Related to ASTM Update Total Annualized Costs (in thousands of 2022 dollars) per Year

Component	Mines Incurring Costs	Total Annualized Costs (thousands of dollars) per Year at Specified Discount Rate			Percentage of Total Costs[1]
		0 Percent	3 Percent	7 Percent	
Total	***3,411***	***$1,181***	***$1,231***	***$1,315***	***100.0%***
Metal/Nonmetal	2,305	$628	$653	$694	53.1%
Coal	1,106	$553	$578	$622	46.9%

Note: 1. Calculated at the 3 percent real discount rate.

6. Cost Summary

MSHA estimates that the annualized cost of the final rule will range from $88.8 million to $92.4 million in 2022 dollars. At a discount rate of 3 percent,[88] 59.0 percent is attributable to exposure monitoring; 20.9 percent to medical surveillance; 15.1 percent to engineering, improved maintenance and repair, and administrative controls; 3.7 percent to additional respiratory protection (*e.g.,* when miners need temporary respiratory protection from exposure at the new PEL when it would not have been necessary at the existing PEL); and 1.4 percent related to the selection, use, and maintenance of approved respirators in accordance with ASTM F3387–19, respiratory protection practices (see Table IX–21).

Table IX-21: Summary of Estimated Compliance Costs by Provision (in millions of 2022 dollars)

Provision	0 Percent Discount Rate		3 Percent Discount Rate		7 Percent Discount Rate	
	Annualized Cost	Percent	Annualized Cost	Percent	Annualized Cost	Percent
Exposure Monitoring	$51.60	58.1%	$53.24	59.0%	$55.64	60.2%
Exposure Controls	$13.79	15.5%	$13.66	15.1%	$13.40	14.5%
Respiratory Protection	$3.38	3.8%	$3.32	3.7%	$3.22	3.5%
Medical Surveillance[2, 3]	$18.82	21.2%	$18.84	20.9%	$18.82	20.4%
Subtotal, Part 60 Costs	*$87.59*	*98.7%*	*$89.05*	*98.6%*	*$91.07*	*98.6%*
ASTM 2019	$1.18	1.3%	$1.23	1.4%	$1.32	1.4%
Total, All Mines	***$88.77***	***100.0%***	***$90.28***	***100.0%***	***$92.39***	***100.0%***

Note: Due to the uncertainty on how many currently employed miners will participate in voluntary medical surveillance programs, MSHA considered two rates (25 percent and 75 percent) when estimating medical surveillance costs. The values presented in this table are the average costs between the assumed participation rates of 25 percent and 75 percent.

Given the larger size of the MNM sector and the higher proportion of samples in the MNM sector that are above 50 μg/m^3, most costs are attributable to MNM mines (see Table IX–1 and Table IX–2). Of the $90.3 million total, MSHA estimates that the MNM sector will incur $82.1 million (91 percent) and the coal sector will incur $8.2 million (9 percent) in annualized compliance costs (see Table IX–22).

[88] In its analysis, MSHA annualizes all costs using 3 percent and 7 percent real discount rates as recommended by OMB. Using a 7 percent discount rate, the annualized cost of the rule is estimated at $75.4 million in 2022 dollars.

Table IX-22: Summary of Estimated Annualized Compliance Costs by Sector (in millions of 2022 dollars)

Sector	2019 Number of Mines[1]	0 Percent Discount Rate		3 Percent Discount Rate		7 Percent Discount Rate	
		Annualized Cost	Percent	Annualized Cost	Percent	Annualized Cost	Percent
Total, All Mines	***12,631***	***$88.77***	***100.0%***	***$90.28***	***100.0%***	***$92.39***	***100.0%***
Metal/ Nonmetal	11,525	$80.75	91.0%	$82.06	90.9%	$83.84	90.7%
Coal	1,106	$8.02	9.0%	$8.22	9.1%	$8.55	9.3%

Note: 1. The estimated number of current and future mines are based on 2019 data (MSHA, 2022d) and are assumed to have remained constant through the 60 years following the start of implementation.

To estimate compliance costs, MSHA determined the expected measures necessary for mines to comply with each provision of the final rule then estimated the costs incurred by a typical mine to comply with each provision. These include one-time costs, such as those to purchase and install an engineering control, provide equipment expected to last multiple years (*e.g.,* respirators), or devise and implement an administrative control. They also include recurring costs, such as the operating and maintenance (O&M) costs of using an engineering control or the value of the labor hours and supplies used to perform periodic exposure monitoring. To aggregate costs for each provision, MSHA multiplies the average cost per mine by the number of mines expected to incur that cost or the average cost per miner by the number of miners expected to be affected by the given provision. These costs are summed across all provisions for each of the two major mining sectors to estimate total industry costs. For purposes of the cost analysis, MSHA assumes employment is constant over this period.

MSHA annualizes all costs using 3 percent and 7 percent discount rates as recommended by OMB.[89] All costs and benefits are annualized over a 60-year analysis period. MSHA annualized benefits to reach the long-run steady state values projected in MSHA's FRA.[90] Costs are also estimated and annualized over a 60-year period. This means that costs for durable equipment, for example, are estimated based on their expected service life. If the expected service life of a building ventilation system is 30 years, MSHA assumes that a mine operator would purchase the system in year 1 and again in year 31 to estimate 60 years of capital costs. This is the major change in costing methodology for the final rule. Under the proposed rule, MSHA annualized costs over shorter periods. Given the types of controls appropriate for meeting the requirements of the proposed rule, this approach was reasonable. Because MSHA set a 1-year difference between the compliance dates for the coal and MNM sectors under the final rule, that method is no longer accurate. MSHA's analysis of this final rule is based on a timeframe of 60 years (which is enough time to analyze 45 years of working life and 15 years of retirement for new miners who only experience exposures under the new PEL).

For both MNM and coal mines, the estimated costs to comply with the new PEL (50 μg/m³) assumes that all mines are compliant with the existing PEL of 100 μg/m³ for MNM mines (for a full shift, calculated as an 8-hour TWA) and 85.7 μg/m³ for coal mines (for a full shift, calculated as an 8-hour TWA).

Two mining trade organizations, American Exploration and Mining Association and Nevada Mining Association, stated that MSHA's cost projections were inaccurate because they predicted fixed costs based on gross proceeds (instead of net proceeds) (Document ID 1424; 1441). These commenters also noted that, because the cost model for each commodity differs, compliance costs for each commodity will differ. MSHA did not estimate compliance costs based on either gross or net proceeds. MSHA has determined that its approach better identifies likely costs than the approach recommended by the commenters. The Agency estimated compliance costs based on a wide range of quantitative and qualitative data including: sampling data on miner exposure, MSHA program experience, and MSHA's knowledge of typical controls, maintenance, and work practices at mines of different types and size. MSHA estimates compliance costs using mine size, labor cost, and other factors at commodity level, which is more flexible and accurate than the estimation of proceeds.

One commenter, a mining-related business, stated that MSHA's cost estimates were based on flawed sampling data, that ''used samples taken by MSHA inspectors and then weighted these based on the number of samples plus exposures to the current standard (Document ID 1392). The commenter stated that powered haulage operators account for the bulk of samples, while conveyor operators account for the fewest samples, resulting in a ratio of about 1 conveyor operator to 79 powered haulage operators. The commenter stated that in its experience, the ratio is about 1 conveyor operator to 4 haulage operators. Because conveyor operators are underrepresented in the analysis, this would affect MSHA's cost estimates.

As described in *Part B—Miners and Mining Industry,* MSHA used 2019 OEWS data to estimate the number of miners in each occupational group.[91] The OEWS is a nationally representative dataset and MSHA uses it to examine labor force in the mining industry. While BLS reported the number of workers under powered haulage operators, it did not report any employment in the OCC Code 53–7011 (Conveyor Operators and Tenders) due to an insufficient number of respondents identified as Conveyor Operators and Tenders.

The samples taken by MSHA inspectors were not weighted based on

[89] Discount rates throughout this section refer to real discount rates. Real discount rates are distinct from nominal discount rates because they do not include inflation.

[90] Technically, MNM benefits would not reach their long-run average values until 61 years following the compliance date for the coal sector since the compliance deadline for MNM is 1 year after the compliance deadline for coal.

[91] OEWS data available at *https://www.bls.gov/oes/* (last accessed Jan. 10, 2024).

the ''number of samples plus exposures to the current standard,'' as the commenter suggested, but rather by the estimated number of workers in each occupational group (Document ID 1392). MSHA took this approach because the samples taken by inspectors are not representative of all jobs at a mine, rather they are concentrated in areas where miners are at the greatest risk for dust exposure. The FRIA analysis is based on sample and employment data to provide an overview of all occupational groups and their associated risks for the mining industry.

One commenter, N-Compliance Safety Services, Inc., stated that large mining company costs under the proposed rule would be in the millions of dollars annually, a figure that does not include the cost of citations, downtime, and contesting violations (Document ID 1383). Stating that the proposed rule's costs would drive up the costs of commodities and impact transportation needs and expenses, the commenter said that the proposed 25 μg/m^3 action level would place most mines in violation, as it is four times less than the current PEL and would require four times the actions to maintain compliance below it. Downtime to maintain controls is included in the cost of the final rule. In response to the comment from mine operators that the action level would place most mines in violation, MSHA clarifies that mine operators are not required to maintain exposures below the action level. The purpose of the action level is to alert mine operators and miners when exposures are approaching the PEL. Mine operators will be in violation if exposures exceed the new PEL. Mine operators who maintain exposures at or above the action and at or below the new PEL will incur sampling costs but will not be in violation of the final rule and will not be faced with citations, downtime, or contesting violations. MSHA notes that the commenter has provided no data to support their statement that the rule will cost large mining companies millions of dollars in compliance costs.

D. Benefit Analysis

In the FRIA, MSHA estimates that, during the 60 years following the compliance date for the coal sector (*i.e.,* the start of the timeframe for the cost analysis), annual benefits will gradually increase, as the share of miners' working lives under the new PEL (rather than the existing standards) increases.[92] In the FRA, MSHA estimated the avoided cases attributable to the new PEL using a comparison of a population of miners exposed only under the new PEL to one exposed only under the existing standards throughout their working and retired lives. These benefits included reductions to excess cases of fatal silicosis, fatal non-malignant respiratory diseases (NMRD), fatal end-stage renal disease, fatal lung cancer, and non-fatal silicosis. These five health outcomes were chosen based on their well-established exposure-response relationships with occupational respirable crystalline silica exposure.[93]

In the FRIA, MSHA estimates and monetizes the excess morbidity and mortality cases avoided during the same 60-year analysis timeframe as considered by the cost analysis so that benefits can be directly compared with the costs of the final rule. The number of avoided cases presented in the FRIA during the 60-year analysis period is less than the number of lifetime cases avoided estimated in the FRA, since miners with exposure under the current limits are gradually replaced by miners with exposure under the new PEL during the 60 years following the start of implementation.

In the PRA, MSHA underestimated the number of miners who would benefit from this rule. Based on the 2019 Quarterly Employment Production Industry Profile (MSHA, 2019a) and the 2019 Quarterly Contractor Employment Production Report (MSHA, 2019b), the current number of working miners full-time equivalents (FTEs) is assumed to be 184,615 for MNM and 72,768 for coal.[94] In the PRA, MSHA assumed excess cases of disease would be reduced only among these working miners. However, once the current mining workforce is replaced with new entrants to the mining industry so that the entire workforce has worked only under the new PEL for their 45-years of working life (*i.e.,* 60 years after the start of implementation), the future mining workforce will experience fewer excess deaths and illnesses from excess exposure to respirable crystalline silica. The PRA's methodology did not include the number of future retired miners who experienced lower exposures for their working lives under the final rule and will continue to benefit during their retirement, and therefore, the PRA underestimated the benefits attributable to the final rule.

Both the FRA and the FRIA are updated to account for benefits among both working miners and future retired miners. It is important to note that the FRIA only monetizes benefits to future retired miners—*i.e.,* retired individuals who were employed as miners after the start of implementation. The FRIA methodology does not attribute any health benefits to individuals who retired before the start of implementation of the final rule. The FRIA is updated to reflect the number of future retired miners, which increases gradually after the start of implementation. For example, in the first year after the start of implementation, there will be no retired miners who benefit from the rule. In the second year after the start of implementation, there will be one cohort of retired miners (*i.e.,* those in their final year of mining when implementation began). In this way, the FRIA monetizes benefits to future retired miners while accounting for the fact that future retired miners who benefit from the rule increase in size gradually during the 60-year analysis period.

MSHA estimates that:

• For a population of working and retired miners exposed only under the new PEL, the final respirable crystalline silica rule will result in a total of 1,067 lifetime avoided deaths (982 in MNM mines and 85 in coal mines) and 3,746 lifetime avoided morbidity cases (3,421 in MNM mines and 325 in coal mines). These avoided cases will be achieved once all miners, working and retired, have been exposed exclusively under the new PEL (see Table IX–23).

• Over the first 60 years immediately following the start of implementation, fewer cases will be avoided than are shown in Table IX–23. This is because the annual number of cases avoided will increase gradually to the long-run steady-state values, which ultimately will be achieved only when all miners have been exposed only under the new PEL. Table IX–24 shows that, in the first 60 years following the start of implementation, the final rule will result in a total of 531 avoided deaths (487 in MNM and 44 in coal) and 1,836 avoided morbidity cases (1,673 in MNM and 162 in coal), which are the benefits MSHA monetized in its FRIA. In general, the actual number of cases that will be avoided in the 60 years

[92] Throughout this document, the term ''long-run'' refers to the period of time when all surviving working and retired miners will have only been exposed under the new PEL.

[93] The standalone Health Effects document and the FRA discuss the evidence for these relationships in depth, as well as the exposure-response models used for analysis in the FRA.

[94] The analysis of this FRIA assumes the mining workforce will not change size during the 60 years following compliance with the rule to simplify estimation of health benefits. The current and long-term size of the mining workforce was estimated using 2019 data, since the COVID–19 pandemic may have led to temporary changes in the mining workforce that will be reversed in coming years.

following the start of implementation is approximately half the number of avoided cases once benefits reach their long-run average annual values (see Table IX–24).

• Under a discount rate of 3 percent, the total benefits of the new respirable crystalline silica rule from these avoided deaths and morbidity cases, including the benefits of avoided morbidity preceding mortality, are $246.9 million per year in 2022 dollars (see Table IX–25).

• Because a higher monetary value is placed on avoided death as compared to an avoided morbidity case, the majority (62.5 percent; $154.3 million) of these benefits is attributable to avoided mortality due to non-malignant respiratory disease (NMRD) ($75.4 million), silicosis ($40.3 million), and end-stage renal disease (ESRD) ($28.4 million), and lung cancer ($10.2 million) (see Table IX–25).

○ Benefits from avoided morbidity due to non-fatal silicosis are $72.8 million per year. Of this, $66.3 million are due to cases avoided in MNM mines and $6.5 million are due to cases avoided in coal mines (see Table IX–25).

○ Benefits from avoided morbidity that precedes fatal cases of NMRD, silicosis, renal disease, and lung cancer, are $19.8 million. Of this, $18.2 million are due to cases avoided in MNM mines and $1.6 million are due to cases avoided in coal mines (see Table IX–25).

BILLING CODE 4520–43–P

Table IX-23: Estimated Cases of Avoided Lifetime Mortality and Morbidity Attributable to the New Rule Among a Population Exposed Only to the New PEL

Health Outcome	Total Lifetime Avoided Cases[1]		
	MNM	Coal	Total
Avoided Morbidity			
Silicosis	3,421	325	3,746
Avoided Morbidity Total (Net of Silicosis Deaths)	**3,421**	**325**	**3,746**
Avoided Mortality			
NMRD (net of silicosis mortality)	489	47	536
Silicosis	233	15	248
ESRD	185	15	200
Lung Cancer[2]	75	7	82
Avoided Mortality Total	**982**	**85**	**1,067**

Notes: 1. Avoided cases include all miners (including contract miners). Calculations show the difference between excess cases when assuming compliance with the existing limits versus assuming compliance with the new PEL.
2. A 15-year lag between exposure and observed health effect was assumed for lung cancer estimates.

Table IX-24: Estimated Cases of Avoided Mortality and Morbidity Attributable to the New Rule during the 60 Years Immediately Following the Start of Implementation

Health Outcome	Total Avoided Cases During 60 Years Following the Start of Implementation[1]		
	MNM	Coal	Total
Avoided Morbidity			
Silicosis	1,673	162	1,836
Avoided Morbidity Total (Net of Silicosis Deaths)	**1,673**	**162**	**1,836**
Avoided Mortality			
NMRD (net of silicosis mortality)	241	22	263
Silicosis	123	11	134
ESRD	90	8	98
Lung Cancer[2]	33	3	36
Avoided Mortality Total	**487**	**44**	**531**

Notes: Due to rounding, some totals do not exactly equal the sum of corresponding individual entries.
1. Avoided cases include all miners (including contract miners). Calculations show the difference between excess cases when assuming compliance with the existing limits versus assuming compliance with the new PEL of 50 $\mu g/m^3$. Estimates account for the fact that some miners during the 60-year period will have worked under the existing standards (and thus may have combination of exposures under the existing standards and the new PEL), while other new entrants into the mining workforce would be solely exposed under the new PEL.
2. A 15-year lag between exposure and observed health effect was assumed for lung cancer estimates.

Table IX-25: Estimated Monetized Benefits over 60 Years for the New Respirable Crystalline Silica Rule Annualized at a 3 Percent Discount Rate (in millions of 2022 dollars)

Health Outcome	MNM	Coal	Total
Avoided Morbidity (Not Preceding Mortality)			
Silicosis (Net of Silicosis Mortality)	$66.3	$6.5	$72.8
Avoided Morbidity (Not Preceding Mortality) Total	**$66.3**	**$6.5**	**$72.8**
Avoided Mortality			
NMRD (Net of Silicosis Mortality)	$69.1	$6.3	$75.4
Silicosis	$37.0	$3.3	$40.3
ESRD	$26.1	$2.3	$28.4
Lung Cancer	$9.4	$0.9	$10.2
Avoided Mortality Total	**$141.6**	**$12.7**	**$154.3**
Avoided Morbidity (Preceding Mortality)			
NMRD (Net of Silicosis Mortality)	$8.6	$0.8	$9.4
Silicosis	$5.0	$0.5	$5.5
ESRD	$3.4	$0.3	$3.6
Lung Cancer	$1.1	$0.1	$1.2
Avoided Morbidity (Preceding Mortality) Total	**$18.2**	**$1.6**	**$19.8**
Grand Total	**$226.0**	**$20.9**	**$246.9**

BILLING CODE 4520–43–C

MSHA acknowledges that its benefit estimates are influenced by underlying assumptions and that the long timeframe of this analysis (*i.e.,* 60 years) is a source of uncertainty. The main assumptions underlying these estimates of avoided mortality and morbidity include the following:

- Employment is held constant over the 60 years (*i.e.,* the analysis period of the final rule).[95]
- For analyses under the ''Baseline'' scenario, any exposures to respirable crystalline silica above the existing standards (*i.e.,* 100 μg/m³ for MNM miners and 85.7 μg/m³ for coal miners) were capped at 100 μg/m³ and 85.7 μg/m³ for MNM and coal exposures, respectively.
- For analyses under the ''New PEL 50'' scenario, any exposures to respirable crystalline above the new PEL are capped at the new PEL (*i.e.,* 50 μg/m³).
- Miners have identical employment and hence identical exposure tenures (*i.e.,* 45 years).

In addition to the above-mentioned quantified health benefits, MSHA expects that there will be additional benefits from requiring approved respirators be selected, fitted, used, and maintained in accordance with ASTM F3387–19. The ASTM standard reflects improved developments in respiratory protection since the time in which MSHA issued its existing standards. ASTM F3387–19 also includes respiratory protection program elements such as program administration; standard operating procedures (SOPs); medical evaluation; respirator selection; training; fit testing; and respirator maintenance, inspection, and storage.

This provision of the final rule will ensure that, in circumstances where respirator use is required, mine operators will provide miners with respiratory protection that incorporates advances in technology and changes in respiratory protection practices. This respiratory protection will play a critical role in safeguarding the health of miners and reducing their exposures to respirable crystalline silica and other airborne contaminants. As demonstrated in the FRA, reductions in occupational exposure to respirable crystalline silica are expected to reduce adverse health outcomes. However, given the uncertainty about the current state of mine operator respiratory protection practices, MSHA did not quantify the expected additional benefits that would be realized by requiring approved respirators to be selected, fitted, used, and maintained in accordance with the requirements of ASTM F3387–19.

MSHA believes that reductions in coal miners' exposure to respirable crystalline silica may also lead to lower levels of coal mine dust inhalation. MSHA expects that adverse health outcomes attributable to respirable coal mine dust exposure, such as simple and complex coal workers' pneumoconiosis (CWP), will also be reduced. MSHA has not estimated the reduction in risk associated with CWP among coal miners because the literature does not contain an exposure-response model that quantifies the impact of respirable crystalline silica on CWP mortality risk, and because MSHA is not making any assumptions about whether levels of coal mine dust will be reduced due to the final rule. MSHA anticipates that there will be additional unquantified benefits from the reduction in CWP provided by the final rule. Within the avoided silicosis and NMRD deaths, however, MSHA includes benefits from avoided mortality due to progressive massive fibrosis (PMF)—including mortality due to complicated CWP and complicated silicosis.

Finally, MSHA also expects that the final rule's medical surveillance provisions will reduce mortality and morbidity from respirable crystalline silica exposure among MNM miners. The initial mandatory examination that assesses a new miner's baseline pulmonary status, coupled with periodic examinations, will assist in the early detection of respirable crystalline silica-related illnesses. Early detection of illness often leads to early intervention and treatment, which may slow disease progression and/or improve health outcomes. This may also result in less miner time-off and less miner turnover. However, MSHA lacks data to quantify these additional benefits.

[95] MSHA recognizes that it is very challenging to predict economic factors over such a long period with high degrees of confidence. Given known information and forecast limitations, MSHA believes assuming constant employment is reasonable.

National Coalition of Black Lung and Respiratory Disease Clinics was concerned that the projected benefits of the proposed rule for coal miners were significantly lower than the projected benefits for MNM miners and suggested that MSHA correct for this by including dust samples from coal mines taken prior to August 1, 2016 (Document ID 1410). Similarly, the Appalachian Citizens' Law Center asserted that the benefits estimated in the PRA are low and urged MSHA to include a longer history of coal dust sampling data (Document ID 1445). MSHA believes that samples from before August 1, 2016, may not accurately reflect the current conditions in coal mines and therefore should not be used in analyzing the impact of this final rule. As discussed in Appendix A of the preamble, on August 1, 2016, Phase III of the 2014 RCMD Standard went into effect, and this lowered the PEL for RCMD in coal mines. The controls put in place to achieve that new PEL impacted both RCMD with and without respirable crystalline silica dust in coal mines, and as such, these controls likely lowered concentrations of respirable crystalline silica. Using data from after the coal mine dust rule went into effect helps to ensure that benefits attributable to that rule are not attributed to this rule incorrectly. More details about the respirable crystalline silica sample dataset, including the time coverage and brief statistics, are described in ''Description of MSHA Respirable Crystalline Silica Samples'' (Appendix A of the preamble of Proposed Rule). In addition to the prior effects of the 2014 RCMD Standard on respirable crystalline silica exposure in the coal sector, there will also be greater benefits to MNM miners owing to the medical surveillance requirements which are already existing for coal miners. However, these benefits are unquantified in the FRA and FRIA analyses and therefore, do not specifically contribute to the discrepancy mentioned by these commenters.

Further, the benefits quantified here may underestimate the true benefits to coal miners. MSHA believes this final rule will likely lower not only respirable crystalline silica concentrations, but also RCMD levels. As a result, MSHA believes this final rule will provide additional reductions in CWP, NMRD, and PMF beyond those conferred by the 2014 RCMD Standard. In the 2014 Coal Dust Rule, NIOSH emphasized the important role respirable crystalline silica plays in causing these diseases, stating that, ''in concentrating on this particular exposure-response relationship with coal mine dust, we must not forget that [coal] miners today are being exposed to excess silica levels, particularly in thinner seam and small mines, and that this situation could well get worse as the thicker seams are mined out. Hence, since silica is more toxic than mixed coal dust, tomorrow's [coal] miners could well be at greater risk, despite a reduction in the mixed coal mine dust standard.'' While additional reductions in total RCMD would be expected due to this final rule, these reductions cannot be quantified as the reductions depend on the particular control measures that mine operators implement. Additionally, exposure-response models for respirable crystalline silica exposure and resultant CWP are not available. Thus, the benefits quantified in this FRIA may underestimate the true benefits to coal miners, as MSHA does not account for expected reductions in CWP or in other diseases due to reduced RCMD.

E. Benefit-Cost Analysis

The net benefits of the final rule are the differences between the estimated benefits and costs. Table IX–26 shows estimated net benefits using alternative discount rates of 0, 3, and 7 percent. The choice of discount rate has an effect on annualized costs, benefits, and net benefits. While the net benefits of the final respirable crystalline silica rule vary depending on the choice of discount rate used to annualize costs and benefits, total benefits exceed total costs under all discount rate considered. MSHA's estimate of the net annualized benefits of the final rule, using a discount rate of 3 percent, is $156.6 million a year, with the majority ($143.9 million; 91.9 percent) attributable to the MNM sector.

Table IX-26: Annualized Costs, Benefits, and Net Benefits of MSHA's Final Respirable Crystalline Silica Rule (in millions of 2022 dollars)

Quantified Benefits and Costs	MNM			Coal			Total		
	0%	3%	7%	0%	3%	7%	0%	3%	7%
Benefits									
Avoided Mortality	$230.4	$141.6	$68.9	$20.5	$12.7	$6.4	$250.9	$154.3	$75.3
Avoided Morbidity Preceding Mortality	$27.1	$18.2	$10.0	$2.4	$1.6	$0.9	$29.5	$19.8	$11.0
Avoided Morbidity Not Preceding Mortality	$93.1	$66.3	$41.5	$9.0	$6.5	$4.2	$102.1	$72.8	$45.7
***Total*[1]**	***$350.7***	***$226.0***	***$120.4***	***$31.9***	***$20.9***	***$11.5***	***$382.6***	***$246.9***	***$131.9***
Costs									
Exposure Monitoring	$46.1	$47.6	$49.7	$5.5	$5.6	$5.9	$51.6	$53.2	$55.6
Exposure Controls	$11.9	$11.7	$11.4	$1.9	$1.9	$2.0	$13.8	$13.7	$13.4
Respiratory Protection	$3.3	$3.3	$3.2	$0.1	$0.1	$0.1	$3.4	$3.3	$3.2
Medical Surveillance	$18.8	$18.8	$18.8	--	--	--	$18.8	$18.8	$18.8
ASTM Update	$0.6	$0.7	$0.7	$0.6	$0.6	$0.6	$1.2	$1.2	$1.3
Total	***$80.7***	***$82.1***	***$83.8***	***$8.0***	***$8.2***	***$8.5***	***$88.8***	***$90.3***	***$92.4***
Net Benefits	***$270.0***	***$143.9***	***$36.6***	***$23.9***	***$12.7***	***$3.0***	***$293.8***	***$156.6***	***$39.5***

Notes: Medical surveillance cost is the average cost under the assumed participation rate of 25 percent and 75 percent.

1. For the purpose of simplifying the estimation of the monetized benefits of avoided illness and death, MSHA added the monetized benefits of morbidity preceding mortality to the monetized benefits of mortality at the time of death, and both would be discounted at that point.

F. Sensitivity Analysis on the Tenure of Miners

As mentioned in *Part E. Benefit-Cost Analysis,* in performing the benefit analysis, MSHA assumed that all miners have a working tenure of 45 years, from the start of age 21 to the end of age 65. MSHA also assumed that each miner's level of exposure remains the same in each day of each year. MSHA also performed a sensitivity analysis to see how benefits would differ under three scenarios with alternative tenures, though with all three sharing the same simplifying assumption that exposure remains constant for each miner across all of their working years. These alternative scenarios involved: (1) a tenure of 35 working years (rather than 45), between the ages of 26 and 60; (2) a tenure of 25 working years, between the ages of 31 and 55; and a tenure of 15 years, between the ages of 36 and 50. These age ranges were selected to maintain the same midpoint miner age of 43.

Under the assumption that the same number of miners (257,383) are working at any given time the lower the tenure, the more turnover there would be among miners, the greater the number of new miners who would enter each year to replace those who are retiring or changing jobs. For example, when the scenario changes from a 45-year tenure (which was used in the benefit analysis) to a 15-year tenure, the analysis would require a single miner who would work for 45 years to be effectively replaced by three miners who would each be working for 15 years (one after another) during those same 45 years. This means that, in these lower-tenure scenarios, each miner would have accumulated less exposure by the time they retire, but there would be more miners retiring with that level of exposure.

From analyzing the alternative scenarios with different tenures, using its risk model, MSHA found that lower tenures tended to result in more avoided cases of mortality. This is because, while the risk of mortality increases for any miner who works more years, at lower tenure rates, many more miners are exposed and are put at risk of dying from the disease. According to the models, the increased number of exposed miners, when tenure is short, leads to a greater increase in overall mortality than does the increased likelihood of mortality occurring for each miner, when the tenure is long. As a result, this sensitivity analysis found that the rule would have greater benefits, in terms of reducing mortality, under scenarios with shorter tenure than under the 45-year tenure assumption used in the benefits analysis. The assumption of a 45-year tenure may be seen as effectively leading to an underestimate the benefits of the rule in terms of reduced mortality, relative to assumptions involving lower tenures.

From the way the risk model is designed, however, the opposite effect was observed with regard to morbidity cases, where there were more cases of morbidity under longer tenure rates. Under longer tenure rates, there are estimated to be more cases of morbidity overall, and therefore the rule has a greater estimated effect on reducing cases of morbidity under the assumption of a 45-year tenure than under the alternative scenarios. Nevertheless, because the benefits of reduced mortality cases count much more than the benefits of reduced morbidity cases, it may be concluded that under the shorter tenures of the alternative scenarios, the benefits of the rule would be greater. In other words, if the tenures of miners are, in fact, shorter than 45 years, the assumption of a 45-year tenure has the net effect of underestimating the benefits of the rule.

G. Regulatory Alternatives

In developing the final rule, MSHA considered three regulatory alternatives. The first two alternatives contain less stringent exposure monitoring provisions than the final rule, which comparatively presents a comprehensive approach for lowering miners' exposure to respirable crystalline silica and improving respiratory protection for all airborne contaminants. The first alternative includes no change to the final rule's PEL and action level, whereas the second alternative includes a more stringent PEL. The second alternative combines less stringent exposure monitoring with a more stringent PEL. The third alternative examines a different methodology for calculating miners' exposures and assessing compliance. MSHA discusses the regulatory options in the sections below.

1. Regulatory Alternative 1: Changes in Sampling and Evaluation Requirements

Under this alternative, the new PEL would remain unchanged at 50 μg/m³ and the action level would remain unchanged at 25 μg/m³. Further, mine operators would conduct: (1) first-time and second-time sampling for miners who may be exposed to respirable crystalline silica at or above the action level of 25 μg/m³, (2) above-action-level sampling twice per year for miners who are at or above the action level of 25 μg/m³ but at or below the PEL of 50 μg/m³, and (3) annual evaluation of changing mining processes or conditions that would reasonably be expected to result in new or increased exposures.

Mine operators would still be required to conduct sampling under this Regulatory Alternative and would thus incur compliance costs. However, exposure monitoring requirements under this alternative are less stringent than the requirements under the final rule because the frequency of above-action-level sampling and periodic evaluations are set at half the frequency of the final exposure monitoring requirements. Therefore, the cost of compliance would be lower under this alternative. MSHA estimates that annualized exposure monitoring costs would total $29.3 million for this alternative (at a 3 percent discount rate), compared to $53.2 million for the final exposure monitoring requirements, resulting in an estimated difference of $24.0 million in compliance costs per year (Table IX–27).

Although this alternative does not eliminate exposure monitoring, the requirements are minimal relative to the monitoring requirements under the final rule. However, MSHA believes it is necessary for mine operators to establish an initial baseline for any miner who may be reasonably expected to be exposed to respirable crystalline silica. In addition, above-action-level sampling helps mine operators correlate mine conditions to miner exposure levels and see exposure trends more rapidly than would result from semi-annual or annual sampling. This will enable mine operators to take necessary measures to ensure continued compliance with the new PEL. Further, more frequent monitoring will enable mine operators to ensure the adequacy of controls at their mines and better protect miners' health. These benefits cannot be quantified, but they are nevertheless material benefits that increase the likelihood of compliance.

Table IX-27: Summary of Part 60 Annualized Compliance Costs (in millions of 2022 dollars), Regulatory Alternative 1 and Final Requirements: All Mines

	0 Percent Discount Rate		3 Percent Discount Rate		7 Percent Discount Rate	
Mine Sector	**Annualized Cost**	**Percent of New Requirements**	**Annualized Cost (millions of dollars)**	**Percent of New Requirements**	**Annualized Cost (millions of dollars)**	**Percent of New Requirement**
Regulatory Alternative 1: Changes in Sampling and Evaluation Requirements						
Exposure Monitoring	$27.79		$29.27		$31.56	
Exposure Controls	$13.79		$13.66		$13.40	
Respiratory Protection	$3.38		$3.32		$3.22	
Medical Surveillance	$18.82		$18.84		$18.82	
Total, Part 60 Costs	***$63.77***	***72.8%***	***$65.08***	***73.1%***	***$66.99***	***73.6%***
Final Requirements						
Exposure Monitoring	$51.60		$53.24		$55.64	
Exposure Controls	$13.79		$13.66		$13.40	
Respiratory Protection	$3.38		$3.32		$3.22	
Medical Surveillance	$18.82		$18.84		$18.82	
Total, Part 60 Costs	***$87.59***	***100.0%***	***$89.05***	***100.0%***	***$91.07***	***100.0%***

MSHA also believes that requiring more frequent above-action-level sampling will provide mine operators with greater confidence that they are in compliance with the new PEL. Because of the variable nature of miner exposures to airborne concentrations of respirable crystalline silica, maintaining exposures below the action level provides mine operators with reasonable assurance that miners would not be exposed to respirable crystalline silica at levels above the PEL on days when sampling is not conducted. MSHA believes that the benefits of the final sampling requirements justify the additional costs relative to Regulatory Alternative 1.

Two mining trade associations, American Exploration and Mining Association and National Mining Association, expressed support for Regulatory Alternative #1 (Changes in Sampling and Evaluation Requirements) as a more appropriate approach than the one in the proposed rule, with one clarifying that its support for Regulatory Alternative #1 is only secondary to its primary recommendation that MSHA adopt OSHA's risk-based approach to sampling and evaluation requirements (Document ID 1424; 1428). Specifically, these commenters supported the Regulatory Alternative #1 requirement for baseline sampling for miners whose exposure is at or above the proposed action level of 25 μg/m³ in lieu of the requirement for baseline sampling of each miner who is or may reasonably be expected to be exposed to respirable crystalline silica of any level. Further, these commenters supported the Regulatory Alternative #1 periodic sampling requirement of twice per year for miners between the action level and the PEL, which they said was more in line with established industrial hygiene guidelines and would allow mine operators to allocate industrial hygiene resources to those areas where they are better used, including areas where there is higher risk of exposure above the PEL. Finally, these commenters supported the Regulatory Alternative #1 requirement for annual evaluation of mine processes or conditions, instead of the proposed rule's semi-annual review, stating that it would provide an equal amount of protection to miners (given that mining processes and conditions are relatively stable and non-changing), while lowering operator compliance costs.

MSHA believes it is necessary for mine operators to establish a solid baseline for any miner who is reasonably expected to be exposed to respirable crystalline silica. In addition, frequent, regular sampling and evaluation help mine operators correlate mine conditions to mine exposure levels and see exposure trends more rapidly than would result from semi-annual sampling and annual evaluation. This will enable mine operators to take measures necessary to ensure continued compliance with the PEL. Further, more frequent monitoring will enable mine operators to ensure the adequacy of controls at their miners and better protect miners' health. These benefits cannot be quantified, but they are nevertheless material benefits that increase the likelihood of compliance. MSHA believes that the benefits of the sampling and evaluation requirements justify the additional costs for the final rule relative to Regulatory Alternative 1. Therefore, MSHA did not select Regulatory Alternative 1.

2. Regulatory Alternative 2: Changes in Sampling and Evaluation Requirements and the PEL

Under this Regulatory Alternative, the PEL would be set at 25 μg/m³, mine operators would install whatever controls were necessary to meet the PEL, and no action level would be designated. Further, under this Regulatory Alternative, mine operators would not be required to conduct first-time and second time sampling, above-action-level sampling, and corrective actions sampling. However, mine operators would be required to perform periodic evaluations of changing conditions and to sample as frequently as necessary to determine the adequacy of controls. Additionally, mine operators would be required to perform post-evaluation sampling when the operators determine as a result of the periodic evaluation that miners may be exposed to respirable crystalline silica at or above the action level of 25 μg/m³.

When estimating the cost of monitoring requirements under the final rule, MSHA assumed that the number of samples for post-evaluation sampling are relatively small (2.5 percent of miners) because mine operators are already collecting information which can be used for these purposes through the significant amount of above-action-level sampling. Since Regulatory Alternative 2 does not require above-action-level sampling given the lack of an action level under this alternative, MSHA increases the share of samples after each evaluation to 10 percent of miners to ensure the monitoring requirements can be met.

In addition, to meet the PEL of 25 μg/m³, mine operators would incur greater engineering control costs as compared to the estimated cost of compliance for reaching a PEL of 50 μg/m³. To estimate these additional engineering control costs, MSHA largely uses the same methodology as for mines affected at the new PEL of 50 μg/m³.

a. Number of Mines Affected Under Regulatory Alternative 2

MSHA first estimated the number of mines expected to incur the cost of implementing engineering controls to reach the more stringent PEL. After excluding mines that are affected at the new PEL of 50 μg/m³ (to avoid double-counting), MSHA finds that 3,477 mines (2,991 MNM mines and 486 coal mines) operating in 2019 had at least one sample at or above 25 μg/m³ but below 50 μg/m³.[96]

In addition, MSHA also includes the 1,226 affected mines expected to incur costs to reach the new PEL of 50 μg/m³. Based on its experience and knowledge, MSHA does not expect the mines that install engineering controls to meet the PEL of 50 μg/m³ would also be able to comply with a PEL of 25 μg/m³. For example, to comply with the PEL of 50 μg/m³, a mine might need to add the engineering controls necessary to achieve an additional 10 air changes per hour over that achieved by existing controls, which are included in the costs presented in Table IX–21. However, such a mine facility would then need to add an additional 10 air changes per hour to meet the more stringent PEL of 25 μg/m³, which is not included in the costs presented in Table IX–21. Thus, MSHA expects that the 1,226 affected mines will incur additional costs to meet the PEL of 25 μg/m³ specified under this alternative.

MSHA estimates a total of 4,703 mines will incur costs to purchase, install, and operate engineering controls to meet the more stringent PEL of 25 μg/m³ under this alternative. MNM mines account for 4,087 (87 percent) and coal accounts for the remaining 616 mines (13 percent).

b. Estimated Engineering Control Costs Under Regulatory Alternative 2

MSHA identified potential engineering controls that would enable mines with respirable crystalline silica dust exposures at or above 25 μg/m³ but below 50 μg/m³ categories to meet the more stringent PEL of 25 μg/m³ for this alternative. While MSHA assumed that mine operators will base such decisions on site-specific conditions such as mine layout and existing infrastructure, MSHA cannot make further assumptions about the specific controls that might be adopted and instead assumed the expected value of purchased technologies should equal the simple average of the technologies listed in each control category.

Where more precise information is unavailable, MSHA assumed operating and maintenance (O&M) costs to be 35 percent of initial capital expenditure

[96] About 8,053 of mines active in 2019 either had neither a sample >25 μg/m³ nor a sample in the last 5 years.

and installation cost to be equal to the initial capital expenditure (Table IX–28). MSHA also assumed the larger capital expenditure controls will have a 30-year service life.

Table IX-28: Selected Engineering Controls to Decrease Respirable Crystalline Silica Dust Exposure by Capital Expenditure Cost Range Under Regulatory Alternative 2 (in 2022 dollars)

Engineering Control	Capital Cost	Installation Cost[1]	O&M Cost[2]	Expected Service Life[3]
Minimal capital expenditure				
Stone saw enclosure	$0	$0	$1,468	1
Larger capital expenditure				
Increase facility ventilation from 20 to 30 air changes per hour	$167,263	$167,263	$9,751	30
Full length of conveyor enclosed and ventilated	$960,883	$960,883	$55,386	30
Crusher/grinder: appropriate size ventilation for air flow	$197,928	$197,928	$11,409	30
Plumbing for hose installations, floor re-sloping and troughs	$45,892	$45,892	$4,209	30
Average	***$274,393***	***$274,393***	***$16,445***	***24.2***

Notes: 1. Unless otherwise specified, MSHA assumed installation costs are equal to capital cost.
2. Unless otherwise specified, MSHA assumed annual O&M costs are equal to 35 percent of capital cost.
3. Service life assumed to be 10 years if not otherwise specified.

However, the difficulty of meeting a PEL of 25 μg/m³ is such that MSHA's experience suggests a single control from Table IX–29 would not be sufficient. For example, respirable crystalline silica dust exposure at such a stringent limit is likely to occur in more than one area of the mine; in addition to increasing ventilation to a crusher/grinder, enclosing and ventilating the belt conveyor would likely be necessary to reduce concentrations below a PEL of 25 μg/m³. Similarly, increasing facility ventilation from 20 to 30 air changes per hour may not be adequate to meet the PEL. Rather, 40 air changes per might be necessary. Therefore, MSHA assumes mine operators will purchase and install at least two of the engineering controls listed in Table IX–28 under this Regulatory Alternative. This assumption was made to err on the side of overestimation.

Table IX–29 presents the annualized engineering control costs per mine and total annualized engineering control costs by mine sector. At a 3 percent discount rate, the annualized engineering control costs are about $98,124 per mine, resulting in an additional cost of $461.5 million if the PEL were set at 25 μg/m³ instead of 50 μg/m³.

Table IX-29: Estimated Annualized Costs as a Simple Average per Mine and Total Engineering Controls per Mine Under Regulatory Alternative 2 (in 2022 dollars), by Sector

	Annualized Cost of Engineering Controls at Specified Real Discount Rate		
	0 Percent	**3 Percent**	**7 Percent**
Annualized Engineering Control Costs per Mine, Over All Controls			
Total	***$78,145***	***$98,124***	***$128,441***
MNM	$78,073	$97,714	$127,269
Coal	$78,621	$100,847	$136,218
Total Annualized Engineering Control Costs by Mine Sector (millions)[1]			
Total	***$367.5***	***$461.5***	***$604.1***
MNM	$319.1	$399.4	$520.1
Coal	$48.4	$62.1	$83.9

Note: 1. Based on an estimated 4,087 MNM and 616 Coal mines, for 4,703 total affected mines.

Table IX–30 summarizes the estimated annualized cost of this Regulatory Alternative under consideration. At a 3 percent discount rate, exposure monitoring costs less than it does for the final rule. However, this lower monitoring cost is more than offset by the increased control costs necessitated by the requirement that mines maintain respirable crystalline silica exposure levels below 25 μg/m³. At an estimated annualized cost of $520.7 million, this alternative would cost nearly six times more than the final requirements.

Table IX-30: Summary of Part 60 Annualized Compliance Costs (in millions of 2022 dollars) Under Regulatory Alternative 2 and New Requirements: All Mines

Mine Sector	0 Percent Discount Rate		3 Percent Discount Rate		7 Percent Discount Rate	
	Annualized Cost	Percent of New Requirements	Annualized Cost	Percent of New Requirements	Annualized Cost	Percent of New Requirements
Regulatory Alternative 2: Changes in PEL and Sampling and Evaluation Requirements						
Exposure Monitoring	$32.17		$31.67		$30.80	
Exposure Controls	$367.52		$461.48		$604.06	
Respiratory Protection	$8.90		$8.75		$8.50	
Medical Surveillance	$18.82		$18.84		$18.82	
Total, Part 60 Costs	***$427.41***	***488.0%***	***$520.73***	***584.8%***	***$662.17***	***727.1%***
New Requirements						
Exposure Monitoring	$51.60		$53.24		$55.64	
Exposure Controls	$13.79		$13.66		$13.40	
Respiratory Protection	$3.38		$3.32		$3.22	
Medical Surveillance	$18.82		$18.84		$18.82	
Total, Part 60 Costs	***$87.59***	***100.0%***	***$89.05***	***100.0%***	***$91.07***	***100.0%***

c. Avoided Mortality and Morbidity Under Regulatory Alternative 2

Regulatory Alternative 2 increases miner protection by establishing the PEL at 25 μg/m³, resulting in measurable increases in avoided mortality cases and other health benefits. Table IX–31 presents the avoided morbidity and mortality cases over the 60-year regulatory analysis time horizon under this alternative. Under this alternative, 1,271 mortality cases are expected to be avoided, which is 2.4 times higher than the 531 mortality cases expected to be avoided under the new PEL (50 μg/m³). Additionally, 2,521 morbidity cases are expected to be avoided under this alternative, which is 1.4 times higher than the 1,836 morbidity cases expected to be avoided under the new PEL (50 μg/m³).

Table IX-31: Estimated Cases of Avoided Mortality and Morbidity over 60 Years (Regulatory Analysis Time Horizon) Following Compliance with the Rule Under Regulatory Alternative 2

Health Outcome	Total Avoided Cases over 60 Years[1]		
	MNM	Coal	Total
Avoided Morbidity			
Silicosis	2,239	282	2,521
Avoided Morbidity Total (Net of Silicosis Deaths)	**2,239**	**282**	**2,521**
Avoided Mortality			
NMRD (net of silicosis mortality)	527	77	605
Silicosis	267	34	301
ESRD	249	36	286
Lung Cancer[2]	70	10	80
Avoided Mortality Total	**1,114**	**158**	**1,271**

Notes:

1. Avoided cases include both production and contract miners. Calculations show the difference between excess cases when assuming compliance with the existing limits versus assuming compliance with the new PEL of 50 μg/m³. Estimates account for the fact that some miners during the 60-year period will have worked under the existing standards (and thus may have combination of exposures under the existing standards and the new PEL), while other new entrants into the mining workforce would be solely exposed under the new PEL.
2. A 15-year lag between exposure and observed health effect was assumed for lung cancer estimates.

d. Monetized Benefits Under Regulatory Alternative 2

Table IX–32 presents the monetized benefits associated with this avoided morbidity and mortality. The expected total benefits, discounted at 3 percent, are $516.3 million, which is more than twice the expected total benefits of $246.9 million under the new PEL (50 μg/m³).

Under this Regulatory Alternative, these benefits are made up of $369.0 million due to avoided mortality, $47.3 million due to avoided morbidity preceding mortality, and $100.0 million due to avoided morbidity not preceding mortality. However, when compared to the annualized costs of $520.7 million (3 percent) and $662.2 million (7 percent) for the Part 60 requirements, the net benefits of this alternative are negative at a 3 percent and 7 percent discount rate.

Table IX-32: Annualized Monetized Benefits over 60 Years (Regulatory Analysis Time Horizon) Following the Start of Implementation of the Rule (in millions of 2022 dollars) Under Regulatory Alternative 2, by Health Outcome and Discount Rate

Health Outcome	MNM			Coal			Total		
	0%	3%	7%	0%	3%	7%	0%	3%	7%
Avoided Morbidity (Not Preceding Mortality)									
Silicosis (Excluding Silicosis Deaths)	$124.6	$88.7	$55.5	$15.7	$11.3	$7.2	$140.3	$100.0	$62.7
Avoided Morbidity (Not Preceding Mortality) Total	**$124.6**	**$88.7**	**$55.5**	**$15.7**	**$11.3**	**$7.2**	**$140.3**	**$100.0**	**$62.7**
Avoided Mortality									
NMRD (Excluding Silicosis Deaths)	$252.9	$151.2	$69.0	$36.9	$22.2	$10.3	$289.8	$173.3	$79.3
Silicosis	$121.5	$80.1	$44.8	$15.2	$10.4	$6.1	$136.7	$90.5	$50.9
ESRD	$118.8	$72.0	$34.5	$17.2	$10.6	$5.3	$136.0	$82.6	$39.7
Lung Cancer	$34.5	$19.8	$8.1	$4.8	$2.8	$1.2	$39.3	$22.5	$9.3
Avoided Mortality Total	**$527.7**	**$323.1**	**$156.4**	**$74.1**	**$46.0**	**$22.8**	**$601.8**	**$369.0**	**$179.2**
Avoided Morbidity (Preceding Mortality)									
NMRD (Excluding Silicosis Deaths)	$29.3	$18.9	$9.6	$4.3	$2.8	$1.5	$33.6	$21.7	$11.1
Silicosis	$14.8	$10.9	$7.0	$1.9	$1.4	$1.0	$16.7	$12.3	$8.0
ESRD	$13.9	$9.2	$5.0	$2.0	$1.4	$0.8	$15.9	$10.5	$5.8
Lung Cancer	$3.9	$2.4	$1.1	$0.5	$0.3	$0.2	$4.5	$2.7	$1.2
Avoided Morbidity (Preceding Mortality) Total	**$62.0**	**$41.3**	**$22.7**	**$8.8**	**$5.9**	**$3.4**	**$70.7**	**$47.3**	**$26.1**
Grand Total	**$714.2**	**$453.1**	**$234.7**	**$98.6**	**$63.2**	**$33.4**	**$812.8**	**$516.3**	**$268.0**

A professional association, American Industrial Hygiene Association, expressed support for Regulatory Alternative 2 (Changes in Sampling and Evaluation Requirements and the Proposed PEL) (Document ID 1351). However, the commenter recommended that mine operators be required to (1) conduct baseline sampling and periodic sampling, (2) conduct semi-annual or more frequent evaluations of changing conditions, and (3) sample as frequently as necessary to determine the adequacy of controls. In addition, the commenter stated that, under this alternative, mine operators should be required to perform post-evaluation sampling when the operators determine from the semi-annual evaluation that miners are exposed at the 95-percent confidence level to respirable crystalline silica above the PEL of 50 μg/m³, referencing a NIOSH Occupational Sampling Strategy Manual.

e. Net Benefits Under Regulatory Alternative 2

Although the benefits associated with this avoided morbidity and mortality under Regulatory Alternative 2 (Table IX–31 and Table IX–32) are greater than those for the final rule, the net benefits of this alternative are negative at both a 3 percent and 7 percent real discount rate owing to the much higher compliance costs for this alternative as compared to those for the final rule (Table IX–31). Further, MSHA determines that meeting a PEL of 25 μg/m³ is not achievable for all mines and therefore, Regulatory Alternative 2 is not chosen.

3. Regulatory Alternative 3: Changes in the Calculation of Exposure Concentrations

Regulatory Alternative 3 calculates exposure concentrations as an entire-shift time-weighted average, called a ''full shift TWA''. Under this Regulatory Alternative, a different methodology is used for calculating exposures and assessing compliance. Elsewhere in the final rule, the costs and benefits are based on calculating exposure for a full shift, calculated as an 8-hour TWA. In this Regulatory Alternative, MSHA calculates exposure as a full shift TWA and re-analyzes the costs and benefits of the rule. No other changes, such as changes to the rule requirements, are included under this Regulatory Alternative.

a. Number of Mines Affected Under Regulatory Alternative 3

MSHA expects a change in the number of affected mines. MSHA has estimated the number of mines expected to incur costs when baseline exposure concentrations are re-calculated as full shift TWAs. Based on the use of a full shift TWA, MSHA finds that 1,053 mines operating in 2019 would incur costs to purchase, install, and operate exposure controls under the final rule. Of this total, 955 are MNM mines and 98 are coal mines. This total is 173 fewer mines than what would incur new compliance costs under an 8-hour TWA (1,226 affected mines).

b. Estimated Costs Under Regulatory Alternative 3

Aside from the change to the calculation of exposure concentrations and the number of affected mines at those concentrations, MSHA does not make any additional changes in assumptions or calculations under this Regulatory Alternative. Therefore, the cost estimates of this Regulatory Alternative are calculated using the same methodology as described in Section 4 of the FRIA. The changes in cost estimates are completely attributable to changes in the estimated baseline exposure conditions and the total number of affected mines, as described in Section 7.3.1 of the FRIA.

Table IX–33 below presents the estimated annualized compliance costs of part 60 if exposure concentrations were calculated using a full shift TWA instead of a full shift, 8-hour TWA.

Total part 60 annualized compliance costs are estimated at $86.4 million (at a 3 percent discount rate), with 92.3 percent of costs attributable to MNM mines and 7.7 percent attributable to coal mines. This is $2.7 million (3.0 percent) less than the total part 60 annualized compliance costs when using an 8-hour TWA ($89.1 million). The difference is explained by the decreased number of mines and miners who are affected by the rule under this Regulatory Alternative as compared to the main analysis.

Table IX-33: Summary of Part 60 Annualized Compliance Costs (in millions of 2022 dollars) Under Regulatory Alternative 3 and New Requirements: All Mines

Mine Sector	Annualized Cost		
	0 Percent Discount Rate	3 Percent Discount Rate	7 Percent Discount Rate
Alternative Exposure Calculated Using Full Shift TWA			
Exposure Monitoring	$50.71	$52.05	$54.02
Exposure Controls	$12.70	$12.57	$12.32
Respiratory Protection	$2.95	$2.90	$2.81
Medical Surveillance	$18.82	$18.84	$18.82
Total, Part 60 Costs	***$85.17***	***$86.35***	***$87.97***
Final Rule: Exposure Calculated Using Full Shift, 8-hour TWA			
Exposure Monitoring	$51.60	$53.24	$55.64
Exposure Controls	$13.79	$13.66	$13.40
Respiratory Protection	$3.38	$3.32	$3.22
Medical Surveillance	$18.82	$18.84	$18.82
Total, Part 60 Costs	***$87.59***	***$89.05***	***$91.07***

c. Avoided Mortality and Morbidity Under Regulatory Alternative 3

While the compliance costs decrease when a full shift TWA is used, the estimated benefits of the rule are also expected to decrease. When miners work shifts that are longer than 8 hours (which commonly occurs, as seen both in the exposure data and in the employment data), the full shift, 8-hour TWA will result in a higher calculated exposure level than the full shift TWA.

Table IX–34 presents the estimated number of avoided deaths and illnesses during the 60 years following the start of implementation of the new rule, under the Regulatory Alternative. The total number of avoided morbidity cases over the 60-year analysis period is 1,500, which is 18 percent lower under the Regulatory Alternative than the estimate of 1,836 avoided morbidity cases in the main analysis (see Table IX–24). The total number of avoided mortality cases over the 60-year analysis period is 434, which is 18 percent lower under the Regulatory Alternative than the estimate of 531 avoided mortality cases in the main analysis (see Table IX–24).

Table IX-34: Estimated Cases of Avoided Mortality and Morbidity over 60 Years (Regulatory Analysis Time Horizon) Following Compliance with the Rule Under Regulatory Alternative 3

Health Outcome	Total Avoided Cases During 60 Years Following the Start of Implementation of the Rule [a]		
	MNM	Coal	Total
Morbidity			
Silicosis	1,392	108	1,500
Morbidity Total (Net of Silicosis Deaths)	**1,392**	**108**	**1,500**
Mortality			
NMRD (net of silicosis mortality)	198	15	213
Silicosis	105	7	112
ESRD	75	5	80
Lung Cancer [b]	28	2	30
Mortality Total	**405**	**29**	**434**

Notes: [a] Avoided cases include both production and contract miners. Calculations show the difference between excess cases when assuming compliance with the existing limits versus assuming compliance with the new PEL of 50 μg/m^3. Estimates account for the fact that some miners during the 60-year period will have worked under the existing standards (and thus may have combination of exposures under the existing standards and the new PEL), while all new entrants into the mining workforce would be solely exposed under the new PEL.

[b] A 15-year lag between exposure and observed health effect was assumed for lung cancer estimates.

d. Monetized Benefits Under Regulatory Alternative 3

Table IX–35 presents the annualized benefits of the final rule under this Regulatory Alternative. The undiscounted annualized benefits under the Regulatory Alternative are estimated at $312.8 million, with $291.5 million attributable to MNM mines and $21.3 million attributable to coal mines. The discounted annualized benefits under the Regulatory Alternative are estimated at $201.9 million at a 3 percent discount rate and $107.9 million at a 7 percent discount rate. At a 3 percent discount rate, the annualized benefits are $45.0 million (18 percent) less under the Regulatory Alternative than when using an 8-hour TWA ($246.9 million). The annualized benefits under the Regulatory Alternative are also 18 percent lower both at the 0 percent discount and 7 percent discount rates.

BILLING CODE 4520–43–P

Table IX-35: Annualized Monetized Benefits over 60 Years (Regulatory Analysis Time Horizon) Following the Start of Implementation of the Rule (in millions of 2022 dollars) Under Regulatory Alternative 3, by Health Outcome and Discount Rate

Health Outcome	MNM			Coal			Total		
	0%	3%	7%	0%	3%	7%	0%	3%	7%
Avoided Morbidity (Not Preceding Mortality)									
Silicosis (Net of Silicosis Mortality)	$77.4	$55.2	$34.5	$6.0	$4.3	$2.8	$83.5	$59.5	$37.3
Avoided Morbidity (Not Preceding Mortality) Total	**$77.4**	**$55.2**	**$34.5**	**$6.0**	**$4.3**	**$2.8**	**$83.5**	**$59.5**	**$37.3**
Mortality									
NMRD (Excluding Silicosis Deaths)	$94.9	$56.6	$25.6	$7.1	$4.3	$1.9	$102.0	$60.9	$27.5
Silicosis	$47.6	$31.6	$18.0	$3.1	$2.1	$1.3	$50.7	$33.7	$19.3
Renal Disease	$35.4	$21.7	$10.6	$2.5	$1.5	$0.8	$37.9	$23.3	$11.4
Lung Cancer	$13.62	$7.8	$3.2	$0.99	$0.6	$0.2	$14.6	$8.4	$3.4
Avoided Mortality Total	**$191.5**	**$117.7**	**$57.4**	**$13.7**	**$8.5**	**$4.2**	**$205.2**	**$126.2**	**$61.6**
Avoided Morbidity (Preceding Mortality)									
NMRD (Excluding Silicosis Deaths)	$11.0	$7.1	$3.5	$0.8	$0.5	$0.3	$11.8	$7.6	$3.8
Silicosis	$5.8	$4.3	$2.9	$0.4	$0.3	$0.2	$6.2	$4.6	$3.1
Renal Disease	$4.2	$2.8	$1.5	$0.3	$0.2	$0.1	$4.5	$3.0	$1.7
Lung Cancer	$1.5	$0.9	$0.4	$0.1	$0.1	$0.0	$1.7	$1.0	$0.4
Avoided Morbidity (Preceding Mortality) Total	**$22.5**	**$15.1**	**$8.4**	**$1.6**	**$1.1**	**$0.6**	**$24.2**	**$16.2**	**$9.0**
Grand Total	**$291.5**	**$188.0**	**$100.2**	**$21.3**	**$13.9**	**$7.6**	**$312.8**	**$201.9**	**$107.9**

BILLING CODE 4520–43–C

e. Net Benefits Under Regulatory Alternative 3

The net annualized benefits under the Regulatory Alternative are $226.5 million (undiscounted), $114.3 million (3 percent discount rate), and $18.6 million (7 percent discount rate). The net benefits under the Regulatory Alternative are lower than those in the main analysis by 23 percent (0 percent discount rate), 27 percent (3 percent discount rate), and 53 percent (7 percent discount rate).[97]

MSHA received comments both in agreement with the Agency's proposed ''full-shift, 8-hour TWA'' calculation method and against it. Commenters in favor stated that the proposed calculation method of collecting a sample for a full-shift and calculating the exposure level over an 8-hour period (*i.e.,* normalizing a longer work shift to an 8-hour shift) capture the total cumulative exposure to silica dust properly. Those against the proposal preferred the use of the entire duration of the miner's extended work shift without any adjustment, and stated that normalizing the extended shift sampling result to an 8-hour period inaccurately skews the results. For more details on the comments received, please see section VIII.B.3 of this preamble.

The Agency does not choose Regulatory Alternative 3, that uses full shift TWA as an alternate calculation of exposure concentration. Regulatory Alternative 3 yields much smaller net benefits than the final rule. Importantly, Regulatory Alternative 3 would provide miners less health protection. Cumulative exposure to respirable crystalline silica is an important risk factor in the development of silica-related disease, as discussed in the standalone FRA document and section VIII.B.3.c of this preamble. However, the full shift TWA methodology does not account for the increased health risks associated with the higher cumulative exposures that can occur during longer work shifts. The full shift TWA calculation does not differentiate between the impacts of working 8-hour shifts and working extended shifts. Regulatory Alternative 3 would provide less protection for miners working longer shifts.

[97] There are limitations in how the risk calculations can be performed because of limitations in the underlying exposure-response models from the literature. The exposure-response models were not designed to detect the impact of longer work shifts, nor were they based on longitudinal data that could track individuals' work shifts over their careers. These calculations presented in this Alternative analysis provide new estimates of avoided cases when calculating exposure as a full shift TWA and when accounting for the fact that fewer samples would meet the threshold of the new PEL or the new action level under a full shift TWA.

X. Final Regulatory Flexibility Analysis

A. The Regulatory Flexibility Act

The Regulatory Flexibility Act of 1980 as amended by the Small Business Regulatory Enforcement Fairness Act of 1996, hereafter jointly referred to as the RFA, requires that an agency consider the economic impact that a final rulemaking will have on small entities. The RFA provides that, ''[w]hen an agency promulgates a final rule under section 553 of this title, after being required by that section or any other law to publish a general notice of proposed rulemaking . . . the agency shall prepare a final regulatory flexibility analysis.'' 5 U.S.C. 604(a). However, under section 605(b), in lieu of an initial regulatory flexibility analysis (IRFA) or final regulatory flexibility analysis (FRFA), the head of an agency may certify that the final rule ''will not, if promulgated, have a significant economic impact on a substantial number of small entities.'' 5 U.S.C. 605(b). That certification must be supported by a factual basis.

As part of its notice of proposed rulemaking, MSHA prepared an IRFA that analyzed the potential impact of the proposed rule on small entities. *See* 5 U.S.C. 603(a). After considering public comments on the IRFA, MSHA believes that the final rule will not have a significant economic impact on a substantial number of small entities. However, in the furtherance of good governance principles and consistent with guidance from the Small Business Administration (SBA), the Agency has prepared a FRFA. Under section 604(a), the FRFA analysis must contain:

(1) a statement of the need for, and objectives of, the rule;

(2) a statement of the significant issues raised by the public comments in response to the initial regulatory flexibility analysis, a statement of the assessment of the agency of such issues, and a statement of any changes made in the proposed rule as a result of such comments;

(3) the response of the agency to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration in response to the proposed rule, and a detailed statement of any change made to the proposed rule in the final rule as a result of the comments;

(4) a description of and an estimate of the number of small entities to which the rule will apply or an explanation of why no such estimate is available;

(5) a description of the projected reporting, recordkeeping and other compliance requirements of the rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record; and

(6) a description of the steps the agency has taken to minimize the significant economic impact on small entities consistent with the stated objectives of applicable statutes, including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why each one of the other significant alternatives to the rule considered by the agency which affect the impact on small entities was rejected; and for a covered agency, as defined in section 609(d)(2), a description of the steps the agency has taken to minimize any additional cost of credit for small entities. 5 U.S.C. 604(a).

While a full understanding of MSHA's analysis and conclusions with respect to costs and economic impacts on small entities requires a reading of the standalone FRIA document, this FRFA summarizes the key aspects of MSHA's analysis as they affect small entities.

B. Initial Assessment

As part of the proposed rule, MSHA published an IRFA. MSHA's proposed rule would affect MNM and coal mining operations. The IRFA identified which mine controllers were small entities, estimated the direct compliance costs for those small entities, and compared the compliance costs to the revenues of the small entities. Results from the IRFA are summarized below.

1. Definition of Small Entities

In its IRFA analysis, MSHA relied on the Small Business Administration (SBA)'s 2017 *Table of Size Standards* to define the size thresholds for small entities. MSHA identified small-entity controllers in each North American Industry Classification System (NAICS) code, after determining that a ''controller,'' the entity that owns and controls one or more mines, is the appropriate unit of the IRFA analysis, based on SBA guidance.[98] (SBA, 2017).[99] The IRFA detailed how SBA's size standards vary by North American Industry Classification System (NAICS) code, which NAICS codes were used in the IRFA, and which controllers were small entities according to these standards.

2. Number of Affected Small Entities

MSHA estimated that in 2021, there were a total of 11,791 mines and a total of 5,879 controllers. Of the controllers, 5,007 were small-entity controllers; these small-entity controllers owned 8,240 mines. Many controllers owned one or two mines, while some controllers owned hundreds of mines nationwide (or worldwide).

3. Results of the Initial Regulatory Flexibility Analysis

MSHA estimated the regulatory compliance costs and revenues for each of the 5,007 small-entity controllers identified in 2021. In estimating compliance costs for small-entity controllers, MSHA factored in the types of commodities that controllers produced and their employment size, which were gathered from the MSHA Standardized Information System (MSIS). MSHA estimated the revenues of the small-entity controllers based on data from the Statistics of U.S. Businesses published by the U.S. Census Bureau, using NAICS codes and each controller's employment size.[100] MSHA then calculated the compliance costs as a proportion of revenues and used that as an indicator of the relative burden of the compliance costs for small-entity controllers.

From these two sets of estimates, MSHA generated estimates of the ratios of regulatory compliance cost to revenue for each controller. Table X–1 shows the number of controllers, average annual regulatory costs, average annual

[98] Small Business Administration, Office of Advocacy, *How to Comply with the Regulatory Flexibility Act,* August 2017.

[99] A controller is a parent company owning or controlling one or more mines, whereas a mine is an establishment of a parent company. Small entities subject to the requirements of the Regulatory Flexibility Act are entities that are parent companies only and not establishments. *See* Small Business Administration, Office of Advocacy, How to Comply with the Regulatory Flexibility Act, August 2017. Sec. 3(d) of the Mine Act defines ''operator'' as ''any owner, lessee, or other person who operates, controls, or supervises a coal or other mine.'' 30 U.S.C. 802(d). Under 30 CFR part 41, an operator must file a legal identity report with MSHA, and with this report, MSHA identifies a controller for each mine. 30 U.S.C. 819(d) (each operator shall file the name and address of the ''person who controls or operates the mine''). In the FRFA, consistent with SBA guidance and the Mine Act, MSHA determines whether the controller is a small entity.

[100] U.S. Census Bureau, ''Statistics of U.S. Businesses,'' released May 2021. *https://www.census.gov/data/tables/2017/econ/susb/2017-susb-annual.html* (last accessed Jan. 10, 2024). Data in the report were in reference to the year 2017, which MSHA adjusted to 2021 dollars. Data on revenues are presented in the report under the equivalent term ''receipts.'' MSHA converted the 2017 revenues to 2021 dollars using the GDP Implicit Price Deflator published by the Bureau of Economic Analysis October 26, 2022, Table 1.1.9 Implicit Price Deflators for Gross Domestic Product, Series A191RD. *https://apps.bea.gov/histdata/fileStructDisplay.cfm?HMI=7&DY=2022&DQ=Q3&DV=Advance&dNRD=October-28-2022* (last accessed Jan. 10, 2024). The index was 107.749 for 2017 and 118.895 for 2021, creating an adjustment factor (from 2017 to 2021 dollars) of 118.895/107.749 or 1.103.

revenues, and average cost as a percent of revenue presented in the IFRA. As shown in Table X–1, for every $1 million in revenue earned by a small-entity controller, the average compliance cost was estimated to be $1,220.

Table X-1: Summary of the IRFA Findings: Annualized Compliance Costs to Revenues for a Typical Small-Entity Controller

	Number of Small-Entity Controllers	Average Annual Regulatory Cost Per Small-Entity Controller (in 2021 $) at a 3 Percent Discount Rate	Average Annual Revenue Per Small-Entity Controller (in 2021 $)	Average of Cost as a Percent of Revenue (Unweighted Average of the Percentages Among All Small-Entity Controllers)[1]
Coal Small-Entity Controllers	235	$ 3,191	$ 12,816,000	0.025
MNM Small-Entity Controllers	4,772	$ 4,250	$ 3,822,000	0.127
Total	5,007	$ 4,200	$ 4,243,000	0.122

1. Note that because the column displays the unweighted average of the controller-level percentages across all controllers, it is not equivalent to the ratio of the average cost among all controllers and the average revenue among all controllers in the previous two columns.

C. MSHA Compliance With RFA Requirements

1. Outreach and Small Business Advocacy Review

On July 13, 2023, MSHA published its notice of proposed rulemaking in the **Federal Register**. The proposed rule was also posted on *Regulations.gov* and on MSHA's website to ensure that members of the public, including small businesses, had more than one way to access the proposal. Prior to publication, MSHA made an informal copy of the proposed rule available on the Agency's website to provide small businesses and other stakeholders with additional time to become familiar with the proposal. MSHA also reached out to mining labor and industry stakeholders, public interest groups, and trade associations, notifying them of the upcoming publication of the proposed rule. Some of these stakeholders represented small businesses.

During the public comment period, MSHA held three public hearings (virtual and in-person)—in Arlington, Virginia (on August 3, 2023), Beckley, West Virginia (on August 10, 2023), and Denver, Colorado (on August 21, 2023)—to facilitate the participation of the public, small businesses and organizations that represent them, and all other stakeholders.

On August 30, 2023, MSHA attended a Small Business Labor Safety Roundtable organized by the SBA's Office of Advocacy to discuss the proposal. The Roundtable was also attended by the small business community and representatives from industry and labor. MSHA provided education about the NPRM's content at this roundtable.[101]

[101] MSHA considered the testimonies from the public hearings and written comments submitted to the docket for its development of the final rule, but not the discussion at the Roundtable. For transparency, however, MSHA makes the materials presented at the Roundtable available in the docket at *Regulations.gov.*

2. Final Regulatory Flexibility Analysis

a. Objectives of, and Need for, the Final Rule

Based on its review of the health effects literature, MSHA determined that occupational exposure to respirable crystalline silica causes silicosis and other diseases. In its FRA, MSHA also determined that, under existing standards, miners face a risk of material impairment of health or functional capacity from exposures to respirable crystalline silica.

Following these determinations, MSHA is issuing a final rule to better protect miners against occupational exposure to respirable crystalline silica, a carcinogen, and to improve respiratory protection for airborne contaminants. The final rule will affect both MNM and coal mining operations.

The final rule establishes, for mines of all sizes, a PEL of 50 μg/m³ for a full-shift exposure, calculated as an 8-hour TWA, and an action level of 25 μg/m³ for a full-shift exposure, calculated as an 8-hour TWA. In addition to the PEL and action level, the rule includes provisions for methods of compliance, exposure monitoring, corrective actions, respiratory protection, medical surveillance for MNM mines, and recordkeeping. MSHA also amends existing standards for other airborne contaminants to replace requirements for respiratory protection and incorporates by reference ASTM F3387–19 *Standard Practice for Respiratory Protection* to update existing respiratory protection standards. The final rule will significantly improve health protections for all miners over the course of their working lives.

b. The Agency's Response to Public Comments

MSHA received written comments from trade associations representing small businesses or small mines (Document ID 1406; 1408; 1411; 1413; 1415; 1422; 1424; 1427; 1430; 1435; 1436; 1441; 1448; 1453; 1456; 1300; 1302; 1303; 1349; 1368; 1369; 1378; 1383; 1392; 1398). The Agency also received a letter from the Deputy Chief Counsel and Assistant Chief Counsel for Advocacy of the SBA requesting a 60-day extension of the public comment period to give small businesses more time to comment and provide small business representatives time to consult their membership about their operations and how the proposed rule would impact them.

On August 14, 2023, MSHA published a notice in the **Federal Register** extending the comment period by changing the closing date from August 28, 2023, to September 11, 2023 (88 FR 54961).

Commenters raised concerns about MSHA's estimates of the proposed rule's costs and impacts. MNM operators, mining and industry trade associations, and a mining related business stated that MSHA had underestimated the costs of the proposal for small mines (Document ID 1427; 1430; 1435; 1436 1448; 1456; 1392). Commenters, including mining related businesses, MNM operators, and mining trade associations, also stated that, for some mines, there would be high costs of initial compliance or high costs of annual compliance thereafter (Document ID 1408; 1411; 1415; 1427; 1430; 1435; 1436; 1448; 1453; 1456; 1383; 1392). Commenters including mining trade associations and MNM operators cited the cost of obtaining equipment and services needed to establish sampling and medical surveillance programs, as well as the cost of implementing engineering controls (Document ID 1408; 1411; 1415; 1427; 1435; 1436; 1441; 1448; 1392). MNM operators, mining trade associations, and other mine organizations commented on the costs of lab fees, respirators, and travel to undergo medical examinations for medial surveillance (Document ID 1408; 1411; 1415; 1435; 1436; 1448; 1453; 1378; 1392). Several MNM operators and a mining-related business stated that compliance with the proposal would substantially increase their water costs (Document ID 1411; 1415; 1427; 1435; 1436; 1392). Some commenters including a mining-related business, mining trade associations, MNM operators, and other mine industry organizations noted that the costs of compliance would be higher for small mines operating in remote locations (Document ID 1408; 1411; 1415; 1422; 1424; 1453; 1378; 1392). A mining trade association and a mining-related business stated that MSHA failed to consider that some small mines might go out of business due to being unable to afford to comply with the new rule, which would result in losses to local economies (Document ID 1429; 1368; 1392).

Taking these comments into consideration, MSHA changed its compliance dates and other requirements, which resulted in revisions to some of previous cost estimates. MSHA's cost estimates are detailed in Section 4 of the standalone FRIA document. MSHA believes its cost estimates for sampling, exposure controls, laboratory fees, and medical surveillance are accurate for small-entity controllers. As explained in Section 8 of the standalone FRIA document, MSHA adjusted some compliance costs upwards in response to commenters; in particular, sampling and exposure control costs. MSHA incorporated these adjusted costs in the cost estimates for small entities. In the FRFA methodology, the compliance costs that were derived in the FRIA, per mine employee, were estimated for specific size categories of mines, and for the type of commodity produced in the mine.[102] Based on these costs, and the number of employees at mines, MSHA estimated the average, expected compliance cost for each small-entity controller in 2021. These are average costs, which will vary among small-entity controllers. However, overall, MSHA believes that these estimates support the conclusion that the compliance costs incurred by small-entity controllers, on average, will be a small fraction of the revenue that small controllers earn from their operations. MSHA found that, among small-entity controllers, the compliance costs of the final rule represent, on average, about 0.318 percent of the revenues that small entities earn. MSHA concluded that these compliance costs are generally unlikely to have significantly negative economic impacts on small-entity controllers or on local economies.

MSHA understands that some small-entity controllers might have high initial capital investments for the installation of new engineering controls. However, high initial capital expenses, in general, are not uncommon in mining operations, especially with regard to the purchase of major units of equipment for engineering controls. Because these new engineering controls will last for many years, their purchase is comparable to any other type of investment in physical capital, for mining operations, that will be either paid directly or financed through periodic payments. If they are paid directly, this would be a one-time payment to cover several years, resulting in a lower cost per year. If the payment is financed, the annual (or monthly) costs will be much lower as well. Because these costs, on an annual basis, as determined by the useful life of the engineering controls, will be much lower than the initial investment, and these annual costs will be a small fraction of the revenues earned in those years, MSHA believes these new engineering controls will not, on average, be significantly burdensome to small-entity controllers. Moreover, MSHA expects that many of the mines that implement new engineering controls will be able to discontinue sampling once exposure levels are reduced below the action level. Thus, even mines with higher initial expenditures are unlikely to also have high annual costs thereafter.

MSHA acknowledges the concerns from small mine operators in rural and remote areas. Because of the nature of mining, many mine operators, including small-entity operators, operate in rural and remote areas. MSHA believes that this final rule will not present major logistical challenges for small mine operators. As MSHA has stated in *Section VIII.A. General Issues,* once the final rule is implemented, the Agency will provide compliance assistance, including training and best practice materials, to all mine operators, with an emphasis on small operators.

A mining-related business noted that the IRFA included no estimates of indirect costs of the rule (Document ID 1392). Examples of such costs cited by the commenter included lost

[102] These size categories were mines with 20 or fewer employees, 21–100 employees, 101–500 employees, and over 500 employees.

production, the expenses of employees traveling to medical examinations, and impacts on local communities of reductions in charitable donations by operators.

MSHA considered the comment that the rule might lead to lost production. MSHA is providing additional compliance time for mine operators, including small-entity controllers, to prepare for the final rule's requirements. The extended compliance period under the final rule (24 months after the publication date for MNM operators and 12 months after the publication date for coal operators) provides additional time for mine operators to comply with the requirements, such as implementing engineering controls and finding appropriate resources (industrial hygienists, medical facilities, laboratories, sampling devices, etc.). This extended compliance period is intended to provide industry additional time for planning. For example, a MNM small entity mine operator could use the increased time to identify and implement engineering controls to reduce miners' exposures.

As in the IRFA, the FRFA includes the travel expenses related to miners' time lost due to travelling to medical examinations and their transportation costs. Regarding the costs of travel time to medical examinations, MSHA believes its estimates of the average travel time spent to and from medical examinations and the related cost are reliable, though it should be recognized that these are averages and that travel times could be different for different mines.

MSHA considered the comment that the rule could incur ''costs to communities'' by making it harder for mine operators to make charitable donations to those communities. MSHA has not included charitable donations from operators in its analysis, as charitable donations are voluntary. MSHA believes that the final rule will benefit communities because the health and safety of miners is greatly improved. In this regard, MSHA's final rule is expected to have a net beneficial effect on mining communities through the improved health of miners, which should reduce the need for charitable support. Details on the revised estimates are provided in *Section X.D. Analysis of Small Business Impacts.*

c. Description of the Number of Small Entities to Which the Final Rule Will Apply

The final rule, like the proposed rule, will affect MNM and coal mining operations. As in its IRFA, MSHA considered a controller (parent company) that owns and operates one or more mines as the appropriate unit of this FRFA.

To determine the number of small entities subject to the final rule, MSHA used SBA's 2023 Size Standards and other guidance from the Office of Advocacy such as how to determine if a government entity is a small entity, NAICS codes, and MSIS, which identifies mines and their numbers of employees working at mines.

MSHA estimated that the number of small-entity controllers in 2021 was 5,462 out of the total number of controllers (5,879). The 5,462 small-entity controllers owned a total of 9,395 mines out of a total of 12,529 mines owned by all controllers in 2021.[103] The estimated number of small-entity controllers reflects an increase from 5,007 in the IRFA; this revision is due to the use of more current NAICS codes and more current SBA size standards. In addition, MSHA performed a more thorough analysis of potential enterprises that might be small but had not been estimated as small in the IFRA, such as small local governments that owned mines.

In analyzing controllers of mines, MSHA determined that mining operations subject to the final rule would fall under 19 NAICS codes. These industry categories and their accompanying six-digit NAICS codes are shown in Table X–2.[104] MSHA then matched the NAICS codes with SBA small-entity size standards (based on the number of employees) to determine the number of small entities within each of the respective NAICS codes. MSHA then counted the number of small-entity controllers in each NAICS code, after determining which controllers owned which mines. Many controllers owned one or two mines, while some controllers owned hundreds of mines nationwide (or worldwide).[105] [106] Table X–2 shows the count of all controllers and a count of small-entity controllers in each NAICS code.

Table X–2 presents the distribution of controllers by the one NAICS code for which they have the most employees, because some controllers are in more than one mining NAICS code.

BILLING CODE 4520–43–P

[103] The total number of mines (12,529) was updated in the FRFA based on additional analysis of the data.

[104] The NAICS classifications used in this analysis are drawn from the latest version of the NAICS, which was effective in July 2022. MSHA also used, in the analysis, an earlier version of NAICS categories that was effective in August 2019. MSHA had begun developing this analysis prior to the most current NAICS being effective. The older NAICS categories were still used in the part of the current analysis that estimated revenues. This is because the older categories were still needed in order for MSHA to cross-tabulate (or crosswalk) its data on mines and controllers with Bureau of Census data on revenues by NAICS codes, where these Census data were organized by the same NAICS codes that were in the earlier version. No comparable revenue data, at this writing, had yet been revised to the most recent NAICS categories.

[105] The number of controllers and mines examined in this regulatory flexibility analysis are those specifically known to operate in 2021. The year 2021 is the most current year for which complete information was available. Such information about controllers as parent companies might include, for example, knowledge of whether the parent company is a large, multinational corporation, which would then have bearing on this regulatory flexibility analysis.

[106] Each mine is assigned only one NAICS code, reflecting the commodity that mine primarily produces. There are several cases in which more than one mine, owned by the same controller, have different NAICS codes, so that there are different NAICS codes for that one controller. In particular, of the 5,879 unique controllers identified in 2021, 608 of them each had mines that had different NAICS codes. In theory, this could present an ambiguity as to whether a controller with more than one NAICS code should be considered a small entity or not. Since NAICS codes vary by their small-entity thresholds, it is theoretically possible for a controller with more than one NAICS code to be a small entity according to the threshold for one of its NAICS codes, while not being a small entity according to a lower threshold for a different one of its NAICS codes. However, this situation was not found to occur for any of the mine controllers; all controllers that were determined to be small entities met the conditions for a small entity for each of their NAICS codes.

Table X-2: Small Entities Affected by the Final Rule: Distribution of Controllers by NAICS Category, with One NAICS Code Per Controller[1]

NAICS Code	Industry Description	SBA Size Standards in Maximum Number of Employees[2]	Number of All Controllers	Number of Small-Entity Controllers
211120	Crude Petroleum Extraction[3]	1,250	3	3
211130	Natural Gas Extraction[3]	1,250	1	0
212114	Surface Coal Mining	1,250	246	218
212115	Underground Coal Mining	1,500	93	75
212210	Iron Ore Mining	1,400	19	18
212220	Gold Ore and Silver Ore Mining	1,500	98	82
212230	Copper, Nickel, Lead, and Zinc Mining	1,400	31	25
212290	Other Metal Ore Mining	1,250	14	12
212311	Dimension Stone Mining and Quarrying	500	415	382
212312	Crushed and Broken Limestone Mining and Quarrying	750	716	675
212313	Crushed and Broken Granite Mining and Quarrying	850	133	130
212319	Other Crushed and Broken Stone Mining and Quarrying	550	617	596
212321	Construction Sand and Gravel Mining	500	3,046	2,839
212322	Industrial Sand Mining	750	120	113
212323	Kaolin, Clay, and Ceramic and Refractory Minerals Mining	650	108	101
212390	Other Nonmetallic Mineral Mining and Quarrying	600	108	95
327310	Cement Manufacturing	1,000	61	49
327410	Lime Manufacturing	1,050	48	47
331313	Primary production of alumina and aluminum	1,300	2	2
	Total		5,879	5,462

1. Each controller is assigned the one NAICS code for which it devotes the most employees, based on the employees at its mines and each of its mines being associated with only one NAICS code.
2. SBA, effective March 17, 2023, https://www.sba.gov/document/support-table-size-standards, last updated October 25, 2023.
3. These categories are commonly associated with mines with activities involving crude petroleum or natural gas extraction, but the mines in these categories that are counted here, and included in this analysis, also involve mining operations that would fall under MSHA's jurisdiction. This analysis does not include crude petroleum or natural gas extraction (and the mines that perform them exclusively) since MSHA does not regulate these activities.

BILLING CODE 4520–43–C

d. Reporting, Recordkeeping, and Other Compliance Requirements of the Final Rule

The final rule not only establishes a PEL of 50 μg/m³ and an action level of 25 μg/m³ for respirable crystalline silica, but also includes provisions for methods of compliance, exposure monitoring, corrective actions, respiratory protection, and medical surveillance for MNM mines. Under the final rule, mine operators are required to install, use, and maintain feasible engineering and administrative controls to keep each miner's exposure to respirable crystalline silica at or below the PEL. Mine operators are required to conduct sampling to assess miners' exposure to respirable crystalline silica. MNM operators are required to provide to all miners, including those who are new to the mining industry, periodic medical examinations performed by a PLHCP or specialist, at no cost to the miner. This requirement will ensure that MNM miners, like coal miners, are able to monitor their health and detect early signs of respiratory illness.

In addition, the final rule creates new information collection requirements for mine operators. As described in greater detail in *Section XI. Paperwork Reduction Act,* operators are required to collect information involving: (1) exposure monitoring, (2) corrective actions, (3) respiratory protection, and (4) medical surveillance for MNM mines. (Table XI–1 in that section displays an estimate of the annualized information collection burden for the whole mining industry.)

e. Steps the Agency Has Taken To Minimize the Economic Impact on Small Entities

In response to commenters who expressed concerns that the rule would lead to excessive demand and backlogs for sampling devices, industrial hygienists, labs, medical facilities, and NIOSH B Readers, MSHA adjusted the requirements in the final rule to provide additional time for small-entity controllers and other controllers, to prepare for compliance (24 months after publication of the final rule for MNM mines and 12 months after publication of the final rule for coal mines). MSHA is allowing this longer period for compliance because MNM operators, particularly small-entity controllers, may have less experience with sampling and may also need time to prepare for compliance with medical surveillance. For coal mines, the delayed compliance period gives operators sufficient time to plan and prepare for effective compliance with the new standards, while also ensuring that improved protections for miners from the hazards of respirable crystalline silica take effect as soon as practically possible. For additional details on the compliance dates, see *Section VIII.B. Section-by-Section Analysis.*

MSHA will also provide compliance assistance to small-entity controllers and the mining community overall (including industry and labor) after publication of the final rule. This assistance will include guidance to assist mine operators in developing and implementing appropriate controls; outreach seminars (onsite and virtual, dates and locations will be posted on MSHA's website); dust control workshops at the National Mine Health and Safety Academy; support from the Educational Field and Small Mine Services staff; support from MSHA's Technical Support staff; silica training and best practice materials; and information on MSHA's enforcement efforts.

MSHA examined three possible regulatory alternatives to this final rule and considered how they could affect small-entity controllers.

Under Regulatory Alternative 1, the PEL would remain unchanged at 50 μg/m3 and the action level would remain unchanged at 25 μg/m3. Further, mine operators would conduct: (1) first-time and second-time sampling for miners who may be exposed to respirable crystalline silica at or above the action level of 25 μg/m3, (2) periodic sampling twice per year, and (3) an annual evaluation of changing mining processes or conditions that would reasonably be expected to result in new or increased respirable crystalline silica exposures. Under Regulatory Alternative 2, the PEL would be set at 25 μg/m3; mine operators would install whatever controls are necessary to meet the PEL; and there would not be an action level. Further, mine operators would (1) not be required to conduct any sampling, but they would be required to (2) conduct periodic evaluations of changing conditions and (3) sample as frequently as necessary to determine the adequacy of controls.

MSHA determined that the final rule will provide improved health protections for miners and will be achievable for all mines, including those that are owned and operated by small entities. MSHA has made the following determinations regarding the three alternatives considered:

- Regulatory Alternative 1, ''Changes in Sampling and Evaluation Requirements,'' would reduce overall costs to the mining industry by 26.9 percent for costs calculated at a 3 percent, and by 26.4 percent for costs calculated at a 7 percent discount rate. These reduced costs would be proportionally experienced by small entities. The average costs as a percent of revenues for small entities would then be reduced (relative to the final rule) from 0.318 percent to 0.232 percent based on a 3 percent discount rate, or to 0.234 percent based on a 7 percent discount rate.
- Regulatory Alternative 2, ''Changes in Sampling and Evaluation Requirements and the Proposed PEL,'' would increase overall costs to the mining industry by 484.8 percent for costs calculated at a 3 percent discount rate, and by 627.1 percent for costs calculated at a 7 percent discount rate. The average costs as a percent of revenues for small entities would then rise (relative to the final rule) from 0.318 percent to 1.859 percent based on a 3 percent discount rate, and from 0.318 percent to 2.31 percent based on a 7 percent discount rate.
- Regulatory Alternative 3, ''Changes in the Calculation of Exposure Concentrations,'' would change the methodology used for calculating exposures and assessing compliance to a full shift TWA, rather than a full-shift exposure, calculated as an 8-hour TWA. MSHA estimated that this alternative would decrease overall costs to the mining industry by 3.02 percent for costs calculated at a 3 percent discount rate, and by 3.41 percent for costs calculated at a 7 percent discount rate. The average costs as a percent of revenues for small entities would then fall from 0.318 percent to 0.308 percent based on a 3 percent discount rate, and to 0.307 percent based on a 7 percent discount rate.

Regulatory Alternative 1 would reduce the costs to small entities. However, the final rule will better protect miners from exposures to respirable crystalline silica. The final rule's exposure monitoring requirements are necessary to ensure that miners' health is adequately protected. MSHA determined that Regulatory Alternative 1 would not protect miners' health. The final rule's exposure monitoring requirements, including monitoring on a more frequent basis, will provide mine operators with greater confidence that they are in compliance with the final rule.

Regulatory Alternative 2 would increase costs to small entities, making it an unsuitable choice for small mines. Additionally, this alternative would not be achievable for all mines because a PEL of 25 μg/m^3, while technically feasible, is not practical for all mines.

Regulatory Alternative 3 would reduce the costs to small entities. However, the final rule will better protect miners by using an exposure calculation method that recognizes the importance of cumulative exposure to respirable crystalline silica being an important risk factor in the development of silica-related disease. Regulatory Alternative 3 does not take into account the increased health risks associated with the higher cumulative exposures that can occur during longer work shifts, and, therefore, is less protective for those miners who work longer shifts. A more in-depth discussion of the costs associated with each regulatory alternative is presented in *Section IX. Summary of Final Regulatory Impact Analysis and Regulatory Alternatives* and the standalone FRIA document.

D. Analysis of Small Business Impacts

1. Data and Methodology

a. Average Annual Cost per Small-Entity Controller

Because the controllers vary in the scale of their mining operations, MSHA first estimated regulatory costs on a per-miner basis. MSHA anticipated that the regulatory costs per miner would vary across the six major commodity categories: coal, metal, nonmetal, stone, crushed limestone, and sand and gravel.[107] The differences in regulatory costs by commodity reflect the varying levels of expected exposure to silica, as calculated in the FRIA.

MSHA examined employment data for each controller. By combining this information with per-mine compliance cost information, MSHA derived estimates of the regulatory costs for each of the 5,462 small-entity controllers identified in 2021. See the average annual regulatory cost per controller in Table X–3.

The compliance burden on the controllers, large and small, consists primarily of the costs of additional dust control measures, exposure monitoring, medical surveillance for MNM mines, and other program activities needed to comply with the rule. For costs estimates by component, by commodity, and by mine size, please see Section 4 of the standalone FRIA document.

b. Average Annual Revenue per Small-Entity Controller

MSHA estimated revenues for each small-entity controller. The Agency estimated revenues per employee, by mine, and by controller, using data published by the U.S. Bureau of Census in their report, ''Statistics of U.S. Businesses'' (SUSB).[108] The SUSB data provided revenue estimates for enterprises (mines) in each NAICS code and for each ''size category'' (based on number of employees) within each NAICS code.[109]

Some of the small-entity controllers have operations in non-mining industries. Non-mining revenues are not accounted for in this analysis, as the data was not available. If non-mining revenues were accounted for, the ratio of regulatory costs to revenues shown in the summary table would be even smaller.

MSHA calculated the number of mining employees for each small-entity controller, and for each NAICS category (for mining NAICS) within each controller's activities. MSHA then combined these data with SUSB data on revenues by NAICS category and size category to generate estimated revenues for each small-entity controller. See the estimated average annual revenue per controller in Table X–3.

c. Average of Cost as a Percent of Revenue (Among Small-Entity Controllers)

MSHA estimated the average annual regulatory cost per small-entity controller, as well as the average annual revenue per small-entity controller. MSHA estimated, for each controller, the annual compliance cost of the final rule as a proportion of that controller's annual revenue.

2. Economic Analysis Results

Based on the methodology described above, MSHA generated estimates of the ratios of regulatory compliance cost to revenue for each controller. Table X–3 shows the number of controllers, average annual regulatory costs, average annual revenues, and average cost as a percent of revenue.

BILLING CODE 4520–43–P

[107] MSHA also anticipated that regulatory costs would vary by the size of the mine in terms of the number of miners, with the size categories of: (1) 20 or fewer miners, (2) 21–100 miners, (3) 101–500 miners, and (4) over 500 miners.

[108] U.S. Census Bureau, ''Statistics of U.S. Businesses,'' released May 2021. *https://www.census.gov/data/tables/2017/econ/susb/2017-susb-annual.html* (last accessed Jan. 10, 2024). Data in the report were in reference to the year 2017, which MSHA adjusted to 2021 dollars. Data on revenues are presented in the report under the equivalent term ''receipts.'' MSHA converted the 2017 revenues to 2022 dollars using Price Indexes for Gross Domestic Product, Bureau of Economic Analysis, Table 1.1.4. *https://apps.bea.gov/iTable/?reqid=19&step=3&isuri=1&1910=x&0=-99&1921=survey&1903=4&1904=2009&1905=2018&1906=a&1911=0* (last accessed Jan. 10, 2024). The index was 100 for 2017 and 117 for 2021, creating an adjustment factor (from 2017 to 2022 dollars) of 1.118.

[109] In a small number of cases (in terms of NAICS codes and size categories) the SUSB data were incomplete. In these cases, MSHA imputed revenue/employee ratios based on closely related data for comparable NAICS-size categories. MSHA then used these imputed revenue/employee ratios to estimate the revenues of some small-entity controllers, by the methodology just described.

Table X-3: Annual Compliance Costs to Revenues for a Typical Small-Entity Controller

	Number of Controllers	Average Annual Regulatory Cost Per Small-Entity Controller (in 2022 $)	Average Annual Revenue Per Small-Entity Controller (in 2022 $)	Average of Cost as a Percent of Revenue (Unweighted Average of the Percentages Among All Small-Entity Controllers)[2]	Average of Cost as a Percent of Revenue (Unweighted Average of the Percentages Among Small-Entity Controllers with 5 or Fewer Employees)[2]
Coal Small-Entity Controllers[1]	293	$9,542	$26,857,599	**0.0710**	0.066
MNM Small-Entity Controllers[1]	5,169	$11,110	$5,461,261	**0.332**	0.307
Total	5,462	$11,026	$6,609,033	**0.318**	0.299

1. If a controller has both coal and MNM mines, the controller is categorized based on the NAICS code with the most employees.
2. Note that because the column displays the unweighted average of the controller-level percentages across all controllers, it is not equivalent to the ratio of the average cost among all controllers and the average revenue among all controllers in the previous two columns.

BILLING CODE 4520–43–C

MSHA estimated that the final rule would have an average cost, per small-entity controller, of $11,026 per year in 2022 dollars. The estimated costs for the final rule represent the costs necessary for small-entity mine operators to achieve full compliance with the final rule.[110]

From the cost and revenue estimates described above, MSHA estimated the ratio of annual regulatory cost to annual revenue for each small-entity controller. As shown in Table X–3, the average of these proportions (weighting controllers equally) was 0.318 percent. In other words, for every $1 million in revenue earned by a small-entity controller, the average compliance cost was estimated to be approximately $3,000. This compliance cost-to-revenue ratio is slightly lower for controllers with five or fewer employees (0.299), implying that the low compliance cost-to-revenue ratios are generally applicable for the smallest of the small-entity controllers. The low cost-to-revenue ratio of these controllers with five or fewer employees is due largely to the estimated annual revenues of these controllers averaging above $1 million in 2022 dollars, in comparison to their estimated compliance costs averaging approximately $3,000 per year.

MSHA believes that the Agency could certify the economic impact of this final rule on small entities, however, in the interest of public disclosure and transparency, the Agency prepared a full analysis to inform the public of its decision-making process.

XI. Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3501–3521) provides for the Federal Government's collection, use, and dissemination of information. The goals of the Paperwork Reduction Act include minimizing paperwork and reporting burdens and ensuring the maximum possible utility from the information that is collected under 5 CFR part 1320. The Paperwork Reduction Act requires Federal agencies to obtain approval from the Office of Management and Budget (OMB) before requesting or requiring "*a collection of information*" from the public.

As part of the Paperwork Reduction Act process, agencies are generally required to provide a notice in the **Federal Register** concerning each proposed collection of information to solicit, among other things, comment on the necessity of the information collection and its estimated burden, as required in 44 U.S.C. 3506(c)(2)(A). To

[110] MSHA estimated the costs of the rule for small-entity controllers by summing the costs for each of these controller's mines. The estimated cost for each mine was based on the number of miners and the mine's industry category. A controller's estimated cost was the sum of costs for each of its mines. Similarly, the estimated revenues of a controller was the sum of the revenues of each of its mines.

comply with this requirement, MSHA published a notice of proposed collection of information in the Agency's notice of proposed rulemaking on July 13, 2023 (88 FR 44852). MSHA solicited comment on the proposed information collection requirements and provided an opportunity for comments to be sent directly to OMB. MSHA also prepared and submitted an information collection request (ICR) to OMB for the collection of information requirements identified in the proposal for OMB's review in accordance with 44 U.S.C. 3507(d).

MSHA has made several additions and changes to the proposed rule and methodology that have paperwork burden implications. Key additions include the immediate reporting of samples over the PEL to MSHA, reporting chest X-ray classification results to NIOSH, as well as a written respiratory protection program consistent with the requirements of ASTM F3387–19. Key changes include certain compliance dates, sampling requirements, medical examination dates for current miners, as well as the frequency of periodic evaluations and post-evaluation recordkeeping. Each addition and change and reasons for each are discussed in detail in *Section VIII.B. Section-by-Section Analysis.* The Agency has also changed the compliance dates from the proposed rule to provide mine operators adequate preparation time to comply effectively with the final rule's requirements.

A. Responses to Comments

MSHA sought comment on the utility of the recordkeeping requirements in part 60. MSHA received multiple comments on the proposed recordkeeping requirements, with several commenters supporting MSHA's proposed recordkeeping provisions or recommending that records have a longer retention period than proposed. None of the comments addressed the methodology, assumptions, or calculations made in the Paperwork Reduction Act portion of the proposal.

This section presents a summary of the comments received and the Agency's responses. *Section VIII.B.9. Section 60.16—Recordkeeping Requirements* provides a more detailed summary of the comments related to recordkeeping and MSHA's responses.

The NSSGA stated that MSHA should adopt the same rule as the Occupational Safety and Health Administration's (OSHA) 2016 Silica Rule since some companies have OSHA and MSHA regulated facilities (Document ID 1448). This commenter stated that MSHA's silica rule with different requirements than OSHA creates excessive, unnecessary paperwork for these companies.

The Agency clarifies that the Mine Act gives MSHA jurisdiction over each MNM or coal mine and each operator of such mine. The mining industry is different from the industries that are subject to OSHA's standards. MSHA did consider and adopt, as appropriate, some of OSHA's regulatory approach to controlling workers' exposures to respirable crystalline silica in developing its final rule. This final rule will better protect miners against occupational exposure to respirable crystalline silica, a carcinogenic hazard, and improve respiratory protection for airborne contaminants miners encounter. Nonetheless, the Agency has developed the rule's paperwork requirements to minimize burden on mine operators.

For records retained under proposed paragraphs 60.16(a)(1) through (3)—evaluation records, sampling records, and corrective action records, respectively—many commenters, including labor organizations, advocacy organizations, and a MNM mine operator, recommended that record retention periods should be extended beyond the proposed requirements, especially for MNM mines (Document ID 1416; 1417; 1425; 1439; 1447; 1449). A miner health advocate recommended that sampling records under § 60.16(a)(2) be preserved for as long as the mine is in operation instead of the 2-year proposed requirement (Document ID 1372). Additionally, Appalachian Voices recommended that the records under § 60.16(a)(2) should be retained for longer than the life of the mine operation (Document ID 1425).

In response to comments requesting an increase in the record retention period, in the final rule, MSHA increases the record retention period for evaluation, sampling, and corrective actions records in paragraphs (a)(1) to (3) to at least 5 years. The 5-year record retention period for evaluation, sampling, and corrective actions records is consistent with the 5-year record retention period for operator samples collected while monitoring for airborne exposure to diesel particulate matter in underground metal and nonmetal mines (§ 57.5071(d)(2)) and other injury and illness reports required under section 50.40. MSHA concludes in this final rule that a 5-year retention period for the records retained under paragraphs § 60.16(a)(1) through (3) is effective in providing information for the protection of miners. This is because the evaluation, § 60.16(a)(1), and sampling, § 60.16(a)(2), records can identify a change in operation that might lead to increased exposures to respirable crystalline silica. Similarly, the 5-year recordkeeping requirement for corrective action records under § 60.16(a)(3) is intended to help the operator and MSHA identify the effectiveness of existing controls, or the need for maintenance or additional control measures. In MSHA's experience, recent records can more effectively assist MSHA and mine operators in achieving these goals. MSHA believes the 5-year retention period achieves the proper balance between the operator's burden to maintain records and the effective utility of older records to mine operators, miners, and MSHA.

For records retained under proposed paragraphs § 60.16(a)(4) and (5)—written determination and medical opinion records, respectively, received from a PLHCP or specialist—some commenters such as a medical professional organization, a public health advocacy organization, and labor unions also suggested an increased retention period to help miners diagnosed with silica-related health conditions request workers' compensation claims (Document ID 1416; 1425; 1373; 1437; 1412; 1398; 1447). A labor union recommended that medical surveillance data collected by mine operators should be kept for the duration of a miner's employment plus 20 or 30 years and for the records to be provided to the miner upon termination of employment (Document ID 1398). MSHA concludes in this final rule that it is appropriate to retain determination and medical opinion records, which have very limited medical information only relevant to the miner's ability to wear a respirator, for the duration of the miner's employment plus 6 months because the miner may need to wear a respirator at some point without notice. The requirement to retain records for an additional 6 months beyond the miner's employment gives miners more time to request records once they terminate their employment at the mine.

A commenter (NVMA) asked for clarification on the medical surveillance recordkeeping requirements, stating that the rule does not include provisions requiring tracking of miners' silica exposure throughout their careers and noting that miners often change companies over the course of their careers (Document ID 1441). MSHA clarifies that mine operators do not have access to a miner's medical information and, therefore, do not maintain a record of such information. Instead, the mine operator will retain a record of the date of the medical examination, a statement that the examination has met the requirements of this section, and any recommended limitations on the miner's use of respirators. Each miner, or the miner's physician or other designee at the request of the miner, will have access to all medical examination results.

Two commenters including a labor union also suggested that corrective action records and cumulative exposure records be submitted to MSHA, miner representatives, or miners (Document ID 1447; 1439). After considering the comments, MSHA determined that it is not necessary to change the requirement of providing all the listed records promptly upon request to miners, authorized representatives of miners, and authorized representatives of the Secretary of Labor. This is because the requirement to provide all the listed records promptly upon request ensures that miners and MSHA will have access to records as needed can facilitate enforcement and transparency. Because miners, miners' representatives, and MSHA can request the records at any time for their own recordkeeping purposes, MSHA does not believe it is necessary to have operators submit the records to miners and MSHA without request. However, in response to comments, the final rule requires mine operators to immediately report all exposures above the PEL from operator sampling to the MSHA District Manager or to any other MSHA office designated by the District Manager. This modification will allow the Agency to promptly address overexposures as appropriate. As discussed below, this change from the proposal presents a modest increase in the estimated paperwork burden.

The final rule requires a new information collection as well as modifications to existing collections. As required by the Paperwork Reduction Act, the Department has submitted information collections, including a new information collection and revisions of two existing collections, to OMB for review to reflect new burdens and changes to existing burdens. Once OMB completes its review, the Agency will publish a notice on the new information collection under OMB Control Number 1219–0156. (The regulated community is not required to respond to any collection of information unless it displays a current, valid, OMB Control Number.)

B. New Information Collection Under Part 60, Respirable Crystalline Silica

Under final part 60, certain new burdens apply to all mine operators, and other burdens apply to only some mine operators. Section 60.16 lists all the recordkeeping requirements related to part 60. Each of the requirements are discussed below:

Section 60.12 requires mine operators to make a record for each sampling and each periodic evaluation conducted pursuant to the section. The samplings identified in § 60.12(a) include: sampling by the compliance date (§ 60.12(a)(1)), an additional sampling (§ 60.12(a)(2)), above-action-level-sampling (§ 60.12(a)(3)), corrective actions sampling (§ 60.12(b)), and post-evaluation sampling (§ 60.12(d)). The sampling record consists of the sampling date, the occupations sampled, and the concentrations of respirable crystalline silica and respirable dust, and the mine operator must also retain laboratory reports on sampling results under § 60.12(g).

In a change from the proposal, under final § 60.12(c), the periodic evaluations must be conducted at least every 6 months or whenever there is a change in: production; processes; installation and maintenance of engineering controls; installation and maintenance of equipment; administrative controls; or geological conditions; mine operators shall evaluate whether the change may reasonably be expected to result in new or increased respirable crystalline silica exposures. The periodic evaluation record includes the evaluated change, the impact on respirable crystalline silica exposure, and the date of the evaluation under § 60.12(c)(1). In addition, the mine operator is required to post the sampling and evaluation records and the laboratory report on the mine bulletin board and, if applicable, by electronic means, for 31 days, upon receipt under § 60.12(c)(2).

The mine operator must immediately report all exposures above the PEL to the MSHA District Manager or to any other MSHA office designated by the District Manager under § 60.12(b). A corrective action must be taken immediately to lower the concentration of respirable crystalline silica to at or below the PEL, once a sample reporting exposure above the PEL is recorded. The corrective actions record must include the corrective actions taken, including any related respirator use by affected miners, and the dates of the corrective actions under § 60.13(c). All records must be retained for at least 5 years from the date of each sampling, evaluation, or corrective action.

Section 60.14(b) requires mine operators to temporarily transfer a miner either to work in a separate area of the same mine or to an occupation at the same mine where respiratory protection is not required if the miner has a written determination from the PLHCP that the miner is unable to wear a respirator. Section 60.16(a)(4) requires the written determination record to be retained for the duration of a miner's employment plus 6 months. In a change from the proposal, final § 60.14(c)(2) requires mine operators to have a written respiratory protection program that meets the following requirements in accordance with ASTM F3387–19: program administration; written standard operating procedures; medical evaluation; respirator selection; training; fit testing; maintenance, inspection, and storage.

Section 60.15 requires MNM mine operators to provide miners periodic medical examinations at no cost to the miner. Section 60.15(d)(1) requires the mine operator to ensure that the results of medical examinations or tests are provided from the PLHCP or specialist to the miner within 30 days of the medical examination, and, at the request of the miner, to the miner's designated physician or another designee identified by the miner. Section 60.15(d)(2) requires MNM mine operators to ensure that, within 30 days of the medical examination, the PLHCP or specialist provides the results of chest X-ray classifications to the National Institute for Occupational Safety and Health (NIOSH), once NIOSH establishes a reporting system. Mine operators are required to obtain a written medical opinion from the PLHCP or specialist within 30 days of a miner's medical examination. The written medical opinion must contain only the date of the medical examination, a statement that the examination has met the requirements of the section, and any recommended limitations on the miner's use of respirators under § 60.15(e). The written medical opinion record must be retained by MNM mine operators for the duration of a miner's employment plus 6 months under § 60.15(f).

C. Existing Information Collections

The final rule results in changes to two existing information collection packages: a non-substantive change to information collection package under OMB Control Number 1219–0011, Respirable Coal Mine Dust Sampling; and a substantive change to information collection package under OMB Control Number 1219–0048, Respirator Program Records. This is a change from the proposal, which only contained non-substantive changes to existing information collections.

Non-substantive changes to OMB Control Number 1219–0011 involve references to respirable dust when quartz is present in the respirable coal mine dust standard. OMB Control Number 1219–0011 involves records for quarterly sampling of respirable dust in coal mines. MSHA's standards require that coal mine operators sample respirable coal mine dust quarterly and submit these samples to MSHA for analysis to determine if the mine is complying with the respirable coal mine dust standards. The supporting statement references quartz and a reduced standard for respirable dust when quartz is present. Since the final rule eliminates the reduced standard and establishes a separate standard for respirable crystalline silica, MSHA will make a non-substantive change to the supporting statement by removing such references. However, there will be no changes from the proposal in paperwork burden and costs in this information collection because the change only contains non-substantive changes to existing information collections.

OMB Control Number 1219–0048 involves recordkeeping requirements under 30 CFR parts 56 and 57 for MNM mines when respiratory protection is used. Under the final rule, MSHA updates the existing respiratory protection standard and requires a written respiratory protection program that meets the following requirements in accordance with ASTM F3387–19: program administration; written standard operating procedures; medical evaluation; respirator selection; training; fit testing; maintenance, inspection, and storage. This substantive change will result in an increase in the paperwork burden and costs associated with respiratory protection in the existing information collection.

D. Information Collection Requirements

1. New Information Collection 1219–0156

Type of Review: New Collection.
OMB Control Number: 1219–0156.
Title: Respirable Crystalline Silica Standard.

Description of the ICR: The final rule on respirable crystalline silica contains information collection requirements on sampling, periodic evaluations, medical examinations, and respirator protection practices. The collected information will assist miners and mine operators in tracking actual and potential miners' occupational exposure to respirable crystalline silica, and identifying possible actions taken to control such exposure.

There are provisions of this rule that will take effect at different times after the date of publication of this rule, and there are information collection provisions that will have different respondents, responses, burden hours, and costs in each year. Therefore, this ICR estimates the first 3 years of compliance.

There were changes in this ICR between the proposed and final rule based on changes in methodology and the rule text. Based on changes to § 60.1 in the final rule, MNM mines are not expected to begin implementing the rule until year 2. This change decreases the recordkeeping burden for all cost items in the final rule. In the proposed rule, operators were allowed to use historical and objective data instead of a second-time sampling. In the final rule, every mine is required to conduct a first-time and second-time sampling, thereby increasing the related time burden. The methodology for calculating corrective actions samples and post-evaluation samples was also changed, leading to an increased time burden for both. Additionally, based on changes to § 60.12(b) in the final rule, operators are now required to notify MSHA after every overexposure.

The inclusion of ASTM F3387–19 costs in this ICR was a result of a change in the rule text between the proposed rule and final rule. In the proposed rule, operators could choose which ASTM F3387–19 elements to adopt. In the final rule, mine operators must have a written respiratory protection program that meets an explicit set of requirements in accordance with ASTM F3387–19. This change leads to a substantial increase in the recordkeeping burden for this ICR. Lastly, the addition of § 60.15(d)(2) in the final rule, which requires the mine operator to ensure that a miner's PLHCP or specialist provides the results of chest X-ray classifications to the National Institute for Occupational Safety and Health (NIOSH), created a new recordkeeper cost.

Summary of the Collection of Information

Highlighted below are the key assumptions, by provision, used in the burden estimates in Table XI–1:

a. Section 60.12—Exposure Monitoring

ICR. Section 60.12 requires mine operators to make a record for each sampling, corrective actions sampling, periodic evaluation, and post-evaluation sampling. Per § 60.1, the compliance date for MNM mines begins one year after the compliance date for coal mines.

Number of respondents. For § 60.12, the respondents consist of all active mines, because operators of active mines are assumed to perform sampling and conduct periodic evaluations. MSHA counts the number of active mines in 2019, defining an active mine as one that had at least 520 employment hours (equivalent to 1 person working full time for a quarter of a year) in at least one quarter of 2019. Using this definition, MSHA estimates that a total of 12,631 mines (11,525 MNM mines and 1,106 coal mines) will generate sampling and evaluation records.

Annual number of responses. Annual responses are summed from several separate activities including: all types of sampling (*e.g.,* the first-time/second-time sampling, above-action-level sampling, corrective actions sampling, and post-evaluation sampling), and periodic evaluations. The estimated average annual number of responses is 199,817, including 52,587 first-time and second-time samples (the first sample is taken by the compliance date or within 6 months after beginning operations and the second-time sample is taken within 3 months after the first sample), 44,253 above-action-level samples, 50,834 corrective action samples and MSHA notifications, 12,766 post-evaluation samples, and 39,377 periodic evaluation recordings and postings. Details of each type of sampling and periodic evaluations are discussed below.

First-time sampling and second-time sampling apply to every coal and MNM mine. However, a certain number of mines are predicted to be able to discontinue sampling if the results of these samples are below the action level. Furthermore, subsequent to Year 1 for Coal, and Year 2 for MNM, all first-time and second-time sampling will only be performed by new mines. MSHA projects that about 2 percent of mines in any given year will be new entrants to the mining industry. MSHA assumes that all active coal mines (1,106 mines) will conduct first-time and second-time sampling in year 1 of compliance (producing 29,796 samples). In years 2 and 3, an estimated 22 new coal mines will conduct first-time and second-time sampling (producing 596 samples each year). Similarly, MSHA assumes that all 11,525 MNM mines will conduct first-time and second-time sampling in year 2 of compliance (producing 124,288 samples). In year 3, 231 new MNM mines will conduct first-time and second-time sampling (producing 2,486 samples). MSHA estimates that an annual average of 52,587 first-time and second-time samples will be collected in the first 3 years of compliance.

The estimated number of above-action-level sampling is calculated based on the following factors: the number of miners with sampling results at or above the action level (25 μg/m^3) but at or below the permissible exposure limit (PEL) (50 μg/m³), the percent of miners needed for representative samples, and the number of quarters in a year that mines will be in operation. Estimation of above-action-level sampling does not include costs related to first-time sampling and second-time sampling. MSHA has revised its methodology from the proposal, increasing the number of corrective actions samples to account for some operators needing multiple corrective actions samples before obtaining a sample below the PEL. The estimated number of samples is based only on previous operator samples, not ones from MSHA inspectors. MSHA does not expect above-action-level sampling to begin until the second half of year 1 for coal mines. MSHA estimates there will be 5,423 above-action-level coal samples in the second half of year 1. Due to the projected decrease in the share of samples over the action level for coal mine compliance due to more mines engaging in increased administrative controls and frequent maintenance and repair, the number of above-action-level coal samples is projected to decrease to 10,556 in year 2 and 10,170 in year 3. A more detailed discussion is provided in Section 4.2 of the standalone FRIA document. MSHA expects above-action-level sampling to begin in the second half of year 2 for MNM mines, resulting in the number of above-action-leveling samples increasing from 37,719 in the second half of year 2 to 68,892 in all of year 3. Consequently, MSHA estimates that an annual average of 44,253 above-action-level samples will be collected from coal and MNM mines in the first 3 years of compliance.

MSHA estimates that an annual average of 731 active mines (604 MNM and 127 coal) will carry out an annual average of 25,417 corrective actions (22,152 MNM and 3,265 coal) due to overexposure, and these mines will then conduct corrective actions sampling for each corrective action. Miner operators will have to immediately notify MSHA about each overexposure. MSHA estimates that an annual average of 25,417 corrective action notifications will be sent to MSHA.

Next, MSHA assumes that all 1,106 coal mines will record periodic evaluation results approximately 2.4 times, on average, per year, and then post those results on a mine bulletin board, or if applicable, by electronic means. In a change from the proposal, MSHA increased its estimate for the number of periodic evaluations from about 2 per year to about 2.4 per year, a 20 percent increase. This was done for two reasons. First, § 60.12(c) now requires periodic evaluations at least every 6 months after commencing sampling or whenever there is a change in production; processes; installation or maintenance of engineering controls; installation or maintenance of equipment; administrative controls; or geological conditions. Second, MSHA now accounts for portable mines, which move frequently and are therefore more likely to experience one of the changes noted in § 60.12(c). A more thorough explanation for this calculation can be found in Section 4.2 of the standalone FRIA document.

The number of records for periodic evaluation in coal mines is 2,449 each year. All 11,525 MNM mines will record periodic evaluation results approximately 2.4 times, on average, a year, and then post those results on a mine bulletin board, or if applicable, by electronic means, starting in year 2. The number of records for periodic evaluation in MNM mines is 0 for year 1, and 25,859 for years 2 and 3. Mine operators will also post results of each periodic evaluation on mine bulletin boards, creating an annual average of 19,688 records (2,449 in year 1, 28,308 in year 2, and 28,308 in year 3). Additionally, MSHA estimates mines will conduct post-evaluation sampling as a result of their periodic evaluations, resulting in an annual average of 12,766 sampling records (8,376 for MNM mines and 4,390 for coal mines). MSHA estimates an annual average of 39,377 periodic evaluation recordings and postings and 12,766 post-evaluation samples.

The assumption for calculating corrective actions samples and post-evaluation samples was changed from the proposal. In the proposed rule, the number of corrective actions samples was combined with the number of post-evaluation samples and their sum was assumed to be equivalent to a constant 2.5 percent of all miners per periodic evaluation. In the final rule, the number of corrective actions samples is based on the projected share of samples over the PEL, increased by 25 percent to account for some operators needing multiple samples before obtaining a sample below the PEL, while the number of post-evaluation samples alone is now equivalent to 2.5 percent of miners per periodic evaluation. The change in methodology is intended to made estimates more consistent with existing sampling data. In year 1 for coal mines and year 2 for MNM mines, they will sample for only half a year. See Section 4.2 of the standalone FRIA document for more details.

Estimated annual burden. The estimated average annual burden is 41,781 hours, including 13,147 hours for first-time and second-time sampling, 11,063 hours for above-action-level sampling, 8,472 for corrective actions sampling, 5,907 hours for periodic evaluations recording and posting, and 3,192 hours for post-evaluation sampling.

MSHA estimates that it takes 15 minutes to record the sampling results, 15 minutes to record the results of a periodic evaluation, 5 minutes to notify MSHA after an overexposure, and 3 minutes to post each of the evaluation results on the mine bulletin board, and, if applicable, by electronic means.

b. Section 60.13—Corrective Actions

ICR. Section 60.13 requires mine operators to make approved respirators available to affected miners and immediately take corrective actions to lower the concentration of respirable crystalline silica to at or below the PEL if any sampling indicates overexposure. Once corrective actions are taken, the mine operator is expected to make a record of corrective actions. As per § 60.1, the compliance date for MNM mines begins one year after the compliance date for coal mines. Based on changes to MSHA's methodology, there is no longer a separate paperwork burden related to respirator records. In the proposal, MSHA estimated an annual average of 5,685 records of miners who are provided respirator until corrective actions are complete. In the final rule, MSHA does not treat the paperwork burden of respirator records as a separate cost. Instead, it is assumed to be part of the corrective action records. Hence, the paperwork burden of respirator records is not a separate cost.

Number of respondents. For § 60.13, only those mines with at least one miner exposure above the PEL are assumed to carry out the requirement. MSHA estimates that an annual average of 731 active mines (604 MNM mines and 127 coal mines) will require corrective actions, starting in the second half of year 1 for coal mines and second half of year 2 for MNM mines. This change from the proposed rule is based on MSHA's new methodology for calculating corrective actions samples, which required updating corrective actions calculations to be consistent with that methodology. In the proposal, corrective actions samples were combined with post-evaluation samples, accounting for 2.5 percent of all miners per periodic evaluation. The number of respondents was assumed to be one-fourth of the number of responses for each full year of sampling. In the final rule, the overexposure rate is expected to decrease linearly in the first several years after the start of implementation of the rule. As a result, the number of corrective actions respondents is assumed to start with the current number of operators with an overexposure in their last sampling event from an MSHA inspector (as of 2019 for MNM mines and 2021 for coal mines) and falls each year based on the decreasing overexposure rate in each year. Additionally, some operators are expected to need multiple corrective actions before they carry out a sample below the PEL, thereby increasing the number of corrective actions by 25 percent.

Annual number of responses. The estimated average annual number of responses is 25,417 (22,152 MNM and 3,265 coal). MSHA assumes that each corrective actions sample, whose calculations are described above and in Section 4.2 of the standalone FRIA document, will be preceded by a corrective action, resulting in 25,417 corrective action records.

Estimated annual burden. The estimated average annual burden is 2,118 hours. MSHA estimates that on average it takes 5 minutes to record a corrective action and the date.

c. Section 60.14—Respiratory Protection

ICR. Section 60.14(b) requires mine operators to temporarily transfer a miner when the miner has a written determination from the PLHCP that the miner is unable to wear a respirator. Section 60.14(a) requires the temporary use of respirators in MNM mines under conditions specified in §§ 60.14(a)(1) and 60.14(a)(2). The written determination record must be retained for the duration of a miner's employment plus 6 months under § 60.16(a)(4). Section 60.14(c)(2) requires mine operators to have a written respiratory protection program that meets the following requirements in accordance with ASTM F3387–19: program administration; written standard operating procedures; medical evaluation; respirator selection; training; fit testing; maintenance, inspection, and storage, which is incorporated by reference in the final rule. As per § 60.1, the compliance date for MNM mines is one year after the compliance date for coal mines.

Number of respondents. For § 60.14(b), MSHA assumes that each mine taking a corrective action (an annual average of 604 MNM mines and 127 coal mines) will have one miner unable to wear a respirator. MSHA estimates that an additional 10 percent of MNM mines, which temporarily use respirators, will also have one miner unable to wear a respirator in years 2 and 3 (an annual average of 769 mines). Consequently, MSHA estimates that an annual average of 1,500 (1,373 MNM and 127 coal) mines will have a miner unable to wear a respirator.

This is a change from the proposal, where MSHA assumed that ⅓ of mine operators affected by respiratory protection requirements would have their miners wear respiratory protection in year 1 and 10 percent of the same mine operators would have their miners wear respiratory protection in years 2 and 3. This change is a result of MSHA updating its methodology to be consistent with the final rule requirements.

For the ASTM F3387–19 incorporation by reference under § 60.14(c)(2), MSHA assumes, to err on the side of overestimation, that a total of 3,411 mine respondents (2,305 MNM mines and 1,106 coal mines) would have respiratory protection programs. MSHA assumes that a half of the coal mines (553 mines) would write new standard operating procedures (SOPs) relating to the respiratory protection program and the remaining half (533 mines) would revise existing SOPs in year 1. New coal mines, estimated at 2 percent (22 mines), are assumed to write respiratory protection SOPs in years 2 and 3. Similarly, for MNM mines, MSHA assumes that: a half of them (1,153 mines) would write new SOPs relating to the respiratory protection program; the remaining half (1,152 mines) would revise existing SOPs in year 2; and approximately 46 new MNM mines to write respiratory protection SOPs in year 3.

The inclusion of ASTM F3387–19 costs in this ICR is a result of a change between the proposed rule and final rule. In the proposed rule, operators could choose which ASTM F3387–19 elements to adopt. In the final rule, mine operators must have a written respiratory protection program that meets the following requirements in accordance with ASTM F3387–19: program administration; written standard operating procedures; medical evaluation; respirator selection; training; fit testing; maintenance, inspection, and storage. MSHA estimates that 3,411 mines will be affected by respiratory protection requirements, an annual average of 599 existing mines will have to write new respiratory protection SOPs, and an annual average of 569 mines will have to revise existing SOPs each year.

Annual number of responses. The estimated average annual number of responses is 5,310, including 1,500 for records relating to miners' inability to wear respirators (§ 60.14(b)) and 3,810 for respiratory protection requirements of writing and updating SOPs (§ 60.14 (c)(2)). MSHA estimates that the annual average of 1,500 mines that will need records of miners' inability to wear respirators will each have one miner requiring such record, totaling 1,500 records per year (§ 60.14(b)). The annual 3,810 responses concerning § 60.14 (c)(2) are estimated in the following. First, MSHA assumes that approximately half of the 3,411 existing mine operators affected by respiratory protection requirements, as well as all new mines affected by these requirements, will have to write new respiratory protection SOPs, resulting an annual average of 599 new written SOPs (553 in year 1, 1,175 in year 2, and 68 in year 3). Second, MSHA makes a similar assumption that the other half of mines affected by respiratory protection requirements will have to revise existing ones, generating an annual average of 569 revised SOPs. Together, there will be a total of 1,168 records of new (599) and revised (569) SOPs per year. Finally, based on ASTM F3387–19 guidelines adopted in § 60.14(c)(2) of this rule, MSHA determines that existing and new mine operators will keep records of the new and revised SOPs, which results in an annual average of 2,642 records in total.

Estimated annual burden. The estimated annual burden is 11,333 hours, including 750 for records relating to miners' inability to wear respirators and 10,583 for the ASTM F3387–19 incorporation by reference. MSHA assumes it takes 30 minutes to determine and record where a miner unable to wear a respirator can be temporarily transferred either to work in a separate area of the same mine or to an occupation at the same mine where respiratory protection is not required. This will impact one miner in each of the 1,500 affected mines. MSHA estimates that, on average, it takes 4 hours for mine operators to write respiratory protection program SOPs and 1 hour to revise existing respiratory protection program SOPs. For coal mines, MSHA estimates that it takes 4 hours in year 1 and 2 hours in years 2 and 3 to carry out recordkeeping relating to the respiratory protection program SOPs. For MNM mines, MSHA estimates that it takes 4 hours in year 2 and 2 hours in year 3 to perform the same tasks.

d. Section 60.15—Medical Surveillance for Metal and Nonmetal Mines

ICR. Section 60.15 requires MNM mine operators to ensure that the results of medical examinations or tests will be provided from the PLHCP or specialist within 30 days of the medical examination to the miner, and at the request of the miner, to the miner's designated physician or another designee identified by the miner. MNM mine operators also must ensure that within 30 days of the medical examination, the PLHCP or specialist provides the results of chest X-ray classifications to NIOSH, once NIOSH establishes a reporting system [§ 60.15(d)(2)].

Also, MNM mine operators must obtain a written medical opinion from a PLHCP or specialist regarding any recommended limitations on a miner's use of respirators under § 60.15(e). The written medical opinion must contain the date of the medical examination, a statement that the examination has met the requirements of the section, and any recommended limitations on the miner's use of respirators. The written medical opinion record must be retained by MNM mine operators for the duration of a miner's employment plus 6 months under § 60.16(a)(5).

As per § 60.1, the compliance date for MNM mines begins one year after the compliance date for coal mines.

Number of respondents. Due to uncertainty regarding participation of currently employed miners, including contract workers, in medical surveillance programs, MSHA considered two rates (25 percent and 75 percent) when estimating medical surveillance costs. To be consistent with FRIA estimates, the values presented here are the average number of MNM miners between the assumed participation rates of 25 percent and 75 percent. Furthermore, MSHA expects that 50 percent of current miners will obtain their voluntary medical examinations in year 2, as that is when the compliance period begins for MNM mines. Given that the examinations for current miners do not need to be repeated until 5 years later there is no cost burden associated with this cost item in year 3. As a result, an average of 29,371 current MNM miners are estimated to receive voluntary medical examinations per year (0 in year 1, 88,112 in year 2, 0 in year 3).

MSHA further estimates that 8,392 miners each year, including contract workers, are new miners and contractors working in MNM mines and receive mandatory medical examinations. MSHA estimates that the turnover of MNM miners will be 8,392 miners per year, starting from year 2 (1/22 of the estimated total of 184,615 MNM workers, with an average number of 22 years on the job before leaving the mining industry). This results in an annual average of 5,595 MNM miners receiving mandatory medical examinations (0 in year 1, 8,392 in years 2 and 3). The estimated total respondents per year therefore will be 34,965 (= 29,371 current miners × 5,595 new miners).

Annual number of responses. The estimated annual number of responses is 34,965, including 5,595 medical opinion records for new miners and 29,371 records for current miners.

Estimated annual burden. The estimated annual burden is 8,741 hours, including 1,399 hours for new MNM miners and 7,343 hours for current MNM miners. MSHA estimates it will take 15 minutes to record the medical examination results for each of the 34,965 miners.

Total Recordkeeping Burden for Part 60

Total recordkeeping burden for Part 60 is summarized in Table XI–1.

Table XI-1: Estimated Average Annual Recordkeeping Burden for Part 60

Rule Provision	Annual Number of Respondents	Annual Number of Responses	Estimated Annual Burden (Hours)
§ 60.12 – Exposure Monitoring	12,631	199,817	41,781
§ 60.13 – Corrective Actions	731	25,417	2,118
§ 60.14 – Respiratory Protection	2,643	5,310	11,333
§ 60.15 – Medical surveillance for MNM miners	34,965	34,965	8,741
Annual Recordkeeping Total	**47,596**	**265,509**	**63,972**

Note:
The total number of respondents is not a sum of respondents from each sub-category. The respondents (mine operators) carrying out corrective actions and adhering to respiratory protection program requirements are a subset of the respondents carrying out exposure monitoring.
The responses and burden hours column totals might not add up to the sum of the items in each column due to rounding.

The total annual number of respondents is 47,596; the total annual number of responses will be 265,509; and the estimated annual burden will be 63,972 hours.

The following estimates of information collection burden are summarized in Table XI–2.

Affected Public: Businesses or For-Profit.

Estimated Number of Respondents: 1,106 respondents in year 1; 109,135 respondents in the year 2; and 21,023 respondents in year 3.

Frequency: On Occasion.

Estimated Number of Responses: 52,821 responses in year 1; 433,240 responses in year 2; and 310,467 responses in year 3.

Estimated Number of Burden Hours: 18,720 hours in year 1; 109,983 hours in year 2; and 63,215 hours in year 3.

Estimated Hour Burden Costs: $1,260,819 in year 1; $7,704,098 in year 2; and $4,238,135 in year 3.

Estimated Capital Costs to Respondents: $27,044 in year 1; $2,093,280 in year 2; and $206,725 in year 3.

Table XI-2: Summary of Information Collection Burden for Part 60

	Year 1	Year 2	Year 3	Annual Average
Number of Respondents	1,106	109,135	21,023	47,596
Number of Responses	52,821	433,240	310,467	265,509
Number of Burden Hours (Rounded)	18,720	109,983	63,215	63,972
Hour Burden Costs (Rounded)	$1,260,819	$7,704,098	$4,238,135	$4,401,018
Capital Costs to Respondents	$27,044	$2,093,280	$206,725	$775,683

The number of responses and burden hours decreased from year 2 to year 3 mainly as a result of decreases in sampling in current MNM mines. In year 2, MNM mines will conduct first-time and second-time sampling, while only a small number of new mines starting operations in year 3 are required to conduct this type of sampling. The increase in capital costs in year 2 is a result of all medical examinations for current miners taking place in that year.

For a detailed summary of the burden hours and related costs by provision, see the FRIA accompanying the final rule. The FRIA includes the estimated costs and assumptions related to the paperwork requirements under this final rule.

2. Existing Information Collection 1219–0011

Type of Review: Non-substantive change to currently approved information collection.

OMB Control Number: 1219–0011.

Title: Respirable Coal Mine Dust Sampling.

Description of the ICR

Background

In October 2022, MSHA received OMB approval for the reauthorization of Respirable Coal Mine Dust Sampling under OMB Control Number 1219–0011. This information collection request outlines the legal authority, procedures, burden, and costs associated with recordkeeping and reporting requirements for coal mine operators. MSHA's standards require that coal mine operators sample respirable coal mine dust quarterly and make records of such samples.

Summary of Changes

This non-substantive change request revises the supporting statement for this information collection request due to the establishment of a PEL for respirable crystalline silica separate from coal mine dust in this final rule. These revisions remove any reference in the information collection request to quartz or the reduction of the respirable coal mine dust standard due the presence of quartz. This change does not modify the authority, affected mine operators, or paperwork burden in this information collection request.

Summary of the Collection of Information

Changes in Burden

The calculated burden including respondents and responses remain the same.

Affected Public: Businesses or For-Profit.

Estimated Number of Respondents: 676 (0 from this rule).

Frequency: On occasion.

Estimated Number of Responses: 995,102 (0 from this rule).

Estimated Number of Burden Hours: 58,259 (0 from this rule).

Estimated Hour Burden Costs: $3,271,611 ($0 from this rule).

Estimated Capital Costs to Respondents: $29,835 ($0 from this rule).

3. Existing Information Collection 1219–0048

Type of Review: Substantive change to currently approved information collection.

OMB Control Number: 1219–0048.

Title: Respirator Program Records.

Description of the ICR

Background

Title 30 CFR parts 56 and 57 incorporate by reference requirements of ANSI Z88.2–1969, ''*Practices for Respiratory Protection.*'' Under this standard, certain records are required to be kept in connection with respirators in MNM mines. The final rule incorporates by reference ASTM F3387–19, ''*Standard Practice for Respiratory Protection,*'' in 30 CFR parts 56 and 57 to replace the Agency's existing respiratory protection standard. The final rule requires respiratory protection programs to be in writing and to meet the following requirements in accordance with ASTM F3387–19: program administration; written standard operating procedures; medical evaluation; respirator selection; training; fit testing; maintenance, inspection, and storage.

Summary of Changes

This substantive change request is to revise the supporting statement for this information collection request due to a modification of respiratory protection standard from ANSI Z88.2–1969 to ASTM F3387–19 in the final rule. These revisions require mine operators to update their respiratory protection standard and increase recordkeeping costs. The change does not modify the authority or affected mine operators but increases the paperwork burden and costs associated with respiratory protection in this information collection request.

Summary of the Collection of Information

Changes in Burden

The calculated burden including respondents and responses increases.

Affected Public: Businesses or For-Profit.

Estimated Number of Respondents: 2,305 (1,955 from this rule).

Frequency: On occasion.

Estimated Number of Responses: 43,795 (37,495 from this rule).

Estimated Number of Burden Hours: 23,626 (20,038 from this rule).

Estimated Hour Burden Costs: $1,459,309 ($1,175,211 from this rule).

Estimated Capital Costs to Respondents: $140,000 ($0 from this rule).

XII. Other Regulatory Considerations

A. National Environmental Policy Act

The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq.*), requires each Federal agency to consider the environmental effects of final actions and to prepare an Environmental Impact Statement on major actions significantly affecting the quality of the environment. MSHA has reviewed the final standard in accordance with NEPA requirements, the regulations of the Council on Environmental Quality (40 CFR part 1500), and the Department of Labor's NEPA procedures (29 CFR part 11). As a result of this review, MSHA has determined that this final rule will not have a significant environmental impact. Accordingly, MSHA has not conducted an environmental assessment nor provided an environmental impact statement.

B. The Unfunded Mandates Reform Act of 1995

MSHA reviewed this rule according to the Unfunded Mandates Reform Act of 1995 (UMRA) (2 U.S.C. 1501 *et seq.*). Under section 202(a) of the UMRA, 2 U.S.C. 1532(a), an agency must prepare a written qualitative and quantitative assessment of any regulation that may result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million (adjusted annually for inflation) or more in any one year. That threshold is $196 million as of 2023.

The statutory authority for the final rule is provided by the Mine Act under sections 101(a), 103(h), and 508. 30 U.S.C. 811(a), 813(h), and 957. MSHA implements the provisions of the Mine Act to prevent death, illness, and injury from mining and promote safe and healthful workplaces for miners. The Mine Act requires the Secretary of Labor (Secretary) to develop and promulgate improved mandatory health and safety standards to prevent hazardous and unhealthy conditions and protect the health and safety of the nation's miners. 30 U.S.C. 811(a).

MSHA concludes that the final rule would impose a federal mandate on the private sector in excess of $196 million in expenditures in one of the 60-year implementation years, as documented in the standalone FRIA document (see Table C–2, Appendix C). The expenditure burden on the private sector will be borne by mine operators. Such expenditures may include conducting exposure monitoring; selecting, improving, and implementing exposure controls; providing respiratory protection; updating respiratory protection practices in accordance with the 2019 ASTM standard; and, for MNM mine operators, making specified medical examinations available for all their miners. However, the rule will not require State, local, or tribal governments to expend, in the aggregate, $196 million or more in any one year for their commercial activities. Accordingly, the rule does not trigger the requirements of the UMRA based on its impact on State, local, or tribal governments.

Section 202(c) of the UMRA, 2 U.S.C. 1532(c), authorizes a Federal agency to prepare any written statement required under section 202(a) of the UMRA in conjunction with or as a part of any other statement or analysis that accompanies the final rule. The FRIA constitutes the written statement containing a qualitative and quantitative assessment of these anticipated costs and benefits required under Section 202(a) of the UMRA.

In addition, section 205(a) of UMRA, 2 U.S.C. 1535(a), requires MSHA to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. MSHA is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule unless the Agency publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. After considering three regulatory alternatives, this final rule presents a comprehensive approach for lowering miners' exposure to respirable crystalline silica and MSHA has determined the rule is both technologically feasible and economically justified as described in *Section VII. Feasibility.* A full discussion of the alternatives considered is presented in *Section IX. Summary of the Final Regulatory Impact Analysis and Regulatory Alternatives* and the standalone FRIA document.

C. The Treasury and General Government Appropriations Act of 1999: Assessment 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 effect on family stability or safety, marital commitment, parental rights and authority, or income or poverty of families and children, as defined in the Act. The final rule impacts the mining industry and does not impose requirements on states or families. Accordingly, MSHA certifies that this final rule will not impact family well-being, as defined in the Act.

D. Executive Order 12630: Government Actions and Interference With Constitutionally Protected Property Rights

Section 5 of E.O. 12630 requires Federal agencies to ''identify the takings implications of proposed regulatory actions . . .'' MSHA has determined that the final rule does not implement a taking of private property or otherwise have takings implications. Accordingly, E.O. 12630 requires no further Agency action or analysis.

E. 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 to minimize litigation and avoid 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.

F. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

E.O. 13045 requires Federal agencies submitting covered regulatory actions to OMB's Office of Information and Regulatory Affairs (OIRA) for review, pursuant to E.O. 12866, to provide OIRA with (1) an evaluation of the environmental health or safety effects that the planned regulation may have on children, and (2) an explanation of why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the agency. In E.O. 13045, ''covered regulatory action'' is defined as rules that may (1) be significant under Executive Order 12866 Section 3(f)(1) (*i.e.,* a rulemaking that has an annual effect on the economy of $200 million or more or would adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, territorial, or tribal governments or communities), and (2) concern an environmental health risk or safety risk that an agency has reason to believe may disproportionately affect children. Environmental health risks and safety risks refer to risks to health or to safety that are attributable to products or substances that the child is likely to come in to contact with or ingest through air, food, water, soil, or product use or exposure.

MSHA has determined that, in accordance with E.O. 13045, while the final rule is considered significant under E.O. 12866 Section 3(f)(1), it does not concern an environmental health or safety risk that may have a disproportionate impact on children. MSHA's final rule would lower the occupational exposure limit to respirable crystalline silica for all miners, including pregnant miners, take other actions to protect miners from adverse health risks associated with exposure to respirable crystalline silica, and require updated respiratory standards to better protect miners from airborne contaminants.

MSHA is aware of studies which have characterized and assessed the risks posed by ''take-home'' exposure pathways for hazardous dust particles. However, the final rule's primary reliance on engineering and administrative controls to protect miners from respirable crystalline silica exposures helps minimize risks associated with ''take-home'' exposures by reducing or eliminating silica that is in the mine atmosphere or the miner's personal breathing zone. The risks of take-home exposures are further minimized by MSHA's existing standards, mine operators' policies and procedures, and mine operators' use of clothing cleaning systems.

MSHA's existing standards limit miners' exposures to respirable crystalline silica. MSHA also requires coal mine operators to provide miners with bathing facilities and change rooms. Miners have access to these facilities to shower and change their work clothes at the end of each shift. In addition, some mine operators provide miners with clean company clothing for each shift, have policies and procedures for cleaning or disposing of contaminated clothing, and provide a boot wash for miners to clean work boots during and after each shift. Moreover, some mine operators use clothing cleaning systems that can remove dust from a miner's clothing. Many of these systems include NIOSH-designed dust removal booths that use compressed air to remove dust, which is then vacuumed through a filter to remove airborne contaminants. Overall, the Agency's standards, mine operators' policies and procedures, and other safety and health practices including the use of clothing cleaning systems help to reduce or eliminate the amount of take-home exposure, therefore protecting other persons in a miner's household or persons who come into contact with the miner outside of the mine site.

MSHA identified one epidemiological study (Onyije *et al.,* 2022) that suggests a possible association between paternal exposure to respirable crystalline silica and childhood leukemia. However, this study does not provide dose-response data which would be needed to establish the dose of respirable crystalline silica which results in a no-adverse-effect-level (NOAEL) for childhood leukemia. This potential association has not been independently confirmed by another study.

MSHA has no evidence that the environmental health or safety risks posed by respirable crystalline silica, including ''take-home'' exposure to respirable crystalline silica, disproportionately affect children. Therefore, MSHA concludes no further analysis or action is needed, in accordance with E.O. 13045.

G. Executive Order 13132: Federalism

MSHA has determined that the final rule does not have ''federalism implications'' because it will 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, under E.O. 13132, no further Agency action or analysis is required.

H. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

MSHA has determined the final rule does not have ''tribal implications'' because it will 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.

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

E.O. 13211 requires agencies to publish a Statement of Energy Effects for ''significant energy actions,'' which are agency actions that are ''likely to have a significant adverse effect on the supply, distribution, or use of energy'' including a ''shortfall in supply, price increases, and increased use of foreign supplies.'' MSHA has reviewed the final rule for its impact on the supply, distribution, and use of energy because it applies to the mining industry. The final rule would result in annualized compliance costs of $8.2 million using a 3 percent discount rate and $8.6 million using a 7 percent discount rate for the coal industry relative to annual revenue of $29.1 billion. The final rule would also result in annualized compliance costs of $81.9 million using a 3 percent discount rate and $83.6 million using a 7 percent discount rate for the metal/nonmetal mine industry relative to annual revenue of $95.1 billion. Because it is not ''likely to have a significant adverse effect on the supply, distribution, or use of energy'' including a ''shortfall in supply, price increases, and increased use of foreign supplies,'' it is not a ''significant energy action.'' Accordingly, E.O. 13211 requires no further agency action or analysis.

J. 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. MSHA's analysis is presented in *Section X. Final Regulatory Flexibility Analysis.*

K. Executive Order 13985: Advancing Racial Equity and Support for Underserved Communities Through the Federal Government

E.O. 13985 provides ''that the Federal Government should pursue a comprehensive approach to advancing equity for all, including people of color and others who have been historically underserved, marginalized, and adversely affected by persistent poverty and inequality.'' E.O. 13985 defines ''equity'' as ''consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality.'' To assess the impact of the final rule on equity, MSHA considered two factors: (1) the racial/ethnic distribution in mining in NAICS 212 (which does not include oil and gas extraction) compared to the racial/ethnic distribution of the U.S. workforce (Table XII–1), and (2) the extent to which mining may be concentrated within general mining communities (Table XII–2).

In 2008, NIOSH conducted a survey of mines, which entailed sending a survey packet to 2,321 mining operations to collect a wide range of information, including demographic information on miners. NIOSH's 2012 report, entitled ''National Survey of the Mining Population: Part I: Employees'' reported the findings of this survey (NIOSH, 2012a). Race and ethnicity information about U.S. mine workers is presented in Table XII–1. Of all mine workers, including miners as well as administrative employees at mines, 93.4 percent of mine workers were white, compared to 80.6 percent of all U.S workers.[111] There were larger percentages of American Indian or Alaska Native and Native Hawaiian or Other Pacific Islander people in the mining industry compared to all U.S. workers, while there were smaller percentages of Asian, Black or African American, and Hispanic/Latino people in the mining industry compared to all U.S. workers.

Table XII–2 shows that there are 22 mining communities, defined as counties where at least 2 percent of the population is working in the mining industry.[112] Although the total population in this table represents only 0.15 percent of the U.S. population, it represents 12.0 percent of all mine workers. The average per capita income in these communities in 2020, $47,977,[113] was lower than the U.S. average, $59,510, representing 80.6 percent of the U.S. average. However, each county's average per capita income varies substantially, ranging from 56.4 percent of the U.S. average to 146.8 percent.

The final rule would lower exposure to respirable crystalline silica and improve respiratory protection for all mine workers. MSHA determined that the final rule is consistent with the goals of E.O. 13985 and would support the advancement of equity for all workers at mines, including those who are historically underserved and marginalized.

BILLING CODE 4520–43–P

[111] National data on workers by race were not available for the year 2008; comparable data for 2012 are provided for comparison under the assumption that there would not be major differences in distributions between these two years.

[112] Although 2 percent may appear to be a small number for identifying a mining community, one might consider that if the average household with one parent working as a miner has five members in total, then approximately 10 percent of households in the area would be directly associated with mining. While 10 percent may also appear small, this refers to the county. There are likely particular areas that have a heavier concentration of mining households.

[113] This is a simple average rather than a weighted average by population.

Table XII-1: Racial and Ethnic Distribution of Mine Workers[1] (2012)

	Number of Workers in Mining (except oil and gas) (NAICS code 212)	As a Percent of Total Mine Workers Who Self-Identified in These Categories (Latest Data for 2008)	Percent of All Workers in the United States for Comparison (Latest Data 2012)[4]
Ethnicity			
Hispanic/Latino	26,622	12.1	15.0
Non-Hispanic or Latino	192,839	87.9	85.0
Total	**219,461**	**100.0**	**100.0**
Race[2]			
American Indian or Alaska Native[3]	4,050	1.9	0.8
Asian	183	0.1	5.4
Black or African American	8,893	4.3	13.0
Native Hawaiian or Other Pacific Islander	634	0.3	0.2
White	194,016	93.4	80.6
Total	**207,776**	**100.0**	**100.0**

1. Mine workers includes miners and other workers at mines such as administrative employees.

2. Does not include mine workers who did not self-report in one of these categories. Some of the surveyed mine workers may not have self-reported in one of these categories if they are affiliated with more than one race, or if they chose not to respond to this survey question.

3. Includes mine workers who self-identified as an American Indian or Alaskan Native as a single race, not in combination with any other races. No other data on mine workers in this racial group were available from this source. In other employment statistics often reported on American Indians and Alaska Natives, their population is based on self-reporting as being American Indian or Alaska Native in combination with any other race, which has resulted in the reporting of much higher employment levels. See BLS, *Monthly Labor Review*, "Alternative Measurements of Indian Country: Understanding Their Implications for Economic, Statistical, and Policy Analysis," https://www.bls.gov/opub/mlr/2021/article/alternative-measurements-of-indian-country.htm.

4. More recent data from the 2020 Decennial Census were not available in September 2022.

Sources: National Institute for Occupational Safety and Health (NIOSH). 2012a. National Survey of the Mining Population Mining Publication: Part 1: Employees, DHHS (NIOSH) Pub. No. 2012-152, June 2012; U.S. Census Bureau, 2012 American Community Survey (ACS).

BILLING CODE 4520–43–C

Table XII-2: Mining Counties: Counties in the United States with Relatively High Concentrations of Mine Workers (At Least 2 Percent of the County Population)

#	County	Number of Mine Workers (First Quarter 2022)	Population of County (Latest Data in 2021)	Estimated Percent of Population Who Are Mine Workers
1	White Pine County, Nevada	1,288	9,182	14.0
2	Pershing County, Nevada	771	6,741	11.4
3	Humboldt County, Nevada	1,549	17,648	8.8
4	Campbell County, Wyoming	3,547	46,401	7.6
5	Winkler County, Texas	513	7,415	6.9
6	Mercer County, North Dakota	555	8,323	6.7
7	Chase County, Kansas	166	2,598	6.4
8	Shoshone County, Idaho	723	13,612	5.3
9	Logan County, West Virginia	1,643	31,909	5.1
10	Sweetwater County, Wyoming	2,050	41,614	4.9
11	Glasscock County, Texas	56	1,149	4.9
12	Livingston County, Kentucky	431	8,959	4.8
13	Buchanan County, Virginia	946	19,816	4.8
14	McDowell County, West Virginia	660	18,363	3.6
15	Big Horn County, Wyoming	413	11,632	3.6
16	Sevier County, Utah	601	21,906	2.7
17	Boone County, West Virginia	582	21,312	2.7
18	Moffat County, Colorado	349	13,185	2.6
19	Nye County, Nevada	1,062	43,946	2.4
20	Raleigh County, West Virginia	1,647	73,771	2.2
21	Wyoming County, West Virginia	456	21,051	2.2
22	Elko County, Nevada	1,090	53,915	2.0
	Total	**20,963**	**494,448**	**4.2**
	All U.S. Counties	174,387	331,893,745	
	Mine Workers in Mining Counties as a Percent of All U.S. Mine Workers	12.0%		
	Population of Mine Counties as a Percent of U.S. Population		0.15%	

Source: Bureau of Labor Statistics (BLS), Quarterly Employment and Wages First Quarter 2022 (2022); Bureau of Economic Analysis, Personal Income by County, Metro, and Other Areas 2020 (2020); U.S. Census Bureau, "Annual Estimates of the Resident Population for Counties: April 1, 2020 to July 1, 2021 (CO-EST2021-POP)." available at: https://www.census.gov/data/tables/time-series/demo/popest/2020s-counties-total.html (last accessed Jan. 11, 2024); U.S. Census Bureau, Quick Facts, available at: https://www.census.gov/quickfacts/fact/table/US/PST045221 (last accessed Jan. 11, 2024).

L. Incorporation by Reference

The Office of the Federal Register (OFR) has regulations concerning incorporation by reference. 5 U.S.C. 552(a); 1 CFR part 51. These regulations require that information that is incorporated by reference in a rule be "reasonably available" to the public. They also require discussion in the preamble to the rule of the ways in which materials are reasonably available to interested parties or how the Agency worked to make those materials reasonably available to interested parties. Additionally, the preamble to the rule must summarize the material. 1 CFR 51.5(b).

In accordance with the OFR's requirements, MSHA provides the following: (a) summaries of the materials to be incorporated by reference and (b) information on the public availability of the materials and on how interested parties can access the materials.

ASTM F3387–19, ''Standard Practice for Respiratory Protection''

ASTM F3387–19 is a voluntary consensus standard that represents up-to-date advancements in respiratory protection technologies, practices, and techniques. The standard includes provisions for selection, fitting, use, and care of respirators designed to remove airborne contaminants from the air using filters, cartridges, or canisters, as well as respirators that protect miners in oxygen-deficient or immediately dangerous to life or health atmospheres. These provisions are based on NIOSH's long-standing experience of testing and approving respirators for occupational use and OSHA's respiratory protection standards on assigned protection factors and fit testing. This final rule incorporates by reference ASTM F3387–19 in §§ 56.5005T, 57.5005T, and 72.710T (which will become permanent §§ 56.5005 and 57.5005 720 days after publication and permanent § 72.710 360 days after publication) and in § 60.14(c)(2) to better protect all miners from airborne contaminants. MSHA believes that incorporating by reference ASTM F3387–19 provides mine operators with up-to-date requirements for respirator technology, reflecting an improved understanding of effective respiratory protection and therefore better protecting the health and safety of miners. For further details on MSHA's update to the Agency's existing respiratory protection standard, please see *Section VIII.D. Updating MSHA Respiratory Protection Standards: Incorporation of ASTM F3387–19 by Reference.*

A paper copy or printable version of ASTM F3387–19 may be purchased by mine operators or any member of the public at any time from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959; *www.astm.org.* ASTM International makes read-only versions of its standards that have been referenced or incorporated into Federal regulation or laws available free of charge at its online Reading Room, *www.astm.org/products-services/reading-room.html.*

In addition, upon finalization of this rule, ASTM F3387–19 will be available for review free of charge at MSHA headquarters at 201 12th Street South, Arlington, VA 22202–5450 (202–693–9440) and at Mine Safety Health Enforcement District and Field Offices.

ISO 7708:1995(E): Air quality—Particle Size Fraction Definitions for Health-Related Sampling

ISO 7708:1995 is an international consensus standard that defines sampling conventions for particle size fractions used in assessing possible health effects of airborne particles in the workplace and ambient environment. It defines conventions for the inhalable, thoracic, and respirable fractions. The final rule incorporates by reference ISO 7708:1995 in § 60.12(e)(4) to ensure consistent sampling collection by mine operators through the utilization of samplers conforming to ISO 7708:1995. For further details on MSHA's incorporation by reference of ISO 7708:1995, please see *Section VIII.B.5.d. Sampling Devices: Incorporation of ISO 7708:1995 by Reference.*

A paper copy or printable version of ISO 7708:1995 may be purchased by mine operators or any member of the public at any time from ISO, CP 56, CH–1211 Geneva 20, Switzerland; phone: + 41 22 749 01 11; fax: + 41 22 733 34 30; website: *www.iso.org/.* ISO makes read-only versions of its standards that have been incorporated by reference in the CFR available free of charge at its online Incorporation by Reference Portal, *http://ibr.ansi.org/Default.aspx.*

In addition, upon finalization of this rule, ISO 7708:1995 will be available for review free of charge at MSHA headquarters at 201 12th Street South, Arlington, VA 22202–5450 (202–693–9440) and at Mine Safety Health Enforcement District and Field Offices.

TLVs® Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973

ACGIH's publication entitled ''*TLVs® Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973*'' presents Threshold Limit Value (TLV®) guidelines for hundreds of chemical substances found in the work environment (particulates, gases, and vapors). TLVs® are airborne concentrations of chemical substances that represent conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, over a working lifetime, without adverse effects. TLVs® generally refer to time-weighted average concentrations (TWAs) for a 7 or 8-hour workday and 40-hour workweek that are applied as guidelines in the control of health hazards.

TLVs®, which appears the amendatory text of this rule, was previously approved for use in §§ 56.5001 and 57.5001.

Copies of the document may be purchased from the American Conference of Governmental Industrial Hygienists, 3640 Park 42 Drive, Cincinnati, OH 45241; 513–742–2020; *http://www.acgih.org.* This publication is also available for examination free of charge at MSHA's Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, VA 22202–5452; 202–693–9440; and at Mine Safety and Health Enforcement District and Field Offices.

American National Standards Practices for Respiratory Protection ANSI Z88.2–1969.

ANSI Z88.2–1969, which appears the amendatory text of this rule, was previously approved for use in § 72.710.

XIII. References

Abraham, J.L. and Wiesenfeld, S.L. 1997. Two cases of fatal PMF in an ongoing epidemic of accelerated silicosis in oilfield sandblasters: Lung pathology and mineralogy. Annals of Occupational Hygiene. 41(Suppl.1): 440–447.

Agency for Toxic Substances and Disease Registry (ATSDR). 2019. Toxicological profile for silica. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Division of Toxicology and Human Health Sciences, Atlanta, GA.

Almberg, K.S., Cohen, R.A., Blackley, D.J., Laney, A.S., Storey, E., and Halldin, C.N. 2017. Linking compensation and health surveillance data sets to improve knowledge of US coal miners' health. Journal of Occupational and Environmental Medicine. 59(10):930–934.

Almberg, K.S., Friedman, L.S., Rose, C.S., Go, L.H.T., Cohen, R.A. 2020. Progression of coal workers' pneumoconiosis absent further exposure. Occupational and Environmental Medicine. 77(11):748–751.

Almberg, K.S., Halldin, C.N., Blackley, D.J., Laney, A.S., Storey, E., Rose, C.S., Go, L.H.T. and Cohen, R.A. 2018a. Progressive massive fibrosis resurgence identified in U.S. coal miners filing for black lung benefits, 1970–2016. Annals of American Thoracic Society. 15(12): 1420–1426.

Am. Fuel & Petrochemical Manufacturers v. Env't Prot. Agency, 3 F.4th 373, 384 (D.C. Cir. 2021).

American Conference of Governmental Industrial Hygienists (ACGIH). 2022. TLV chemical substances introduction. Accessed 2023. Retrieved from: *https://www.acgih.org/science/tlv-bei-guidelines/tlv-chemical-substances-introduction/.*

American Conference of Governmental Industrial Hygienists (ACGIH). 2010. Silica, crystalline: α-Quartz and cristobalite. Documentation of TLV Recommendation. Cincinnati, Ohio.

American Conference of Governmental Industrial Hygienists (ACGIH). 1974. TLVs® Threshold limit values for chemical substances in workroom air adopted by the American Conference of Government Industrial Hygienists for 1973. Journal of Occupational Medicine. 16(1):39–49 PMID: 4814108.

American Conference of Governmental Industrial Hygienists (ACGIH). 2006. Silica, crystalline: Quartz and cristobalite. 1–17.

American Iron and Steel Institute et al., v. Occupational Safety and Health Administration, 577 F.2d 825 (3d Cir. 1978).

American National Standards Institute (ANSI). 1969. Practices for Respiratory Protection. ANSI Z88.2–1969. New York, New York.

American Industrial Hygiene Association (AIHA). 2010. American National Standard Respirator Fit Testing Methods. ANSI Z88.10–2010::1–35.

American National Standards Institute (ANSI).2015. American National Standard—Practices for Respiratory Protection—ANSI/ASSE Z88.2 American National Standards Institute, Inc. American Society of Safety Engineers, Park Ridge, Illinois. Approved March 4, 2015.

American Society of Testing and Materials (ASTM). 2019. Standard practice for respiratory protection. F3387–19. West Conshohocken, PA.

American Thoracic Society (ATS). 2010a. Breathing in America: Diseases, progress, and hope. Ed: Schraufnagel, D.E.. American Thoracic Society.

American Thoracic Society (ATS). 2010b. An official American Thoracic Society public policy statement: Novel risk factors and the global burden of chronic obstructive pulmonary disease. By: Eisner M.D., Anthonisen, N., Coultas, D., Kuenzli, N., Perez-Padilla, R., Postma, D., Romieu, I., Silverman, E.K., and Balmes, J.R. American Journal of Respiratory and Critical Care Medicine. 182:693–718.

American Thoracic Society (ATS). 1997. Adverse effects of crystalline silica exposure. Committee members Beckett W., Abraham, J., Becklake M.,Christiani, D., Cowie, R., Davis, G., Jones, R., Kreiss, K., Parker, J., and Wagner, G. . American Journal of Respiratory Critical Care Medicine. 155:761–768.

Antão, V.C., Petsonk, E.L., Sokolow, L.Z., Wolfe, A.L., Pinheiro, G.A., Attfield, M.D. 2005. Rapidly progressive coal workers' pneumoconiosis in the United States: Geographic clustering and other factors. Occupational Environmental Medicine. 62(10):670–4.

ATSDR. 2009. Glossary of terms. Retrieved from: *https://www.atsdr.cdc.gov/glossary.html#:~:text=Body%20burden,leave%20the%20body%20very%20slowly.* Accessed March 4, 2024.

Attfield, M. and Costello, J. 2004. Quantitative exposure-response for silica dust and lung cancer in Vermont granite workers. American Journal of Industrial Medicine. 45(2):129–138.

Attfield, M.D. and Kuempel, E.D. 2008. Mortality among U.S. underground coal miners, a 23-year follow-up. American Journal of Industrial Medicine. 51(4):231–245.

Attfield, M.D., Vallyathan, V., and Green, F.H.Y. 1994. Radiographic appearances of small opacities and their correlation with pathology grading of macules, nodules and dust burden in the lungs. Annals of Occupational Hygiene. 38(Suppl. 1):783–789.

Balaan, M.R. and Banks, D.E. 1998. Silicosis. In: Rom W.N., ed. Environmental and Occupational Medicine. 3rd Edition. Philadelphia, PA. Lippincott-Raven. 435–448.

Bang, K.M., Mazurek, J.M., and Attfield, M.D. 2005. Silicosis Mortality, Prevention, and Control—United States, 1968–2002. Morbidity and Mortality Weekly Report (MMWR). 54(16):401–405.

Banks, D.E. 2005. Silicosis. In: Rosenstock L., M.R. Cullen, C.A. Brodkin, and C.A. Redlich, eds. Textbook of Clinical Occupational and Environmental Medicine. 2nd ed. Philadelphia, PA. Elsevier Saunders. 380–392.

Barnes, H., Goh, N.L., Leong, T.L., and Hoy, R. 2019. Silica-associated lung disease: An old-world exposure in modern industries. Respirology. 24(12): 1165–1175.

Becklake, M.R. 1994. Pneumoconioses. In: Murray J.F. and J.A. Nadel, eds. Textbook of Respiratory Medicine. 2nd edition. Philadelphia, PA. W.B. Saunders Co. 1955–2001.

Becklake, M.R., Irwig, L., Kielowski, D., Webster, I., DeBeer, M., and Landau, S. 1987. The predictors of emphysema in South African gold miners. American Review of Respiratory Disease. 135(6):1234–1241.

Bégin, R., Filion, R., and Ostiguy, G. 1995. Emphysema in silica- and asbestos-exposed workers seeking compensation: A CT scan study. Chest. 108(3):647–655.

Bégin, R., Bergeron, D., Samson, L., Boctor, M., and Cantin, A. 1987. CT assessment of silicosis in exposed workers. American Journal of Roentgenology. 148(3):509–514. doi: 10.2214/ajr.148.3.509. PMID: 3492877.

Bell, J.L. and Mazurek, J.M. 2020. Trends in Pneumoconiosis Deaths—United States, 1999–2018. Morbidity Mortality Weekly Report (MMWR). 69(23):693–698. doi: *http://dx.doi.org/10.15585/mmwr.mm6923a1*

Benmerzoug, S., Rose, S., Bounab, B., Gosset, D., Duneau, L., Chenuet, P., Mollet, L., Le Bert, M., Lambers, C., Geleff, S., Roth, M., Fauconnier, L., Sedda, D., Carvalho, C., Perche, O., Laurenceau, D., Ryffel, B., Apetoh, L., Kiziltunc, A., Uslu1, H., Albez, FS., Akgun, M., Togbe, D., and Quesniaux, V.F.J.. 2018. STING-dependent sensing of self-DNA drives silica-induced lung inflammation. Nature Communications. 9(1):5226. doi: *https://doi.org/10.1038/s41467-018-07425-1.*

Berkes, H. and Hicks, J. 2023. Federal fix for silica dust understates what we found: Thousands of coal miners still sick and dying. Public Health Watch. Accessed 2023. Retrieved from: *https://publichealthwatch.org/2023/08/31/the-federal-fix-for-silica-dust-understates-what-we-found-thousands-of-coal-miners-still-sick-and-dying/.*

Blackley, D., Reynolds, L., Short, C., Carson, R., Storey, E., Halldin, C.N. and Laney, A.S.. 2018b. Research letter: Progressive massive fibrosis in coal miners from 3 clinics in Virginia. Journal of the American Medical Association.

Blackley, D., Halldin, C.N., Cummings, K.J., and Laney, A.S. 2018a. Continued increase in prevalence of coal workers' pneumoconiosis in the United States, 1970–2017. American Journal of Public Health. 108(9):1220–1222.

Blackley, D.J, Halldin, C.N, Cohen, R.A, Cummings, K.J, Storey, E., Laney, A.S. 2017. Misclassification of occupational disease in lung transplant recipients. The Journal of Heart and Lung Transplantation. 36(5):588–590.

Blackley, D.J, Crum, J.B., Halldin, C.N., Storey, E. and Laney, A.S. 2016b. Resurgence of progressive massive fibrosis in coal miners—Eastern Kentucky, 2016. Morbidity and Mortality Weekly Report (MMWR). 65(49):1385–1389.

Blackley, D.J., Laney, A.S., Halldin, C.N., and Cohen R.A. 2015. Profusion of opacities in simple coal workers pneumoconiosis is associated with reduced lung function. Chest. 148(5):1293–1299.

Blackley, D.J. and Halldin, C.N. 2014a. Resurgence of a debilitating and entirely preventable respiratory disease among working coal miners—Correspondence. American Journal of Respiratory and Critical Care Medicine. 190(6):708–709.

Borm, P.J.A., Fowler, P. and Kirkland, D., 2018. An updated review of the genotoxicity of respirable crystalline silica. Particle and Fibre Toxicology. 15:1–17.

Borm, P.J. and Tran, L., 2002. From quartz hazard to quartz risk: the coal mines revisited. Annals of Occupational Hygiene. 46(1):25–32.

Borm, P.J.A. and Driscoll, K. 1996. Particles, inflammation and respiratory tract carcinogenesis. Toxicology Letters. 88:109–113.

Brief, R.S. and Scala, R.A., 1986. Occupational health aspects of unusual work schedules: A review of Exxon's experiences. American Industrial Hygiene Association Journal. 47(4):199–202.

Brown, T. 2009. Silica exposure, smoking, silicosis and lung cancer—complex interactions. Occupational Medicine. 59(2):89–95.

Brown, T. and Rushton, L. 2005b. Mortality in the UK industrial silica sand industry: 2. A retrospective cohort study. Occupational Environmental Medicine. 62(7):446–452.

Brown, L.M., Gridley, G., Olsen, J.H., Mellernkjaer, L., Linet, M.S., and Fraumeni, J.F., Jr.. 1997. Cancer risk and mortality patterns among silicotic men in Sweden and Denmark. Journal of Occupational and Environmental Medicine. 39(7):633–638.

Brown, G.M., and Donaldson, K. 1996. Modulation of quartz toxicity by aluminum. In: Castranova V., Vallyathan, V. and Wallace, W.E. eds. Silica and Silica-Induced Lung Diseases. Boca Raton, FL. CRC Press, Inc. 299–304.

Bruch, J., Rehn, S., Rehn, B., Borm, P.J.A., and Fubini, B. 2004. Variation of biological responses to different respirable quartz flours determined by a vector model. International Journal of Hygiene and Environmental Health. 207(3):203–216.

Buchanan, D., Miller, B.G., and Soutar, C.A. 2003. Quantitative relations between exposure to respirable quartz and risk of silicosis. Occupational and Environmental Medicine. 60(3):159–164.

Bureau of Labor Statistics. Retrieved March 9, 2024. Average weekly hours of production and nonsupervisory employees, mining (except oil and gas), not seasonally adjusted. Series ID CEU1021200007, data for 2017–2022. Accessed from: *https://data.bls.gov/cgi-bin/srgate.*

Bureau of Labor Statistics (BLS), Quarterly Employment and Wages First Quarter 2022. 2022. Bureau of Economic Analysis, Personal Income by County, Metro, and Other Areas 2020 (2020); U.S. Census Bureau, ''Annual Estimates of the Resident Population for Counties: April 1, 2020 to July 1, 2021 (CO–EST–2021–POP)''.

Calvert, G., Rice, F. L., Boiano, J. M., Sheehy, J. W., and Sanderson, W. T. 2003. Occupational silica exposure and risk of various diseases: An analysis using death certificates from 27 states of the United States. Occupational and Environmental Medicine. 60(2):122–129.

Calvert, G.M., Steenland, K., and Palu, S. 1997. End-stage renal disease among silica-exposed gold miners: A new method for assessing incidence among epidemiologic cohorts. Journal of the American Medical Association. 277(15):1219–1223.

Carneiro, A.P., Barreto, S.M., Siqueira, A.L., Cavariani, F., and Forastiere, F. 2006a. Continued exposure to silica after diagnosis of silicosis in Brazilian gold miners. American Journal of Industrial Medicine. 49(10):811–818.

Cao, Z., Song, M., Liu, Y., Pang, J., Li, Z., Qi, X., Shu, T., Li, B., Wei, D., Chen, J. Li, B., Wang, J., and Wang, C..2020. A novel pathophysiological classification of silicosis models provides some new insights into the progression of the disease. Ecotoxicology and Environmental Safety. 202:110834.

Carrington, J.M. and Hershberger, D.M. 2022. Pulmonary alveolar proteinosis. U.S. Department of Health and Human Services, National Institutes of Health, National Library of Medicine, National Center for Biotechnology Information. Accessed 2023. Retrieved from: *https://www.ncbi.nlm.nih.gov/books/NBK482308/.*

Carta, P., Aru, G., and Manca, P. 2001. Mortality from lung cancer among silicotic patients in Sardinia: An update study with 10 more years of follow up. Occupational and Environmental Medicine. 58(12):786–793.

Cassidy, A., Mannetje, A., Van Tongeren, M., Field, J.K., Zaridze, D., Szeszenia-Dabrowska, N., Rudnai, P., Lissowska, J., Fabianova, E., Mates, D., Bencko, V., Foretova, L., Janout, V., Fevotte, J., Fletcher, T., Brennan, P., and Boffetta, P. 2007. Occupational exposure to crystalline silica and risk of lung cancer: A multicenter case-control study in Europe. Epidemiology. 18:36–43.

Case, B.W., Dufresne, A., Richardson, L., Siemiatycki, J. and Takahashi, K., 1995. Lung-retained dose following occupational exposure to silica. Applied Occupational and Environmental Hygiene. 10(12): 1031–1036.

Castranova V. 2004. Signaling pathways controlling the production of inflammatory mediators in response to crystalline silica exposure: Role of reactive oxygen/nitrogen species. Free Radical Biology and Medicine. 37(7):916–925.

Castranova, V. and Vallyathan, V.. 2000. Silicosis and coal workers' pneumoconiosis. Environmental Health Perspectives. 108(Suppl. 4):675–684.

Castranova, V., Pailes, W.H., Dalal, N.S., Miles, P.R., Bowman, L., Vallyathan, V., Pack, D., Weber, K.C., Hubbs, A., Schwegler-Berry, D., Xiang, J., Dey, K., Blackford, J., Ma, J.Y.C., Barger, M., Shoemaker, D.A., Pretty, J.R., Ramsey, D.M., McLaurin, J.L., Khan, A., Baron, P.A., Childress, C.P., Stettler, L.E., and Teass, A. 1996. Enhanced pulmonary response to the inhalation of freshly fractured silica as compared with aged dust exposure. Applied Occupational and Environmental Hygiene. 11(7):937–941.

Cecala A.B., Organiscak, J.A., Noll, J.D. and Zimmer, J.A. 2016. Comparison of MERV 16 and HEPA filters for cab filtration of underground mining equipment. Mining Engineering. 68(8):50–58. doi:10.19150/me.6712.

Centers for Disease Control and Prevention (CDC). 2001. Comparability of cause of death between ICD–9 and ICD–10: Preliminary estimates. By Anderson, R.N., Miniño, A.M.,. Hoyert, D.L., and Rosenberg, Ph.D. H.M.National Vital Statistics Reports. 49(2):1–32.

Chanda, D., Otoupalova, E., Smith, S.R., Volckaert, T., De Langhe, S.P., and Thannickal, V.J.. 2019. Developmental pathways in the pathogenesis of lung fibrosis. Molecular Aspects of Medicine. 65:56–69. doi: 10.1016/j.mam.2018.08.004.

Checkoway H., Hughes, J.M., Weill, H., Seixas, N.S., and Demers P.A. 1999. Crystalline silica exposure, radiological silicosis, and lung cancer mortality in diatomaceous earth industry workers. Thorax. 54:56–59.

Checkoway, H., Heyer, N.J., Seixas, N.S., Welp, E.A.E., Demers, P.A., Hughes, J.M., and Weill, H. 1997. Dose-response associations of silica with nonmalignant respiratory disease and lung cancer mortality in the diatomaceous earth industry. American Journal of Epidemiology. 145(8):680–688.

Checkoway H., Heyer, N.J., Demers, P.A., and Gibbs, G.W. 1996. Reanalysis of mortality from lung cancer among diatomaceous earth industry workers, with consideration of potential confounding by asbestos exposure. Occupational and Environmental Medicine. 53(9):645–647.

Checkoway H., Heyer, N.J., Demers, P.A., and Breslow, NE 1993. Mortality among workers in the diatomaceous earth industry. British Journal of Industrial Medicine. 50:586–597.

Chen, W. and Chen, J. 2002. Nested case-control study of lung cancer in four Chinese tin mines. Occupational and Environmental Medicine. 59(2):113–118.

Chen, J., Yao, Y., Su, X., Shi, Y., Song, X., Xie, L., You, J., Tian, L., Yang, L., Fang, A. and Xiong, J., 2018. Comparative RNA-Seq transcriptome analysis on silica induced pulmonary inflammation and fibrosis in mice silicosis model. Journal of Applied Toxicology. 38(5): 773–782.

Chen, W., Liu, Y., Wang, H., Hnizdo, E., Sun, Y., Su, l., Zhang, X., Weng, S., Bochmann, F., Hearl, F.J., Chen, J., and Wu, T. 2012. Long-term exposure to silica dust and risk of total and cause-specific mortality in Chinese workers: A cohort study. PLoS Medicine. 9(4):1–11.

Chen, W., Yang, J., Chen, J., and Bruch, J. 2006. Exposure to silica mixed dust and cohort mortality study in tin mines: Exposure-response analysis and risk assessment of lung cancer. American Journal of Industrial Medicine. 49(2):67–76.

Chen, W., Hnizdo, E., Chen, J–Q., Attfield, M.D., Gao, P., Hearl, F., Lu, J., and Wallace, W.E. 2005. Risk of silicosis in cohorts of Chinese tin and tungsten miners, and pottery workers (I): An epidemiological study. American Journal of Industrial Medicine. 48(1):1–9.

Chen, W., Zhuang, Z., Attfield, M.D., Chen, B.T., Gao, P., Harrison, J.C., Fu, C., Chen, J–Q, and Wallace, W.E. 2001. Exposure to silica and silicosis among tin miners in China: Exposure-response analyses and risk assessment. Occupational and Environmental Medicine. 58(1):31–37.

Chen, J., McLaughlin, J.K., Zhang, J–Y, Stone, B.J., Luo, J., Chen, R–A, Dosemeci, M., Rexing, S.H., Wu, Z., Hearl, F.J., McCawley, M.A. and Blot, W.J. 1992. Mortality among dust-exposed Chinese mine and pottery workers. Journal of Occupational Medicine. 34(3):311–316.

Cherniack, M. 1986. The Hawks' Nest incident: America's worst industrial disaster. New Haven, CT: Yale University Press.

Chilosi, M., Poletti, V., Zamò, A., Lestani, M., Montagna, L., Piccoli, P., Pedron, S., Bertaso, M., Scarpa, A., Murer, B. Cancellieri, A., Maestro, R., Semenzato, G., and Doglioni, C. 2003. Aberrant Wnt/β-catenin pathway activation in idiopathic pulmonary fibrosis. The American Journal of Pathology. 162(5):1495–1502.

Cocco, P., Ward M.H., and Buiatti, E.. 1996. Occupational risk factors for gastric cancer: An overview. Epidemiologic Reviews. 18(2):218–234.

Cochrane, A.L., Carpenter, R.G., Clarke, W.G., Jonathan, G., Moore, F. 1956. Factors influencing the radiological progression rate of progressive massive fibrosis. British Journal of Industrial Medicine. 13(3):177–183.

Cohen, R., and Velho, V. 2002. Update on respiratory disease from coal mine and silica dust. Clinics in Chest Medicine. 23(4):811–826.

Cohen, R.A., Rose, C.S., Go, L.H.T., Zell-Baran, L.M., Almberg, K.S., Sarver, E.A., Lowers, H.A., Iwaniuk, C., Clingerman, S.M., Richardson, D.L., Abraham, J.L., Cool, C.D., Franko, A.D., Hubbs, A.F., Murray, J., Orandle, M.S., Sanyal, S., Vorajee, N.I., Petsonk, E.L., Zulfikar R., Green, F. 2022. Pathology and mineralogy demonstrate respirable crystalline silica is a major cause of severe pneumoconiosis in US coal miners. Annals of the American Thoracic Society. 19(9):1469–1478.

Cohen, R.A., Orandle, M., Hubbs, A.F., Almberg, K.S., Go, L.H., Clingerman, S., Fluharty, K., Dodd, T., Rose, C.S., Abraham, J.L., Sanyal, S., Franko, A., J. Murray, J., Vorajee, N., Zell-Baran, L., E.L. Petsonk, E.L., Zulfikar, R., and Green, F.H.Y. 2019. Pathologic type of progressive massive fibrosis in the National Coal Workers' Autopsy Study (NCWAS) 1971–1996. American Journal of Respiratory and Critical Care Medicine. 199: A2758. doi: *https://doi.org/10.1164/ajrccm-conference.2019.199.1_MeetingAbstracts.A2758.*

Cohen, R.A., Petsonk, E.L., Rose, C., Young B., Regier M., Najmudin A., Abraham J.L., Churg A., Green, F.H.Y. 2016. Lung pathology in U.S. coal workers with rapidly progressive pneumoconiosis implicates silica and silicates. American Journal of Respiratory and Critical Care Medicine. 190(6):673–680.

Costello, J. and Graham, W.G. 1988. Vermont granite workers' mortality study. American Journal of Industrial Medicine. 13(4):483–497.

Costello, J., Castellan, R.M., Swecker, G.S., and Kullman, G.J. 1995. Mortality of a cohort of U.S. workers employed in the crushed stone industry, 1940–1980. American Journal of Industrial Medicine. 27(5):625–640.

Cowie, R.L. 1998. The influence of silicosis on deteriorating lung function in gold miners. Chest. 113(2):340–343.

Cowie, R.L. 1994. The epidemiology of tuberculosis in gold miners with silicosis. American Journal of Respiratory Critical Care and Medicine. 150(5):1460–1462.

Cowie, R.L. and Becklake, M.R.. 2016. Pneumoconioses. In: Murray and Nadel's Textbook of Respiratory Medicine. Editors: Mason R.J., Slutsky, A., Murray, J.F., Nadel, J.A., Gotway, M., Broaddus, V.C., Ernst, J.D., King Jr., T.E., and Sarmiento, K.F. Sixth Edition. Philadelphia, PA: Elsevier Saunders. Chapter 73:1307–1330.

Cowie R.L, Hay, M., and Thomas, R.G. 1993. Association of silicosis, lung dysfunction, and emphysema in gold miners. Thorax. 48(7):746–749.

Cowie, R.L. and Mabena, S.K. 1991. Silicosis, chronic airflow limitation, and chronic bronchitis in South African gold miners. American Review of Respiratory Disease. 143(1):80–84.

Craighead, J.E. and Vallyathan, N.V. 1980. Cryptic pulmonary lesions in workers occupationally exposed to dust containing silica. Journal of the American Medical Association. 244(17):1939–1941.

Creutzenberg, O., Hansen, T., Ernst, H., Muhle, H., Oberdörster, G., andHamilton, R. 2008. Toxicity of a quartz with occluded surfaces in a 90-day intratracheal instillation study in rats. Inhalation Toxicology. 20(11):995–1008. doi: *https://doi.org/10.1080/08958370802123903.*

Davis, G.S. 1996. Silica. In: Harber P., Schenker, M.B., and Balmes, J.R. eds. Occupational and Environmental Respiratory Disease. 1st edition. Mosby-Year Book, Inc. St. Louis, MO. 373–399.

Davis, L.K., Wegman, D.H., Monson, R.R., and Froines, J. 1983. Mortality experience of Vermont granite workers. American Journal of Industrial Medicine. 4(6):705–723.

Davis, J.M.G., Chapman, J., Collings, P., Douglas, A.N., Fernie, J., Lamb, D., Ottery, J., and Ruckley, A. 1979. Autopsy study of coalminers' lungs. Final report on CEC Contract 6244–00/8/103. Historical Research Report, Research Report TM/79/09. Institute of Occupational Medicine. Edinburgh.

de Beer, M., Kielkowski, Yach, D., and Steinberg, M. 1992. Selection bias in a case-control study of emphysema. South African Journal of Epidemiology Infection. 7:9–13.

de Klerk, N.H. and Musk, A.W. 1998. Silica, compensated silicosis, and lung cancer in Western Australia goldminers. Occupational and Environmental Medicine. 55(4):243–248.

Descatha, A., Fadel, M., Sembajwe, G., Peters, S., Evanoff, B.A. 2022. Job-Exposure Matrix: A useful tool for incorporating workplace exposure data into population health research and practice. Frontiers in Epidemiology 2: 857316. doi: *https://doi.org/10.3389/fepid.2022.857316.*

Dobreva, M., Burilkov, T., Kolev, K. and Lalova, P., 1975. Characteristics of lung dusts and their relation to dust exposure and pathological findings in the lungs. Inhaled Particles. 717–725.

Donaldson, K. and Borm, P.J. 1998. The quartz hazard: a variable entity. Annals of Occupational Hygiene Journal. 42(5):287–294.

Dong D., Xu, G., Sun, Y., and Hu, P. 1995. Lung cancer among workers exposed to silica dust in Chinese refractory plants. Scandinavian Journal of Work, Environment & Health. 21:69–72.

Douglas, A.N., Robertson, A., Chapman, J.S., and Ruckley, V.A. 1986. Dust exposure, dust recovered from the lung, and associated pathology in a group of British coalminers. British Journal of Industrial Medicine. 43:795–801.

Driscoll, K.E. and Borm, P.J., 2020. Expert workshop on the hazards and risks of poorly soluble low toxicity particles. Inhalation Toxicology. 32(2):53–62.

Dufresne, A., Begin, R., Dion, C., Jagirdar, J., Rom, W.N., Loosereewanich, P., Muir, D.C.F., Ritchie, A.C. and Perrault, G., 1998. Angular and fibrous particles in lung in relation to silica-induced diseases. International Archives of Occupational and Environmental Health. 71:263–269.

Dumavibhat, N., Matsui, T., Hoshino, E., Rattanasiri, S., Muntham, D., Hirota, R., Eitoku, M., Imanaka, M., Muzembo, B.A., Ngatu, N.R., Kondo, S., Hamada, N., and Suganuma, N. 2013. Radiographic progression of silicosis among Japanese tunnel workers in Kochi. Journal of Occupational Health. 55(3):142–148.

Eastern Research Group (ERG). 2023. Market Research for MSHA's Respirable Crystalline Silica Rulemaking.

Elias, J., and Reineke, A. 2013. Adjustments for Unusual Work Schedules. Accessed 2023. Retrieved from: *http://eliasconsulting.info/home/wp-content/uploads/2013/06/Adjustments-for-Unusual-Work-Schedules.pdf.*

Eisen, E.A., Wegman, D.H., Louis, T.A., Smith, T.J., and Peters, J.M. 1995. Healthy worker effect in a longitudinal study of one-second forced expiratory volume (FEV1) and chronic exposure to granite dust. International Journal of Epidemiology. 24(6):1154–1162.

EMSL Analytical, Inc. 2022. Industrial Hygiene Lab Services Guide. Accessed December 29, 2022. Retrieved from *https://emsl.com/PDFDocuments/ServicesGuide/Industrial%20Hygiene%20Lab%20Services%20Guide%202022.pdf.*

Erren, T.C., Glende, C.B., Morfeld, P., and Piekarski, C. 2009. Is exposure to silica associated with lung cancer in the absence of silicosis? A meta-analytical approach to an important public health question. International Archives of Occupational and Environmental Health. 82:997–1004.

Ethyl Corp. v. Environmental Protection Agcy., 541 F.2d 1 (D.C. Cir. 1976).

Executive Order 12866 of September 30, 1993: Regulatory Planning and Review. 58 FR 51735. October 4, 1993. Accessed January 5, 2023. Retrieved from: *https://www.archives.gov/files/federal-register/executive-orders/pdf/12866.pdf.*

Executive Order 14094 of April 6, 2023: Modernizing Regulatory Review. 88 FR 21879. April 11, 2023. Accessed April 19, 2023. Retrieved from: *https://www.federalregister.gov/documents/2023/04/11/2023-07760/modernizing-regulatory-review.*

Executive Order 13563 of January 18, 2011: Improving Regulation and Regulatory Review. January 18, 2011. Accessed November 13, 2023. Retrieved from: *https://www.regulations.gov/document/EPA-HQ-OA-2018-0259-0005.*

Fazio, J.C., Gandhi, S.A., Flattery, J., Heinzerling, A., Kamangar, N., Afif, N., Cummings, K.J., Harrison, R.J. 2023. Silicosis among immigrant engineered stone (quartz) countertop fabrication workers in California. JAMA Internal

Medicine. 183(9):991–998. doi: 10.1001/jamainternmed.2023.3295. PMID: 37486642; PMCID: PMC10366949.

Federal Coal Mine Health and Safety Act (Coal Act). 1969. House Report No. 91–563, October 13, 1969. Accessed 2023.Retrieved from: *https://www.msha.gov/regulations/laws/1969-coal-act/house-report-no-91-563.*

Feng, F., Li, N., Cheng, P., Zhang, H., Wang, H., Wang, Y. and Wang, W.. 2020. Tanshinone IIA attenuates silica-induced pulmonary fibrosis via inhibition of TGF-β1-Smad signaling pathway. Biomedicine & Pharmacotherapy. 121:109586.

Fenwick, S. and Main, J. 2000. Increased prevalence of renal disease in silica-exposed workers. The Lancet. 356(9233):913–914.

Fernie, J.M. and Ruckley, V.A. 1987. Coalworkers' pneumoconiosis: Correlation between opacity profusion and number and type of dust lesions with special reference to opacity type. British Journal of Industrial Medicine. 44:273–277.

Finkelstein, M.M.. 2000. Silica, silicosis, and lung cancer: A risk assessment. American Journal of Industrial Medicine. 38(1):8–18.

Finkelstein, M.M. 1998. Radiographic silicosis and lung cancer risk among workers in Ontario. American Journal of Industrial Medicine. 34(3):244–251.

Finkelstein, M.M. 1995. Radiographic abnormalities and the risk of lung cancer among workers exposed to silica dust in Ontario. Canadian Medical Association Journal. 152(1):37–43.

Finkelstein, M.M. and Verma, D.K.. 2005. Mortality among Ontario members of the International Union of Bricklayers and Allied Craftworkers. American Journal of Industrial Medicine. 47(1):4–9.

Forastiere, F., Goldsmith, D.F., Sperati, A., Rapiti, E., Miceli, M., Cavariani, F. and Perucci, C.A.. 2002. Silicosis and lung function decrements among female ceramic workers in Italy. American Journal of Epidemiology. 156(9): 851–856.

Foster, W.M., Walters, D.M., Longphre, M., Macri, K. and Miller, L.M., 2001. Methodology for the measurement of mucociliary function in the mouse by scintigraphy. Journal of Applied Physiology. 90(3):1111–1118.

Friedman, G.K., Harrison, R., Bojes, H., Worthington, K., Filios, M. 2015. Centers for Disease Control and Prevention (CDC). Notes from the field: Silicosis in a countertop fabricator—Texas, 2014. Morbidity Mortality Weekly Report (MMWR). 64(5):129–130.

Fubini, B., Fenoglio, I., Ceschino, R., Ghiazza, M., Martra, G., Tomatis, M., Borm, P., Schins, R., and Bruch, J. 2004. Relationship between the state of the surface of four commercial quartz flours and their biological activity in vitro and in vivo. International Journal of Hygiene and Environmental Health. 207(2):89–104.

Fubini, B. 1998. Surface chemistry and quartz hazard. Annals of Occupational Hygiene Journal. 42(8):521–30.

Goldsmith, D.F. 1997. Does occupational silica exposure or silicosis cause lung cancer? Annals of Occupational Hygiene. 41(Suppl. 1):475–479.

Goodwin, S.S., Stanbury, M., Wang, L–M., Silbergeld, E., and Parker, J.E. 2003. Previously undetected silicosis in New Jersey decedents. American Journal of Industrial Medicine. 44(3):304–311.

Government of Canada. 2022. Application of weight of evidence and precaution in risk assessment. Fact sheet series: Topics in risk assessment of substances under the Canadian Environmental Protection Act, 1999 (CEPA 1999). Accessed: November 18, 2023 Update Date: February 11, 2022. Retrieved from: *https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets/application-weight-of-evidence-precaution-risk-assessments.html.*

Graber, J.M., Harris, G., Almberg, K.S., Rose, C.S., Petsonk, E.L., and Cohen, R.A. 2017. Increasing severity of pneumoconiosis among younger former US coal miners working exclusively under modern dust-control regulations. Journal of Occupational and Environmental Medicine. 59(6):e105–e111.

Graber, J.M., Stayner, L., Cohen, R.A. and Conroy, L.M., 2014. The need for continued investigation of lung cancer risk in coal miners. Occupational and Environmental Medicine. 71(7):523–524.

Graber, J.M., Stayner, L.T., Cohen, R.A., Conroy, L.M. and Attfield, M.D. 2014b. Respiratory disease mortality among US coal miners; results after 37 years of follow-up. Journal of Occupational and Environmental Medicine. 71(1):30–39.

Graham, W.G., Weaver, S., Ashikaga, T., and O'Grady, R.V. 1994. Longitudinal pulmonary function losses in Vermont granite workers: A reevaluation. Chest. 106(1):125–130.

Graham, W.G., O'Grady, R.V., and Dubuc, B. 1981. Pulmonary function loss in Vermont granite workers: A long-term follow-up and critical reappraisal. American Review of Respiratory Disease. 123(1):25–28.

Greaves, I.A. 2000. Not-so-simple silicosis: A case for public health action. American Journal of Industrial Medicine. 37(3):245–251.

Green, F.H.Y. 2019. Lessons learned from the National Coal Workers Autopsy Study (NCWAS) and opportunities for the future—PowerPoint presentation. Cummings School of Medicine, University of Calgary, Alberta, Canada. *http://www.blacklungcoe.org/wp-content/uploads/2019/05/Lessons-Learned-from-the-National-Coal-Workers-Autopsy-Study-NCWAS.pdf.*

Green, F.H.Y, Althouse, R., Parker, J., Kahn, J., Weber, K., and Vallyathan, V. 1998b. Trends in the prevalence of coal workers' pneumoconiosis in U.S. autopsied coal miners. In: Chiyotani K, Y. Hosoda, Y. Aizawa, eds. Advances in the Prevention of Occupational Respiratory Diseases: Proceedings of the 9th International Conference on Occupational Respiratory Diseases, Kyoto, Japan, 13–16, October 1997, Pages 145–148.

Green, F.H.Y. and Vallyathan, V. 1996. Pathologic responses to inhaled silica. In: Castranova V, Vallyathan, V. and Wallace, W.E.. Silica and Silica-Induced Lung Diseases. Boca Raton, FL. CRC Press. 39–59.

Green, F.H.Y., Althouse, R., and Weber, K., 1989. Prevalence of silicosis at death in underground coal miners. American Journal of Industrial Medicine. 16(6):605–615.

Gregorini, G., Ferioli, A., Donato, F., Tira, P., Morassi, L., Tardanico, R., Lancini, L., and Maiorca, R. 1993. Association between silica exposure and necrotizing crescentic glomerulonephritis with p-ANCA and anti-MPO antibodies: A hospital-based case-control study. Advances in Experimental Medicine and Biology. 336:435–440.

Guénel, P., Breum, N.O. and Lynge, E. 1989a. Exposure to silica dust in the Danish stone industry. Scandinavian Journal of Work, Environment & Health. 15(2):147–153.

Guénel, P., Højberg, G. and Lynge, E.. 1989b. Cancer incidence among Danish stone workers. Scandinavian Journal of Work, Environment & Health. 15(4):265–270.

Guo, J., Yang, Z., Jia, Q., Bo, C., Shao, H. and Zhang, Z., 2019. Pirfenidone inhibits epithelial-mesenchymal transition and pulmonary fibrosis in the rat silicosis model. Toxicology Letters. 300:59–66.

Hall, N.B., Blackley D.J., Markle T., Crum J.B., Halldin C.N., Laney A.S. 2022. Postexposure progression of pneumoconiosis among former Appalachian coal miners. American Journal of Industrial Medicine. 65(12):953–958. doi: 10.1002/ajim.23431.

Hall, N.B., Blackley D.J., Halldin C.N., Laney A.S.. 2020b. Pneumoconiosis progression patterns in US coal miner participants of a job transfer programme designed to prevent progression of disease. Occupational and Environmental Medicine. 77(6):402–406.

Hall, N.B., Blackley, D.J., Halldin, C.N., and Laney, A.S. 2019b. Current review of pneumoconiosis among US coal miners. Current Environmental Health Reports. 6:137–147. doi: *https://doi.org/10.1007/s40572-019-00246-4.*

Halldin, C.N., Blackley, D.J., Markle, T., Cohen, R.A., Laney, A.S. 2020. Patterns of progressive massive fibrosis on modern coal miner chest radiographs. Archives of Environmental and Occupational Health. 75(3):152–158.

Halldin, C.N., Hale, J.M., Weissman, D.N., Attfield, M.D., Parker, J.E., Petsonk, E.L., Cohen, R.A., Markle, T., Blackley, D.J., Wolfe, A.L., Tallaksen, R.J., Laney, A.S. 2019. The national institute for occupational safety B reader certification program—An update report (1987–2018) and future directions. Journal of Occupational and Environmental Medicine. 61(12):1045–1051. doi:10.1097/JOM.0000000000001735.

Hamilton, R.F., Jr, Thakur, S.A., and Holian, A. 2008. Silica binding and toxicity in alveolar macrophages. Free Radical

Biology and Medicine, 44(7): 1246–1258. doi: *https://doi.org/10.1016/j.freeradbiomed.2007.12.027.*

Harrison, J., Chen, J.Q., Miller, W., Chen, W., Hnizdo, E., Lu, J., Chisholm, W., Keane, M., Gao, P., and Wallace, W. 2005. Risk of silicosis in cohorts of Chinese tin and tungsten miners and pottery workers (II): Workplace-specific silica particle surface composition. American Journal of Industrial Medicine. 48(1):10–15.

Haustein, U.F. and Anderegg, U. 1998. Silica-induced scleroderma—clinical and experimental aspects. Journal of Rheumatology. 25(10):1917–1926.

Hertzberg V., Rosenman, K.D., Reilly, M.J., and Rice, C.H. 2002. Effect of occupational silica exposure on pulmonary function. Chest. 122(2):721–728.

Hessel, P.A., G.K. Sluis-Cremer, and Hnizdo, E. 1990. Silica exposure, silicosis, and lung cancer: A necropsy study. British Journal of Industrial Medicine. 47:4–9.

Hessel, P.A., Sluis-Cremer, G.K., Hnizdo, E., Faure, M.H., Thomas, RG., Wiles, FJ. 1988. Progression of silicosis in relation to silica dust exposure. Annals of Occupational Hygiene. 32:689–696.

Hessel, P.A., Sluis-Cremer, G.K., and Hnizdo, E. 1986. Case-control study of silicosis, silica exposure, and lung cancer in white South African gold miners. American Journal of Industrial Medicine. 10(1):57–62.

Hnizdo, E. 1992. Loss of lung function associated with exposure to silica dust and with smoking and its relation to disability and mortality in South African gold miners. Journal of Industrial Medicine. 49:472–479.

Hnizdo, E. 1990. Combined effect of silica dust and tobacco smoking on mortality from chronic obstructive lung disease in gold miners. Occupational and Environmental Medicine. 47(10):656–664.

Hnizdo, E. and Murray, J. 1998. Risk of pulmonary tuberculosis relative to silicosis and exposure to silica dust in South African gold miners. Occupational and Environmental Medicine. 55(7):496–502.

Hnizdo, E. and Sluis-Cremer, G.. 1993. Risk of silicosis in a cohort of white South African gold miners. American Journal of Industrial Medicine. 24(4):447–457.

Hnizdo, E. and Sluis-Cremer, G.. 1991. Silica exposure, silicosis, and lung cancer: A mortality study of South African gold miners. British Journal of Industrial Medicine. 48:53–60.

Hnizdo, E. and Vallyathan, V. 2003. Chronic obstructive pulmonary disease due to occupational exposure to silica dust: A review of epidemiological and pathological evidence. Occupational and Environmental Medicine. 60(4):237–243.

Hnizdo, E., Murray, J. and A. Davison. 2000. Correlation between autopsy findings for chronic obstructive airways disease and in-life disability in South African gold miners. International Archives of Occupational and Environmental Health. 73:235–244.

Hnizdo, E., Murray, J. and S. Klempman. 1997. Lung cancer in relation to exposure to silica dust, silicosis, and uranium production in South African gold miners. Thorax. 52(3):271–275.

Hnizdo, E., Sluis-Cremer, G.K., Baskind, E., and Murray, J.1994. Emphysema and airway obstruction in non-smoking South African gold miners with long exposure to silica dust. Occupational and Environmental Medicine. 51(8):557–563.

Hnizdo, E., Murray, J., Sluis-Cremer, G.K., and Thomas, R.G. 1993. Correlation between radiological and pathological diagnosis of silicosis: An autopsy population based study. American Journal of Industrial Medicine. 24(4):427–445.

Hnizdo, E., Sluis-Cremer, G.K. and Abramowitz, J.A.. 1991a. Emphysema type in relation to silica dust exposure in South African gold miners. American Review of Respiratory Disease. 143:1241–1247.

Hnizdo, E, Baskind, E. and Sluis-Cremer, G.K.. 1990. Combined effect of silica dust exposure and tobacco smoking on the prevalence of respiratory impairments among gold miners. Scandinavian Journal of Work, Environment & Health. 16:411–422.

Holman, C.D., Psaila-Savona, P., Roberts, M., McNulty, J.C. 1987. Determinants of chronic bronchitis and lung dysfunction in Western Australian gold miners. British Journal of Industrial Medicine. 44:810–818.

Honma, K., Abraham, J.L, Chiyotani, K., De Vuyst, P., Dumortier, P., Gibbs, A.R., Green, F.H.Y., Hosoda, Y., Iwai, K., Williams, W.J., Kohyama N., Ostiguy, G., Roggli, V.L., Shida, H., Taguchi, O., and Vallyathan, V. 2004. Proposed criteria for mixed-dust pneumoconiosis: Definition, descriptions, and guidelines for pathologic diagnosis and clinical correlation. Human Pathology. 35(12):1515–1523.

Hotz, P., Gonzales-Lorenzo, J., Siles, E., Trujillano, G, Lauwerys, R., Bernard, A. 1995. Subclinical signs of kidney dysfunction following short exposure to silica in the absence of silicosis. Nephron. 70(4):438–442.

Hoy, R.F., Dimitriadis, C., Abramson, M., Glass, D.C., Gwini, S., Hore-Lacy, F., Jimenez-Martin, J., Walker-Bone, K., & Sim, M. R. 2023. Prevalence and risk factors for silicosis among a large cohort of stone benchtop industry workers. Occupational and Environmental Medicine. 80(8):439–446. doi: *https://doi.org/10.1136/oemed-2023-108892.*

Hoy, R.F. and Chambers, DC 2020. Silica-related diseases in the modern world. Allergy. 75(11):2805–2817. doi: 10.1111/all.14202.

Hu, YB., Wu, X., Qin, ZF., Wang, L., Pan, P.H. 2017. Role of endoplasmic reticulum stress in silica-induced apoptosis in RAW264.7 cells. Biomedical and Environmental Science. 30(8):591–600.

Hua F., Xueqi, G., Xipeng, J., Shunzhang, Y., Kaiguo, W., and Guidotti, T.L. 1994. Lung cancer among tin miners in southeast China: Silica exposure, silicosis, and cigarette smoking. American Journal of Industrial Medicine. 26(3):373–381.

Huang, H., Chen, M., Liu, F., Wu, H., Wang, J., Chen, J., Liu, M., andLi, X. 2019. N-acetylcysteine tiherapeutically protects against pulmonary fibrosis in a mouse model of silicosis. Bioscience Reports. 39(7). BSR20190681. doi: *https://doi.org/10.1042/BSR20190681.*

Hughes J.M., Weill, H., Rando, R.J., Shi, R., McDonald, A.D., and McDonald, J.C. 2001. Cohort mortality study of North American industrial sand workers. II. Case-referent analysis of lung cancer and silicosis deaths. Annals of Occupational Hygiene Journal. 45(3):201–207.

Hughes, J.M., Jones, R.N., Gilson, J.C., Hammad, Y.Y., Sammi, B., Hendrick, D.J., Turner-Warick, M., Doll, N.J. and Weill, H. 1982. Determinants of progression in sandblasters' silicosis. Annals of Occupational Hygiene. 26(1):701–712.

Humerfelt, S., Eide, G.E., and Gulsvik, A.. 1998. Association of years of occupational quartz exposure with spirometric airflow limitation in Norwegian men aged 30–46 years. Thorax. 53(8):649–655.

Hurley, F., Kenny, L., and Miller, B. 2002. Health impact estimates of dust-related disease in UK coal miners: Methodological and practical issues. Annals of Occupational Hygiene, 46(Suppl. 1): 261–264.

Hurley, J.F., Alexander, W.P., Hazledine, D.J., Jacobsen, M., and Maclaren, W.M. 1987. Exposure to respirable coalmine dust and incidence of progressive massive fibrosis. British Journal of Industrial Medicine. 44(10):661–672.

Industrial Minerals Association—North America and Mine Safety and Health Administration. 2008. A practical guide to an occupational health program for respirable crystalline silica. Instruction Guide Series IG 103. MSHA Alliance Program. Industrial Minerals Association—North America and the Mine Safety and Health Administration. Washington, DC.

International Agency for Research on Cancer (IARC). 2012. Silica dust, crystalline, in the form of quartz or cristobalite. Monographs on the evaluation of carcinogenic risks to humans: Arsenic, Metals, Fibres, and Dusts-A Review of Human Carcinogens. International Agency for Research on Cancer, World Health Organization. Geneva, Switzerland. 100C:355–406.

International Agency for Research on Cancer (IARC). 1997. Monographs on the evaluation of carcinogenic risks to humans: Silica, some silicates, coal dust and para-aramid fibrils. International Agency for Research on Cancer, World Health Organization. Geneva, Switzerland. 68:41–242, and 68:337–406.

International Labour Organization (ILO). 2022. Guidelines for the use of the ILO classification of radiographs of pneumoconioses. Revised edition 2022. International Labour Organization, Geneva, Switzerland.

International Labour Organization (ILO). 2011. Guidelines for the use of the ILO international classification of radiographs of pneumoconioses. Revised edition 2011. International Labour Organization, Geneva, Switzerland.
International Labour Organization (ILO). 2002. Guidelines for the use of the ILO international classification of radiographs of pneumoconioses. Revised edition 2000. International Labour Organization, Occupational Safety and Health Series No. 22 (Rev.2000), Geneva, Switzerland.
International Labour Organization (ILO). 1980. Guidelines for the use of the ILO international classification of radiographs of pneumoconioses. International Labour Organization, Occupational Safety and Health Series, No.22 (Rev. 80). Geneva, Switzerland.
International Organization for Standardization. 1995. Air Quality–Particle size fraction definitions for health-related sampling. ISO 7708–1995. International Organization for Standardization. Geneva, Switzerland.
International Organization for Standardization. 2017. Conformity assessment—Requirements for accreditation bodies accrediting conformity assessment bodies. ISO/IEC 17011. International Organization for Standardization. Geneva, Switzerland.
International Organization for Standardization/International Electrotechnical Commission. 2017. Standard 17025—''General requirements for the competence of testing and calibration laboratories''. Reference number ISO/IEC 17025–2005(E). 3rd Ed. 2017–11. International Organization for Standardization/International Electrotechnical Commission. Geneva, Switzerland.
Irwig, L.M. and Rocks, P. 1978. Lung function and respiratory symptoms in silicotic and nonsilicotic gold miners. American Review of Respiratory Disease. 117(3):429–435.
Jia, Y., Wang, A., Liu, L., Wang, H., Li, G. and Zhang, F. 2022. Chinese medicinal plant Polygonum cuspidatum ameliorates silicosis via suppressing the Wnt/β-catenin pathway. Open Chemistry. 20(1): 1601–1611.
Jiang, H. and Luo, Y. 2021. Development of a roof bolter drilling control process to reduce the generation of respirable dust. International Journal of Coal Science & Technology. 8. 199–204. doi: *https://doi.org/10.1007/s40789-021-00413-9.*
Jorna, T.H., Borm, P.J.A., Koiter, K.D., Slangen, J.J.M., Henderson, P. T., and Wouters, E.F.M. 1994. Respiratory effects and serum type III procollagen in potato sorters exposed to diatomaceous earth. International Archives of Occupational and Environmental Health. 66:217–222.
K Mart Corp. v. *Cartier, Inc.*, 486 U.S. 281, 294 (1988).
Kambouchner, M. and Bernaudin, J–F. 2015. The pathologist's view of silicosis in 1930 and in 2015. The Johannesburg Conference legacy. American Journal of Industrial Medicine 58(Suppl. 1):48–S58.
Keil, A., Richardson, D., Westreich, D., Steenland, K. 2018. Estimating the impact of changes to occupational standards for silica exposure on lung cancer mortality. Epidemiology. 29(5): 658–665.
Kennecott Greens Creek Mining Company v. Mine Safety and Health Administration and Secretary of Labor, 476 F.3d 946 (D.C. Cir. 2007).
Keles, C., Pokhrel, N., and Sarver, E. 2022. A study of respirable silica in underground coal mines: Sources. Minerals. 12(9):1115. doi: *https://doi.org/10.3390/min12091115.*
Kimura, K. Ohtsuka Y., Kaji H., Nakano I., Sakai I., Itabashi K., Igarashi T., and Okamoto K. 2010. Progression of pneumoconiosis in coal miners after cessation of dust exposure: a longitudinal study based on periodic chest X-ray examinations in Hokkaido, Japan. Internal Medicine. 49(18):1949–1956.
Koskela, R.S., Klockars, M., Laurent, H., and Holopaninen, M. 1994. Silica dust exposure and lung cancer. Scandinavian Journal of Work, Environment & Health. 20:407–416.
Koskela, R.S., Klockars, M., Jarvinen, E., Kolari, P.J., and Rossi, A. 1987. Mortality and disability among granite workers. Scandinavian Journal of Work, Environment & Health. 13:18–25.
Kramer, M.R., Blanc, P.D., Fireman, E., Amital, A., Guber, A., Rhahman, N.A., and Shitrit, D. 2012. Artificial stone silicosis: disease resurgence among artificial stone workers. Chest. 142:419–424. doi: *https://doi.org/10.1378/chest.11-1321.*
Kreiss K., Greenberg, L.M., Kogut, S.J.H., Lezotte, DC, Irvin, C.G., and Cherniack, R.M. 1989. Hard-rock mining exposures affect smokers and nonsmokers differently: Results of a community prevalence study. American Review of Respiratory Disease. 139(6):1487–1493.
Kreiss, K. and Zhen, B. 1996. Risk of silicosis in a Colorado mining community. American Journal of Industrial Medicine. 30(5):529–539
Kurth L., Halldin, C., Laney, A.S., and Blackley, D.J.. 2020. Causes of death among Federal Black Lung Benefits Program beneficiaries enrolled in Medicare, 1999–2016. American Journal of Industrial Medicine. 63(11):973–979.
Laney, A.S and Attfield, M.D.. 2010. Coal workers' pneumoconiosis and progressive massive fibrosis are increasingly more prevalent among workers in small underground coal mines in the United States. Occupational and Environmental Medicine. 67(6):428–431.
Laney, A.S., Blackley, D.J. and Halldin, C.N. 2017. Radiographic disease progression in contemporary US coal miners with progressive massive fibrosis. Journal of Occupational and Environmental Medicine. 74(7): 517–520.
Laney, A.S., Petsonk, E.L., Hale, J.M., Wolfe, A.L. and Attfield, M.D. 2012b. Potential determinants of coal workers' pneumoconiosis, advanced pneumoconiosis, and progressive massive fibrosis among underground coal miners in the United States, 2005–2009. American Journal of Public Health. 102(2): S279–S283.
Laney A.S., Petsonk, E.L., and Attfield, M.D.. 2010. Pneumoconiosis among underground bituminous coal miners in the United States: Is silicosis becoming more frequent? Occupational and Environmental Medicine. 67(10):652–656.
Laney, A.S. and Weissman. 2012. The classic pneumoconioses: New epidemiological and laboratory observations. Clinics in Chest Medicine. 33(4):745–758.
Lapp, N. and Castranova, V. 1993. How silicosis and coal workers' pneumoconiosis develop—A cellular assessment. Occupational Medicine (Philadelphia, PA). 8(1):35–56.
Lee, K.C., Guiney, P.D., Menzie, C.A., and Belanger, S.E. 2023. Advancing the weight of evidence approach to enable chemical environmental risk assessment for decision-making and achieving protection goals. Integrated Environmental Assessment and Management. 19(5):1188–1191. doi: *https://doi.org/10.1002/ieam.4803*
Lee, H.S., Phoon, W.H., and Ng, T.P.. 2001. Radiological progression and its predictive risk factors in silicosis. Occupational and Environmental Medicine. 58(7):467–471.
Leso, V., Fontana, L., Romano, R., Gervetti, P., and Iavicoli, I. 2019. Artificial stone associated silicosis: A systematic review. International Journal of Environmental Research and Public Health. 16(4):568. doi: *https://doi.org/10.3390/ijerph16040568.*
Li, J., Yao, W., Hou, J.Y., Zhang, L., Bao, L., Chen, H. T., Wang, D., Yue, Z.Z., Li, Y.P., Zhang, M., Yu, X.H., Zhang, J. H., Qu, Y.Q., and Hao, C.F. 2018. The role of fibrocyte in the pathogenesis of silicosis. Biomedical and Environmental Sciences. 31(4): 311–316. doi: *https://doi.org/10.3967/bes2018.040.*
Liu, Y., Zhou, Y., Hznido, E., Shi, T., Steenland, K., He, X., and Chen, W. 2017a. Total and cause-specific mortality risk associated with low-level exposure to crystalline silica: A 44-year cohort study from China. American Journal of Epidemiology. 186(4):481–490.
Loosereewanich, P., Ritchie, A.C., Armstrong, B., Bégin, R., Muir, DCF. and Dufresne, A., 1995. Pulmonary Dust Retention in Silicotics with and without Lung Cancer. Applied Occupational and Environmental Hygiene. 10(12): 1104–1106.
Los Angeles County Department of Health Services (LACDHS). 2022. Vigilant Olive View—UCLA Medical Center physicians identify rare occupational lung disease. LACHDS. *https://dhs.lacounty.gov/olive-view-ucla-silicosis/* Access Date: January 8, 2024.
Love, R.G., Waclawski E.R., Maclaren W.M., Porteous R.H., Groat S.K., Wetherill G.Z., Hutchison P.A., Kidd M.W., and Soutar C.A. 1995. Cross-sectional study of risks of respiratory disease in relation to

exposures of airborne quartz in the heavy clay industry. Institute of Occupational Medicine (IOM) Historical Research Report TM/94/07. Edinburgh.
Love, R., Waclawski, E.R., Maclaren, W.M., Wetherill, G.Z., Groat, S.K., Porteous, R.H., and Soutar, C.A. 1999. Risks of respiratory disease in the heavy clay industry. Occupational and Environmental Medicine. 56(2):124–133.
Lynch, H.N., Mundt, K.A., Pallapies, D. and Ricci, P.F. 2022. Lost in the woods: Finding our way back to the scientific method in systematic review. Global Epidemiology, p.100093.
Maclaren, W.M. and Soutar, C.A. 1985. Progressive massive fibrosis and simple pneumoconiosis in ex-miners. British Journal of Industrial Medicine. 42:734–740.
Malmberg, P., H. Hedenström, and Sundblad, B–M. 1993. Changes in lung function of granite crushers exposed to moderately high silica concentrations: A 12 year follow up. British Journal of Industrial Medicine. 50:726–731.
Mamuya, S.H., Bratveit, M., Mashalla, Y., and Moen, B.E. 2007. High prevalence of respiratory symptoms among workers in the development section of a manually operated coal mine in a developing country: a cross sectional study. BMC Public Health. 7(1):17–24.
Manfreda, J., Sidwall, G., Maini, K., West, P., Cherniack, R.M. 1982. Respiratory abnormalities in employees of the hard rock mining industry. American Review of Respiratory Disease. 126(4):629–634.
Mannetje, A., Steenland, K., Checkoway, H., Koskela, R–S., Koponen, M., Attfield, M., Chen, J., Hnizdo, E., DeKlerk, N., and Dosemeci, M. 2002a. Development of quantitative exposure data for a pooled exposure-response analysis of 10 silica cohorts. American Journal of Industrial Medicine. 42(2):73–86.
Mannetje A., Steenland, K., Attfield, M., Boffetta, P., Checkoway, H., DeKlerk, N., and Koskela, R.S. 2002b. Exposure-response analysis and risk assessment for silica and silicosis mortality in a pooled analysis of six cohorts. Occupational and Environmental Medicine. 59(11):723–728.
Martin, P., Bladier, C., Meek, B., Bruyere, O., Feinblatt, E., Touvier, M., Watier, L. and Makowski, D., 2018. Weight of evidence for hazard identification: A critical review of the literature. Environmental Health Perspectives, 126(7):076001.
Mazurek, J.M. and Attfield, M.D. 2008. Silicosis mortality among young adults in the United States, 1968–2004. American Journal of Industrial Medicine. 51(8):568–578.
Mazurek, J.M. and Wood, J.M. 2008a. Silicosis-related years of potential life lost before age 65 years—United States, 1968–2005. Morbidity and Mortality Weekly Report (MMWR). 57(28):771–775.
Mazurek, J.M. and Wood, J.M. 2008b. Erratum, ilicosis-related years of potential life lost before age 65 years—United States, 1968–2005. Morbidity and Mortality Weekly Report (MMWR). 57(30):829.
Mazurek, J.M., Wood, J., Blackley, D.J. and Weissman, D.N. 2018. Coal workers' pneumoconiosis—Attributable years of potential life lost to life expectancy and potential life lost before age 65 years—United States, 1999–2016. Morbidity and Mortality Weekly Report (MMWR). 67(30):819–824.
Mazurek, J.M., Schleiff, P.L., Wood, J.M., Hendricks, S.A., and Weston, A. 2015. Notes from the field. Update: Silicosis mortality—United States, 1999–2013. IN: Morbidity and Mortality Weekly Report (MMWR). 64(23):653–654. June 19, 2015.
McDonald, J.C., McDonald, A.D., Hughes, J.M., Rando, R.J., and Weill, H. 2005. Mortality from lung and kidney disease in a cohort of North American industrial sand workers: An update. Annals of Occupational Hygiene Journal. 49(5):367–373.
McDonald, A.D., McDonald, J.C., Hughes, J.M., Rando, R.J., and Weill, H. 2001. Cohort mortality study of North American industrial sand workers. I. Mortality from lung cancer, silicosis and other causes. Annals of Occupational Hygiene Journal. 45(3):193–199.
McDonald, J.C., Cherry, N., McNamee, R., Burgess, G., and Turner, S. 1995. Preliminary analysis of proportional mortality in a cohort of British pottery workers exposed to crystalline silica. Scandinavian Journal of Work, Environment & Health. 21(Suppl. 2):63–65.
McLaughlin, J.K., Jing-Qiong, C., Dosemeci, M., Rong-An, C., Rexing, S.H., Zhien, W., Hearl, F.J., McCawley, M.A., and Blot, W.J. 1992. A nested case-control study of lung cancer among silica exposed workers in China. British Journal of Industrial Medicine. 49:167–171.
Meijers, J.M., Swaen, G.M., Slangen, J.M., van Vliet, K and F. Sturmans. 1991. Long-term mortality in miners with coal workers' pneumoconiosis in the Netherlands: A pilot study. American Journal of Industrial Medicine. 19(1):43–50.
Meijers J.M., Swaen, G.M., Slangen, J.J., and van Vliet, C. 1988. Lung cancer among Dutch coal miners: A case-control study. American Journal of Industrial Medicine. 14(5):597–604.
Mercer, R.R., Scabilloni, J.F., Wang, L., Battelli, L.A., Antonini, J.M., Roberts, J.R., Qian, Y., Sisler, J.D., Castranova, V., Porter, D.W. and Hubbs, A.F., 2018. The fate of inhaled nanoparticles: detection and measurement by enhanced dark-field microscopy. Toxicologic Pathology. 46(1): 28–46.
Merlo, F., Costantini, M., Reggiardo, G., Ceppi, M. and Puntoni, R., 1991. Lung cancer risk among refractory brick workers exposed to crystalline silica: A retrospective cohort study. Epidemiology. 2(4):299–304.
Miller, B. and MacCalman, L. 2010. Cause-specific mortality in British coal workers and exposure to respirable dust and quartz. Occupational and Environmental Medicine. 67(4):270–276. doi:10.1136/oem.2009.046151.
Miller, B., MacCalman, L. and Hutchison, P. 2007. Mortality over an extended follow-up period in coal workers exposed to respirable dust and quartz. Institute of Medicine Research Report TM/07/06.
Miller, B.G., Hagen, S., Love, R.G., Soutar, C.A., Cowie, H.A., Kidd, M.W., and Robertson, A. 1998. Risks of silicosis in coalworkers exposed to unusual concentrations of respirable quartz. Occupational and Environmental Medicine. 55(1):52–58.
Miller, B., Buchanan, D., Hurley, J.F., Hutchison, P.A., Soutar, C.A., Pilkington, A., and Robertson, A. 1997. The effects of exposure to diesel fumes, low-level radiation, and respirable dust and quartz, on cancer mortality in coalminers. Institute of Occupational Medicine. Historical Research Report TM/97/04.
Miller, B.G., Hagen, S., Love, R.G., Cowie, H.A., Kidd, M.W., Lorenzo, S., Tielemans, E.L.J.P. Robertson, A. Soutar. C.A. 1995. Historical research report, a follow-up study of miners exposed to unusual concentrations of quartz research report TM/95/03:164. Edinburgh: Institute of Occupational Medicine.
Mine Safety and Health Administration (MSHA). 2023. Memorandum for the rulemaking record: Proposed rule on lowering miners' exposure to respirable crystalline silica and improving respiratory protection and SBA Office of Advocacy Small Business labor safety roundtable presentation. August 30, 2023.
Mine Safety and Health Administration (MSHA). 2022a. MSHA MSIS respirable crystalline silica data for the coal industry, August 2016 through July 2021. Washington, DC: US Department of Labor (DOL) Mine Safety and Health Administration (MSHA).
Mine Safety and Health Administration (MSHA). 2022b. MSHA MSIS respirable crystalline silica data for the MNM Industry, 2005 through 2019. Washington, DC: US Department of Labor (DOL) Mine Safety and Health Administration (MSHA).
Mine Safety and Health Administration (MSHA). MSHA, 2022c. Method P–2: X-ray diffraction determination of quartz and cristobalite in respirable metal/nonmetal mine dust. Technical Support. Pittsburgh Safety and Health Technology Center.
Mine Safety and Health Administration (MSHA). 2022d. Mine Data Retrieval System. [Online] Available at: *https://www.msha.gov/data-and-reports/mine-data-retrieval-system* [Accessed 2022].
Mine Safety and Health Administration (MSHA). 2020b. Determination of quartz in respirable coal mine dust by Fourier transform infrared spectrophotometry. Method P–7. Technical Support. Pittsburgh Safety and Health Technology Center.
Mine Safety and Health Administration (MSHA). 2019a. Quarterly employment production industry profile. Mine Data Retrieval System. Accessed 2022. Retrieved from: *https://www.msha.gov/data-and-reports/mine-data-retrieval-system.*

Mine Safety and Health Administration (MSHA). 2019b. Quarterly contractor employment production report. Mine Data Retrieval System. Accessed 2022. Retrieved from: *https://www.msha.gov/data-and-reports/mine-data-retrieval-system.*

Mine Safety and Health Administration (MSHA). 2014. Lowering miners' exposure to respirable coal mine dust, including continuous personal dust monitors. Final Rule. 79 FR 24813.

Mine Safety and Health Administration (MSHA). 2013a. Infrared determination of quartz in respirable coal mine dust. Method P–7. Pittsburgh Safety and Health Technology Center.

Mine Safety and Health Administration (MSHA). 2013b. X-Ray diffraction determination of quartz and cristobalite in respirable mine dust. Method P–2. Pittsburgh Safety and Health Technology Center.

Mine Safety and Health Administration (MSHA). 1995. Respiratory Protective Devices. Final Rule. 60 FR 30398. June 8, 1995

Miyazaki, M. and Une, H. 2001. Risk of lung cancer among Japanese coal miners on hazard risk and interaction between smoking and coal mining. Journal of Occupational Health. 43(5):225–230.

Mohebbi I. and Zubeyri, T. 2007. Radiological progression and mortality among silica flour packers: A longitudinal study. Inhalation Toxicology. 19(12):1011–1017.

Möhner, M., Pohrt, A. and Gellissen, J., 2017. Occupational exposure to respirable crystalline silica and chronic non-malignant renal disease: systematic review and meta-analysis. International Archives of Occupational and Environmental Health. 90:555–574.

Montes, I.I., Fernández, G.R., Reguero, J., Mir, M.A.C, García-Ordás, E., Martínez, J.L.A., and Martínez González, C. 2004a. Respiratory disease in a cohort of 2,579 coal miners followed up over a 20-year period. Chest. 126(2):622–9.

Montes, I.I., Rego, G., Camblor, C., Quero, A., Gonzalez, A., and Rodriguez, C. 2004b. Respiratory disease in aggregate quarry workers related to risk factors and Pi phenotype. Journal of Occupational and Environmental Medicine. 46:1150–1157.

Moshammer, H. and Neuberger, M. 2004. Lung cancer and dust exposure: Results of a prospective cohort study following 3260 workers for 50 years. Occupational and Environmental Medicine. 61(2):157–162.

National Center for Health Statistics (NCHS). 2020b. Table 292A. Death rates for 282 selected causes, by 5-year age groups, race, and sex: United States, 1979–98—(Rates per 100,000 population). Hyattsville, MD: US Dept of Health and Human Services.

National Center for Health Statistics (NCHS). 2009. Table 291R. Death rates for 113 selected causes by 5-year age groups, Hispanic origin, race for non-Hispanic population, and sex: United States, 1999–2006 (Rates per 100,000 population). US Dept of Health and Human Services, National Center for Health Statistics, Hyattsville, MD. Retrieved from: *http://www.cdc.gov/nchs/nvss/mortality/gmwkh291r.htm.*

National Center for Health Statistics (NCHS). 1996. Vital statistics of the United States. Vol II. Mortality, part A. National Center for Health Statistics. Public Health Service, DHHS publ no (PHS) 96–1101. Washington, DC.

National Institute for Occupational Safety and Health (NIOSH). 2022a. Certified Equipment list. Accessed November 21, 2022, Downloaded January 5, 2023. Retrieved from: *https://www.cdc.gov/niosh/npptl/topics/respirators/cel/default.html.*

National Institute for Occupational Safety and Health (NIOSH). 2022b. Direct-on-filter analysis for respirable crystalline silica using a portable FTIR instrument. By Chubb LG, Cauda EG. Pittsburgh PA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2022–108, IC 9533. *https://doi.org/10.26616/NIOSHPUB2022108* (last accessed Jan. 10, 2024).

National Institute for Occupational Safety and Health (NIOSH). 2021d. Mining Topic: Respiratory Diseases. Accessed 2023. Retrieved from: *https://www.cdc.gov/niosh/mining/topics/respiratorydiseases.html.*

National Institute for Occupational Safety and Health (NIOSH). 2021a. Best practices for dust control in coal mining, second edition. By Colinet J.F., Halldin C.N., Schall J. Pittsburgh PA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2021–119, IC 9532.

National Institute for Occupational Safety and Health (NIOSH). 2019a. Current intelligence bulletin 69: NIOSH practices in occupational risk assessment. By Daniels R.D., Gilbert S.J., Kuppusamy S.P., Kuempel E.D., Park R.M., Pandalai S.P., Smith R.J., Wheeler M.W., Whittaker C., and Schulte P.A. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 2020–106, doi: *https://doi.org/10.26616/NIOSHPUB2020106.*

National Institute for Occupational Safety and Health (NIOSH). 2019b. Dust control handbook for industrial minerals mining and processing. Second edition. By Cecala A.B., O'Brien A.D., Schall J., Colinet J.F., Franta R.J., Schultz M.J., Haas E.J., Robinson J., Patts J., Holen B.M., Stein R., Weber J., Strebel M., Wilson L., and Ellis M. Pittsburgh PA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2019–124, RI 9701. doi: *https://doi.org/10.26616/NIOSHPUB2019124.*

National Institute for Occupational Safety and Health (NIOSH). 2017b. Current Intelligence Bulletin 68: NIOSH chemical carcinogen policy. By Whittaker, C., Rice, F., McKernan, L., Dankovic, D., Lentz, T.J., MacMahon, K., Kuempel, E., Zumwalde, R., Schulte, P. on behalf of the NIOSH Carcinogen and RELs Policy Update Committee. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2017–100.

National Institute for Occupational Safety and Health (NIOSH). 2014a. Specifications for medical examinations of coal miners—42 CFR part 37, Interim final rule. National Institute for Occupational Safety and Health. 79 FR 45110, August 4, 2014.

National Institute for Occupational Safety and Health (NIOSH). 2014d. Posthearing brief of the National Institute for Occupational Safety and Health on the Occupational Safety and Health Administration (OSHA) proposed rule (PR) on occupational exposure to respirable crystalline silica. Docket No. OSHA–2010–0034. RIN 1218—AB70.

National Institute for Occupational Safety and Health (NIOSH). 2014b. Occupational respiratory disease surveillance. National Institute for Occupational Safety and Health. 2 pages. *https://www.cdc.gov/niosh/topics/surveillance/ords/statebasedsurveillance.html.*

National Institute for Occupational Safety and Health (NIOSH). 2014e. Analysis of the silica percent in airborne respirable mine dust samples from U.S. operations. Retrieved from: *https://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/aotsp.pdf.*

National Institute for Occupational Safety and Health (NIOSH). 2012a. National survey of the mining population—Part I: Employees. Department of Health and Human Services Centers for Disease Control and Prevention National Institute for Occupational Safety and Health Office of Mine Safety and Health Research Pittsburgh, PA; Spokane, WA.

National Institute for Occupational Safety and Health (NIOSH). 2008c. Respirator use policy for protection against carcinogens. DHHS (NIOSH) *https://www.cdc.gov/niosh/respuse.html.*

National Institute for Occupational Safety and Health (NIOSH). 2007b. NIOSH pocket guide to chemical hazards. Third printing—September 2007, with minor technical changes. DHHS(NIOSH) Publication No. 2005–149. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Cincinnati, Ohio.

National Institute for Occupational Safety and Health (NIOSH). 2003b. NIOSH manual of analytical methods, 4th ed., 3rd Suppl. Chapter R. Determination of

airborne crystalline silica. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Publication No. 03–127. Cincinnati, Ohio.
National Institute for Occupational Safety and Health (NIOSH). 2002b. NIOSH hazard review: Health effects of occupational exposure to respirable crystalline silica. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 2002–129.
National Institute for Occupational Safety and Health (NIOSH). 2000a. Health hazards evaluation report (HETA 93–0795–2783) at U.S. Silica—Columbia. Cayce—W. Columbia, SC. BY: M.S. Filios. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.
National Institute for Occupational Safety and Health (NIOSH). 2000b. Health hazards evaluation report (HETA 91–0375–2779) at U.S. Silica Company, Berkeley Springs. Berkeley Springs, West Virginia. BY: M.S. Filios.
National Institute for Occupational Safety and Health (NIOSH). 1995. Respiratory protective devices 42 CFR part 84. National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention, Public Health Service, HHS. 61 FR 30336, June 8, 1995.
National Institute for Occupational Safety and Health (NIOSH). 1995a. Occupational exposure to respirable coal dust. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.
National Institute for Occupational Safety and Health (NIOSH). 1995b. A NIOSH technical guide. Guidelines for air sampling and analytical method development and evaluation. By Kennedy, Ph.D. E., Fischbach, T., Song, Ph.D., R., Eller, Ph.D., P., and Shulman, Ph.D., S. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control. NIOSH, Division of Safety Research.
National Institute for Occupational Safety and Health (NIOSH). 1978. NIOSH pocket guide to chemical hazards. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute of Occupational Safety and Health. Publication No. 78–210.
National Institute for Occupational Safety and Health (NIOSH). 1975. NIOSH Technical Information—Exposure measurement action level and occupational environmental variability. By Leidel, N.A., Busch K.A., and Crouse W.E.. US Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, Division of Laboratories and criteria Development, Cincinnati, Ohio. HEW Publication No. (NIOSH) 76–131. *http://www.cdc.gov/niosh/docs/76-13I1pdfs/76-131.pdf.*
National Institute for Occupational Safety and Health (NIOSH). 1974. Criteria for a recommended standard: Occupational exposure to crystalline silica. US Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, NIOSH. HEW Publication No. (NIOSH) 75–120. Washington, DC.
National Mining Association (NMA) et al. v. Secretary of Labor, et al. 116 F.3d 520, 527–28. United States Court of Appeals, District of Columbia Circuit, June 17, 1997.
National Mining Association Alabama Coal Association, et al. v. U.S. Department of Labor and Mine Safety and Health Administration. US Court of Appeals—11th Circuit No. 14–11942; 812 F.3d 843, 866. January 25, 2016.
National Mining Association v. United Steel Workers. 2021. 985 F.3d 1309, 1319. United States Court of Appeals, Eleventh Circuit. No. 17–11207. January 22, 2021.
National Research Council (NRC). 2009. Science and decisions: Advancing risk assessment. Washington, DC: The National Academies Press. doi: *https://doi.org/10.17226/12209.*
National Research Council (NRC). 1983. Risk assessment in the Federal Government: Managing the process. National Academies Press. *https://pubmed.ncbi.nlm.nih.gov/25032414/.*
National Toxicology Program (NTP). 2000. Fact Sheet: The Report on Carcinogens—9th edition. News Release. National Toxicology Program, Department of Health and Human Services. 13 page.
National Toxicology Program (NTP). 2016. Silica, Crystalline (Respirable Size). Report on carcinogens, Fourteenth Edition. Department of Health and Human Services, Public Health Service, National Toxicology Program. Washington, DC.
Ndlovu N., Richards, G., Vorajee, N., and Murray, J. 2019. Silicosis and pulmonary tuberculosis in deceased female South African miners. Occupational Medicine 69(4):272–278.
Nelson, G. 2013. Occupational respiratory diseases in the South African mining industry.Global Health Action. 6(1): 19520. doi: 10.3402/gha.v6i0.19520.
Neukirch, F., Cooreman, J., Korobaeff, M., and Pariente, R. 1994. Silica exposure and chronic airflow limitation in pottery workers. Archives of Environmental Health. 49(6):459–464.
Ng, T.P. and Chan, S.L. 1994. Quantitative relations between silica exposure and development of radiological small opacities in granite workers. Annals of Occupational Hygiene Journal. 38:857–863.
Ng, T.P. and Chan, S.L. 1992. Lung function in relation to silicosis and silica exposure in granite workers. European Respiratory Journal 5(8):986–991.
Ng, T.P. and Chan, S.L. 1991. Factors associated with massive fibrosis in silicosis. Thorax. 46(4):229–232.
Ng, T.P., Ng, Y.L., Lee, H.S., Chia, K.S., and Ong, H.Y. 1992a. A study of silica nephrotoxicity in exposed silicotic and non-silicotic workers. British Journal of Industrial Medicine. 49(1):35–37.
Ng, T.P., Phoon, W.H., Lee, H.S., Ng, Y.L., and Tan, K.T. 1992b. An epidemiological survey of respiratory morbidity among granite quarry workers in Singapore: Chronic bronchitis and lung function impairment. Annals Academy of Medicine Singapore. 21(3):312–317.
Ng, T.P., Chan, S.L., and Lam, K.P. 1987a. Radiological progression and lung function in silicosis: A ten year follow up study. British Medical Journal. 295:164–168.
Ng T.P., Tsin, T.W., O'Kelly, F.J., and Chan, S.L. 1987b. A survey of the respiratory health of silica-exposed gemstone workers in Hong Kong. American Review of Respiratory Disease. 135(6):1249–1254.
Nolan, R.P., Langer, A.A., Harington, J.S., Oster, G., and Selikoff, I.J. 1981. Quartz hemolysis as related to its surface functionalities. Environmental Research. 26(2):503–520.
North America's Building Trades Unions v Occupational Safety and Health Administration. No. 16–1105. Consolidated with 16–1113, 16–1125, 16–1126, 16–1131, 16–1137, 16–1138, 16–1146. United States Court of Appeals for the District of Columbia Circuit. December 22, 2017.
Nuyts, G.D., Van Vlem, E., De Vos, A., Daelemans, R.A., Rorive, G., Elseviers, M.M., Schurgers, M., Segaert, M., D'Haese, P.C., and De Broe, M.E. 1995. Wegener granulomatosis is associated to exposure to silicon compounds: A case-control study. Nephrology Dialysis Transplantation. 10(7):1162–1165.
Occupational Safety and Health Administration (OSHA). 2016a. Occupational exposure to respirable crystalline silica; final rule. 81 FR 16286, March 25, 2016.
Occupational Safety and Health Administration (OSHA). 2013b. Occupational exposure to respirable crystalline silica—review of health effects literature and preliminary quantitative risk. Docket OSHA–2010–0034.
Occupational Safety and Health Administration (OSHA). 2006. Assigned protection factors. 71 FR 50122, August 24, 2006.
Occupational Safety and Health Administration (OSHA). 2004. Controlled negative pressure REDON fit testing protocol. 69 FR 46986, August 4, 2004.
Office of Inspector General (OIG) Office of Audit. 2020. MSHA needs to improve efforts to protect coal miners from respirable crystalline silica. November 12, 2020.
Ogawa S., H. Imai, and Ikeda, M. 2003a. A 40-year follow-up of whetstone cutters

on silicosis. Industrial Health. 41(2):69–76.
Oni, T. and Ehrlich, R. 2015. Complicated silicotuberculosis in a South African gold miner: A case report. American Journal of Industrial Medicine. 58(6):697–701.
Onyije, F.M., Olsson, A., Erdmann, F., Magnani, C., Petridou, E., Clavel, J., Miligi, L., Bonaventure, A., Ferrante, D., Piro, S. and Peters, S., 2022. Parental occupational exposure to combustion products, metals, silica and asbestos and risk of childhood leukaemia: Findings from the Childhood Cancer and Leukaemia International Consortium (CLIC). Environment International. 167:107409.
Organiscak, J.A., Cecala, A.B., Zimmer, J.A. Holen, B., Baregi, J.R. 2016. Air cleaning performance of a new environmentally controlled primary crusher operator booth. Mining Engineering. 68(2): 31–37. doi:10.19150/me.6469.
Pairon J–C., Billon-Galland, M.A., Iwatsubo, Y., Bernstein, M., Gaudichet, A., Bignon, J., and Brochard, P. 1994. Biopersistence of Nonfibrous Mineral Particles in the Respiratory Tracts of Subjects following Occupational Exposure. Environmental Health Perspectives. 1 02(Suppl 5):269–275.
Pan, G., Takahashi, K., Feng, Y., Liu, L., Liu, T., Zhang, S., Liu, N., Okubo, T., and Goldsmith, D.S., 1999. Nested case-control study of esophageal cancer in relation to occupational exposure to silica and other dusts. American Journal of Industrial Medicine. 35(3):272–280.
Park, R., Rice, F., Stayner, L., Smith, R., Gilbert, S., and Checkoway, H. 2002. Exposure to crystalline silica, silicosis, and lung disease other than cancer in diatomaceous earth industry workers: A quantitative risk assessment. Occupational and Environmental Medicine. 59:36–43.
Parker, J.E. and Banks, D.E. 1998. Lung diseases in coal workers. In: Banks, D.E. and Parker, J.E.. Chapter 11. Occupational lung disease- an international perspective, E.Ed.. Chapman & Hall. London ISBN O 412 73630 6. 161–181.
Parks, C., Conrad, K., and Cooper, G. 1999. Occupational exposure to crystalline silica and autoimmune disease. Environmental Health Perspectives. 107(Suppl. 5):793–802.
Pavan, C., Delle Piane, M., Gullo, M., Filippi, F., Fubini, B., Hoet, P., Horwell, C. J., Huaux, F., Lison, D., Lo Giudice, C., Martra, G., Montfort, E., Schins, R., Sulpizi, M., Wegner, K., Wyart-Remy, M., Ziemann, C., and Turci, F. 2019. The puzzling issue of silica toxicity: Are silanols bridging the gaps between surface states and pathogenicity?. Particle and Fibre Toxicology. 16(1): 32. *https://doi.org/10.1186/s12989-019-0315-3.*
Phibbs, B.P., Sundin, R.E. and Mitchell, R.S., 1971. Silicosis in Wyoming bentonite workers. American Review of Respiratory Disease. 103(1):1–17.
Poland, C.A., Duffin, R., Weber, K., Dekant, W. and Borm, P.J., 2023. Is pulmonary inflammation a valid predictor of particle induced lung pathology? The case of amorphous and crystalline silicas. Toxicology Letters.
Porter, D.W., Barger, M., Robinson, V.A., Leonard, S.S., Landsittel, D., and Castranova, V. 2002c. Comparison of low doses of aged and freshly fractured silica on pulmonary inflammation and damage in the rat. Toxicology. 175(1–3):63–71.
Pukkala, E., Guo, J., Kyyrönen, P., Lindbohm, M.L., Sallmén, M., Kauppinen, T. 2005. National job-exposure matrix in analyses of census-based estimates of occupational cancer risk. Scandinavian Journal of Work, Environment & Health. 31(2):97–107.
Rando, R.J., Shi, R., Hughes, J.M., Weill, H., McDonald, A.D., and McDonald, J.C. 2001. Cohort mortality study of North American industrial sand workers. III. Estimation of past and present exposures to respirable crystalline silica. Annals of Occupational Hygiene Journal. 45(3):209–216.
Rastogi, S.K., Gupta, B.N., Chandra, H., Mathur, N., Mahendra, P.N., and Husain, T. 1991. A study of the prevalence of respiratory morbidity among agate workers. International Archives of Occupational and Environmental Health. 63:21–26.
Registry of Toxic Effects of Chemical Substances (RTECS). 2016. Silica, crystalline—quartz. Registry of Toxic Effects of Chemical Substances. RTECS# VV7330000. NIOSH, Education and Information Division.
Rego, G., Pichel, A., Quero, A., DuBois, A., Martinez, C., Isidro, I., Gil, M., Cuevro, V., and Gonzales, A. 2008. High prevalence and advanced silicosis in active granite workers: A dose-response analysis including FEV1. Journal of Occupational and Environmental Medicine. 50(7):827–833.
Reid, P.J. and Sluis-Cremer, G.K. 1996. Mortality of white South African gold miners. Occupational and Environmental Medicine. 53(1):11–16.
Requena-Mullor, M., Alarcón-Rodríguez, R., Parrón-Carreño, T., Martínez-López. J.J., Lozano-Paniagua, D., and Hernández, A.F. 2021. Association between crystalline silica dust exposure and silicosis development in artificial stone workers. International Journal of Environmental Research and Public Health. 18(11):5625. doi: 10.3390/ijerph18115625.
Reynolds L., Blackley, D., Colinet, J., Potts, J., Storey, E., Short, C., Carson, R., Clark, K., Laney, A., and Halldin C. 2018b. Work practices and respiratory health status of Appalachian coal miners with progressive massive fibrosis. Journal of Occupational and Environmental Medicine. 60(11): e575–e581.
Reynolds, C.J., MacNeill, N.J., Godges, N.G., Campbell, M.J., Newman, Taylor A.J., and Cullinan, P. 2016. Chronic obstructive pulmonary disease in Welsh slate miners. Occupational Medicine. 67:20–25. doi:10.1093/occmed/kqw147.
Rice, F.L., Park, R., Stayner, L., Smith, R., Gilbert, S., and Checkoway, H. 2001. Crystalline silica exposure and lung cancer mortality in diatomaceous earth industry workers: A quantitative risk assessment. Occupational and Environmental Medicine. 58(1):38–45.
RJ Lee Group. Laboratory Testing Guide. April 2021. 1–97.
Roscoe, R., Deddens, J.A., Salvan, A., and Schnorr, T.M. 1995. Mortality among Navajo uranium miners. American Journal of Public Health. 85(4):535–540.
Rose, C., Heinzerling, A., Patel, K., Sack, C., Wolff, J., Zell-Baran, L., Weissman, D., Hall, E., Sooriah, R., McCarthy, R., Bojes H., Korotzer, B., Flattery, J., Lew Weinberg, J., Ptocoko, J., Jones, K.D., Reeb-Whitaker, C.K., Reul, N.K., LaSee, C.R., Materna, B.L., Raghu, G., Harrison, R. 2019. Severe silicosis in engineered stone fabrication workers—California, Colorado, Texas, and Washington, 2017–2019. Morbidity Mortality Weekly Report. 68: 813–818. doi: *http://dx.doi.org/10.15585/mmwr.mm6838a1.*
Rosenman, K.D., Reilly, M.J., and Henneberger, P.K. 2003. Estimating the total number of newly-recognized silicosis cases in the United States. American Journal of Industrial Medicine. 44(2):141–147.
Rosenman, K.D., Moore-Fuller, M., and Reilly M.J. 2000. Kidney disease and silicosis. Nephron. 85:14–19.
Rosenman K.D., Reilly, M.J., Kalinowski, D.J., and Watt, F.C. 1997. Occupational and environmental lung disease: Silicosis in the 1990s. Chest. 111:779–786.Rosental, P. 2017. Silicosis: A World History. Baltimore: Johns Hopkins University Press., doi:10.1353/book.51996.
Rosental, P. 2017. Silicosis: A world history. Baltimore: Johns Hopkins University Press., doi:10.1353/book.51996.
Rubio-Rivas, M., Moreno, R., and Corbella, X. 2017. Occupational and environmental scleroderma. Systematic review and meta-analysis. Clinical Rheumatology. 36:569–582.
Ruckley, V.A., Fernie, J.M., Chapman, J.S., Collings, P., Davis, J.M., Douglas, A.N., Lamb, D., and Seaton, A. 1984. Comparison of radiographic appearances with associated pathology and lung dust content in a group of coal workers. British Journal of Industrial Medicine. 41:459–467.
Ruckley, V.A., Chapman J.S., Collings P.L., Douglas A.N., Fernie J.M., Lamb D., and Davis J.M.G. 1981. Autopsy study of coalminers' lungs—phase II. Final report on CEC Contract 7246–15/8/001. Historical Research Report—Research Report TM/81/18. Institute of Occupational Medicine. Edinburgh.
Samet, J.M., Young, R.A., Morgan, M.V., and Humble, C.G. 1984. Prevalence of respiratory abnormalities in New Mexico uranium miners. Health Physics. 46(2):361–370.
Sanderson, W.T., Steenland, K., and Deddens, J.A. 2000. Historical respirable quartz exposures of industrial sand workers: 1946–1996. American Journal of Industrial Medicine. 38(4):389–398.
Schins, R.P.F., Duffins, R., Hohr, D., Knappen, A.M., Shi, T., Weishaupt, C.,

Stone, V., Donaldsen, K., and Borm, P.J.A. 2002. Surface modification of quartz inhibits toxicity, particle uptake, and oxidative DNA damage in human lung epithelial cells. Chemical Research in Toxicology. 15(9):1166–1173.

Schmajuk, G., Trupin, L., Yelin, E., and Blanc, P.D. 2019. Prevalence of arthritis and rheumatoid arthritis in coal mining counties of the United States.. Arthritis Care and Research. 71(9):1209–1215.

Schubauer-Berigan, M.K., Daniels, R.D., and Pinkerton, L.E. 2009. Radon exposure and mortality among white and American Indian uranium miners: an update of the Colorado Plateau cohort. American Journal of Epidemiology. 169(6):718–30.

Seaman, C.E., Shahan, M.R., Beck, T.W., and Mischler, SE 2020. Design of a water curtain to reduce accumulations of float coal dust in longwall returns. International Journal of Mining Science and Technology. 30(4):443–447.

Seixas, N.S., Neyer, N.J., Welp, E.A.E., and Checkoway, H. 1997. Quantification of historical dust exposures in the diatomaceous earth industry. Annals of Occupational Hygiene Journal. 41(5):591–604.

Selikoff, I.J. 1978. Carcinogenic potential of silica compounds. In: Bendz, G. and Lindqvist, I. eds. Biochemistry of Silicon and Related Problems. 2016. New York: Plenum Press. Pages 311–336.

SGS Galson. Another lower quantitation level: Crystalline silica cristobalite. Retrieved December 22, 2022, from Another Lower Quantitation Level: Crystalline Silica Cristobalite SGS Galson.

Sherson, D. and Lander, F. 1990. Morbidity of pulmonary tuberculosis among silicotic and non-silicotic foundry workers in Denmark. Journal of Occupational Medicine. 32:110–113.

Shi, X., Castranova, V., Halliwell, B., and Vallythan, V. 1998. Reactive oxygen species and silica-induced carcinogenesis. Journal of Toxicology and Environmental Health, Part B. 1(3):181–197.

Shi, X., Dalal, N.S., Hu, X.N., and Vallythan, V. 1989. The chemical properties of silica particle surface in relation to silica-cell interactions. Journal of Toxicology and Environmental Health. 27(4):435–454.

Shoemaker D.A., Pretty, J.R., Ramsey, D.M., McLaurin, J.L., Khan, A., Teass, A.W., Castranova, V., Pailes, W.H., Dalal, N.S., Miles, P.R., Bowman, L., Leonard, S., Shumaker, J., Vallyathan, V., and Pack, D. 1995. Particle activity and in vivo pulmonary response to freshly milled and aged alpha-quartz. Scandinavian Journal of Work, Environment & Health. 21:15–18.

Sluis-Cremer, G.K., Walters, L.G. and Sichel, H.S. 1967. Chronic bronchitis in miners and non-miners: An epidemiological survey of a community in the gold-mining area in the Transvaal. British Journal of Industrial Medicine.24:1–12.

Small Business Administration, Office of Advocacy. 2017. How to comply with the regulatory flexibility act, August 2017.

Starzynski, Z., Marek, K., Kujawska, A, and Szymczak, W. 1996. Mortality among different occupational groups of workers with pneumoconiosis: Results from a register-based cohort study. American Journal of Industrial Medicine. 30(6):718–725.

Steenland, K. 2005b. One agent, many diseases: Exposure-response data and comparative risks of different outcomes following silica exposure. American Journal of Industrial Medicine. 48(1):16–23.

Steenland, K. and Brown, D. 1995a. Mortality study of gold miners exposed to silica and non-asbestiform amphibole minerals: An update with 14 more years of follow-up. American Journal of Industrial Medicine. 27(2):217–229.

Steenland, K. and Brown, D. 1995b. Silicosis among gold miners: Exposure-response analyses and risk assessment. American Journal of Public Health. 85(10):1372–1377.

Steenland, K. and Sanderson, W. 2001. Lung cancer among industrial sand workers exposed to crystalline silica. American Journal of Epidemiology. 153(7):695–703.

Steenland K., Attfield, M., and Mannejte, A. 2002a. Pooled analyses of renal disease mortality and crystalline silica exposure in three cohorts. Annals of Occupational Hygiene Journal. 46(Suppl. 1):4–9.

Steenland K., Mannetje, A., Boffetta, P., Stayner, L., Attfield, M., Chen, J., Dosemeci, M., DeKlerk, N., Hnizdo, E., Koskela, R., and Checkoway, H. 2001a. Pooled exposure-response analyses and risk assessment for lung cancer in 10 cohorts of silica-exposed workers: an IARC multicentre study. International Agency for Research on Cancer. Cancer Causes Control. 12(9):773–784.

Steenland, K., Sanderson, W., and Calvert, G.M. 2001b. Kidney disease and arthritis in a cohort study of workers exposed to silica. Epidemiology. 12:405–412.

Steenland, N.K., Thun, M.J., Ferguson, C.W., and Port, F.K. 1990. Occupational and other exposures associated with male end-stage renal disease: A case/control study. American Journal of Public Health. 80(2):153–157.

Stern, F., Lehman, E., and Ruder, A.. 2001. Mortality among unionized construction plasterers and cement masons. American Journal of Industrial Medicine. 39(4):373–388.

Stewart, J. 2011. Occupational hygiene: Control of exposures through intervention. Encyclopedia of Occupational Health and Safety. International Labor Organization, Geneva. Accessed January 11, 2024. Retrieved from: *https://www.iloencyclopaedia.org/part-iv-66769/occupational-hygiene-47504/item/573-occupational-hygiene-control-of-exposures-through-intervention.*

Suhr, H., Bang, B., and Moen, B.. 2003. Respiratory health among quartz-exposed slate workers—A problem even today. Occupational Medicine. 53(6):406–407.

Sun, K., and Azman, A. S. 2018. Evaluating hearing loss risks in the mining industry through MSHA citations. Journal of Occupational and Environmental Hygiene. 15(3): 246–262. doi: *https://doi.org/10.1080/15459624.2017.1412584.*

Suter, G., Nichols, J., Lavoie, E. and Cormier, S., 2020. Systematic review and weight of evidence are integral to ecological and human health assessments: They need an integrated framework. Integrated Environmental Assessment and Management. 16(5):.718–728.

Swaen G.M.H., J.M.M. Meijers, and J.J.M. Slangen. 1995. Risk of gastric cancer in pneumoconiotic coal miners and the effect of respiratory impairment. Occupational and Environmental Medicine. 52(9):606–610.

teWaterNaude, J.M., Ehrlich, R.I., Churchyard, G.J., Pemba, L., Dekker, K., Vermeis, M., White, NW, Thompson, M.L., and Myers, J.E. 2006. Tuberculosis and silica exposure in South African gold miners. Occupational and Environmental Medicine. 63(3):187–192.

Theriault, G.P., Burgess, W.A., DiBerardinis, L.J., and Peters, J.M. 1974a. Dust exposure in the Vermont granite sheds. Archives of Environmental Health: An International Journal. 28(1):12–17.

Theriault, G.P., J.M. Peters, and L.J. Fine. 1974b. Pulmonary function in granite shed workers of Vermont. Archives of Environmental Health: An International Journal. 28(1):18–22.

Tomaskova, H., J. Horacek, H. Slachtova, A. Splichalova, P., Riedlova, A. Daleck, Z. Jirak, and R. Madar. 2022. Analysis of histopathological findings of lung carcinoma in Czech black coal miners in association with coal workers' pneumoconiosis. International Journal of Environmental Research and Public Health. 19(2): 710–719. doi: *https://doi.org/10.3390/ijerph19020710.*

Tomaskova H., Splichalova, A., Slachtova, H., and Jirak, Z. 2020. Comparison of lung cancer risk in black coal miners based on mortality and incidence. Medycyna Pracy. 71(5):513–518.

Tomaskova, H., Splichalova, A., Slachtova, H., Urban, P., Hajdukova, Z., Landecka, I., Gromnica, R., Brhel, P., Pelclova, D., and Jirak, Z. 2017. Mortality in miners with coal workers' pneumoconiosis in the Czech Republic in the period 1992–2013. International Journal of Environmental Research and Public Health. 14(3):269–280. doi:10.3390/ijerph14030269.

Tomaskova, H., Jirak, Z., Splichalova, A., and Urban, P. 2012. Cancer incidence in Czech black coal miners in association with coal workers' pneumoconiosis. International Journal of Occupational Medicine and Environmental Health. 25(2):137–144.

ToxaChemica, International, Inc. 2004. Silica Exposure: Risk assessment for lung cancer, silicosis, and other diseases by Steenland, N.K. and Bartell, S.M. Draft final report prepared under Department of Labor Contract No. J–9–F–0–0051. Gaithersburg, Maryland.

Tse, L.A., Li, Z.M., Wong, T.W., Fu, Z.M., and Yu, I.T.S. 2007b. High prevalence of accelerated silicosis among gold miners in Jiangxi, China. American Journal of Industrial Medicine. 50(12):876–880.

Tse, L.A., Yu, I.T.S., Leung, C.C., Tam, W., and Wong, T.W. 2007a. Mortality from non-malignant respiratory diseases among people with silicosis in Hong Kong: exposure-response analyses for exposure to silica dust. Occupational and Environmental Medicine. 64(2):87–92.

Tsuda, T., Mino, Y., Babazono, A., Shigemi, J., Otsu, T., Yamamot, E. 2001. A case-control study of the relationships among silica exposure, gastric cancer, and esophageal cancer. American Journal of Industrial Medicine. 39(1):52–57.

U.S. Department of the Interior, U.S. Geological Survey. 2021. Mineral Commodities Summaries 2021. Page 9.

U.S. Bureau of Economic Analysis (BEA), 2023. Table 1.1.4. Price Indexes for Gross Domestic Product. [Online] Retrieved from: *https://apps.bea.gov/iTable/?reqid=19&step=2&isuri=1&categories=survey* [Accessed 2023].

U.S. Department of Labor, Mine Safety and Health Administration. Respirable Silica (Quartz), Request for Information. Federal Register Notice, 84 FR 45452–45456, August 29, 2019.

U.S. Department of Labor, Mine Safety and Health Administration. 1983. Mine safety and health. Fall. Page 6.

U.S. Environmental Protection Agency (EPA). 2016. Weight of evidence in ecological assessment. Washington, DC: U.S. Environmental Protection Agency, Office of the Science Advisor, Risk Assessment Forum, Publication No. EPA/100/R–16/001 Retrieved from: *https://nepis.epa.gov/Exe/ZyPDF.cgi/P100SFXR.PDF?Dockey=P100SFXR.PDF.*

U.S. Environmental Protection Agency (EPA). 1996. Ambient levels and noncancer health effects of inhaled crystalline and amorphous silica: health issue assessment. Washington, DC: U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Publication No. EPA/600/R–95/115. Retrieved from: *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=12999.*

U.S. Environmental Protection Agency (EPA). 1986. Guidelines for carcinogen risk assessment. Washington, DC: U.S. Environmental Protection Agency, Risk Assessment Forum, Publication No. EPA/630/R–00/004 Retrieved from: *https://www.epa.gov/risk/guidelines-carcinogen-risk-assessment.*

United States Census Bureau. 2017 Statistics of U.S. businesses annual data tables by Establishment Industry. Released May 2021. Retrieved from: *https://www.census.gov/data/tables/2017/econ/susb/2017-susb-annual.html.*

Vacek, P., Glenn, R., Rando, R., Parker, J., Kanne, J., Henry, D., and Meyer, C. 2019. Exposure—response relationships for silicosis and its progression in industrial sand workers. Scandinavian Journal of Work, Environment and Health. 45(3):280–288. doi:10.5271/sjweh.3786.

Vacek, P., Verma, D.K., Graham, W.G., Callas, P.W., and Gibbs, G.W. 2011. Mortality in Vermont granite workers and its association with silica exposure. Occupational and Environmental Medicine. 68(5):312–318. doi:10.1136/oem.2009.054452.

Vallyathan, V., Landsittel, D.P., Petsonk, E.L., Kahn, J., Parker, J.E., Osiowy, K.T. and Green, F.H.Y. 2011. The influence of dust standards on the prevalence and severity of coal worker's pneumoconiosis at autopsy in the United States of America. Archives of Pathology and Laboratory Medicine. 135(12):1550–1556.

Vallyathan V., Castranova, V., Packs, D., Leonard, S., Shumaker, J., Hubbs, A.F., Shoemaker, D.A., Ramsey, D.M., Pretty, J.R., McLaurin, J.L., Khan, A., and Teass, A. 1995. Freshly fractured quartz inhalation leads to enhanced lung injury and inflammation. Potential role of free radicals. American Journal of Respiratory and Critical Care Medicine. 152(3):1003–1009.

Verma, D.K., Ritchie, A.C. and Muir, DC 2008. Dust content of lungs and its relationships to pathology, radiology and occupational exposure in Ontario hardrock miners. American Journal of Industrial Medicine. 51(7):524–31.

Verma, D.K., Muir, D.F.C., Stewart, M.L., Julian, J.A., and Ritchie, A.C. 1982. The dust content of the lungs of hard-rock miners and its relationship to occupational exposure, pathological and radiological findings. Annals of Occupational Hygiene Journal. 26:401–409.

Vihlborg, P., Bryngelsson I–L., Andersson L., and Graff P. 2017. Risk of sarcoidosis and seropositive rheumatoid arthritis from occupational silica exposure in Swedish iron foundries: a retrospective cohort study. BMJ Open. 7(7):e016839. doi: 10.1136/bmjopen-2017–016839.

Wade, W.A., Petsonk, E.L., Young, B., and Mogri, I. 2011. Severe occupational pneumoconiosis among West Virginia coal miners: 138 cases of progressive massive fibrosis compensated between 2000–2009. Chest. 139(6):1458–62.

Wallace, W.E., Keane, M.J., Harrison, J.C., Stephens, J.W., Brower, P.S., Grayson, R.L., and Attfield, M.D. 1996. Surface properties of silica in mixed dusts. Section II, Chapter 4. Silica and silica-induced lung diseases. Boca Raton, FL. CRC Press, Inc. Pages 107–117.

Wallden, A., Graff, P., Bryngelsson, I.-L., Fornander, L., Wiebert, P., and Vihlborg, P. 2020. Risks of developing ulcerative colitis and Crohn's disease in relation to silica dust exposure in Sweden: a case-control study. BMJ Open. 10(2):e034752. doi:10.1136/bmjopen-2019–034752.

Wang, D., Yang, M., Ma, J., Zhou, M., Wang, B., Shi, T., and Chen, W. 2021. Association of silica dust exposure with mortality among never smokers: a 44-year cohort study. International Journal of Hygiene and Environmental Health. 236: Article 113793.

Wang, D., Yang, M., Liu, Y., Ma, J., Shi, T., and Chen, W. 2020a. Association of silica dust exposure and cigarette smoking with mortality among mine and pottery workers in China. Journal of the American Medical Association (JAMA) Network Open. 3(4):e202787. doi:10.1001/jamanetworkopen.2020.2787.

Wang, D., Zhou, M., Liu, Y., Ma, J., Yang, M., Shi, T., and Chen, W. 2020b. Comparison of risk of silicosis in metal mines and pottery factories: a 44-year cohort study. Chest. 158(3):1050–1059.

Wang, W., Yu, Y., Wu, S., Sang, L., Wang, X., Qiu, A., Yu, X., Li, J., Zhang, L., Yi, M., Zheng, H., Gao, Y., Xiao, J., Lu, Y., Jiang, L., Lian, Y., Zhuang, X., Tian, T., and Chu, M. 2018. The rs2609255 polymorphism in the FAM13A gene is reproducibly associated with silicosis susceptibility in a Chinese population. Gene. 661:196–201. doi: *https://doi.org/10.1016/j.gene.2018.03.098.*

Wang, X., Yano, E., Nonaka, K., Wang, M., and Wang, Z. 1997. Respiratory impairments due to dust exposure: A comparative study among workers exposed to silica, asbestos, and coalmine dust. American Journal of Industrial Medicine. 31(5):495–502.

Watts, W., Huynh, T. and Ramachandran, G. 2012. Quartz concentration trends in metal and nonmetal mining. Journal of Occupational and Environmental Hygiene. 9(12):720–732.

Waxweiler, R.J., Zumwalde, R.D., Ness, G.O. and Brown, D.P., 1988. A retrospective cohort mortality study of males mining and milling attapulgite clay. American Journal of Industrial Medicine. 13(3):305–315.

Weber, K., Bosch, A., Bühler, M., Gopinath, C., Hardisty, J.F., Krueger, N., McConnell, E.E. and Oberdörster, G., 2018. Aerosols of synthetic amorphous silica do not induce fibrosis in lungs after inhalation: Pathology working group review of histopathological specimens from a subchronic 13-week inhalation toxicity study in rats. Toxicology Research and Application 2, p.2397847318805273.

Weiderpass, E., Vainio, H., Kauppinen, T., Vasama-Neuvonen, K., Partanen, T., and Pukkala, E. 2003. Occupational exposures and gastrointestinal cancers among Finnish women. Journal of Occupational and Environmental Medicine. 45:305–315.

Wernli, K.J., Fitzgibbons, E.D., Ray, R.M., Gao, D.L., Li, W., Seixas, N.S., Camp, J.E., Astrakianakis, G., Feng, Z., Thomas, D.B., and Checkoway, H. 2006. Occupational risk factors for esophageal and stomach cancers among female textile workers in Shanghai, China. American Journal of Epidemiology. 163(8):717–725.

Wiles, F.J. and Faure, M.H. 1975. Chronic obstructive lung disease in gold miners. In: Inhaled Particles IV, Part 2. Walton WH, ed. Oxford. Pergamon Press.

Windau, J., Rosenman, K., Anderson, H., Hanranhan, L., Rudolph, L., Stanbury, M., and Stark, A. 1991. The identification of occupational lung disease from hospital discharge data. Journal of Occupational Medicine. 33(10):1061–1066.

Winter, P.D., Gardner, M.J., Fletcher, A.C., and Jones, R.D. 1990. A mortality follow-up study of pottery workers: Preliminary findings on lung cancer. International Agency on Research for Cancer Scientific Publications. 97:83–94.

Wong, B.A., 2007. Inhalation exposure systems: design, methods and operation. Toxicologic pathology, 35(1):3–14.

World Health Organization (WHO). 2005. Environmental Health Criteria 231. Bentonite, kaolin, and selected clay minerals. World Health Organization, Geneva. Retrieved from: *http://whqlibdoc.who.int/ehc/WHO_EHC_231.pdf.*

Wright, J.L., Harrison, N., Wiggs, B., and Churg, A. 1988. Quartz but not iron oxide causes air-flow obstruction, emphysema, and small airways lesions in the rat. American Review of Respiratory Disease. 138(1):129–135.

Wu, N., Xue, C., Yu, S., Ye, Q. 2020. Artificial stone-associated silicosis in China: A prospective comparison with natural stone-associated silicosis. Respirology. 25(5):518–524. doi: 10.1111/resp.13744.

Wu, Q., Jiao, B., Gui, W., Zhang, Q., Wang, F., Han, L. 2021. Long non-coding RNA SNHG1 promotes fibroblast-to-myofibroblast transition during the development of pulmonary fibrosis induced by silica particles exposure. Ecotoxicology and Environmental Safety. 228:112938. doi: 10.1016/j.ecoenv.2021.112938.

Xu, Z., Morris Brown L., Pan, L.M., Liu, T–F., Stone, B.J., Guan, D.X., Liu, Q., Sheng, J–H., Dosemeci, M., Fraumeni, Jr, J., and Blot, J.W. 1996a. Cancer risks among iron and steel workers in Anshan, China, Part I: Proportional mortality ratio analysis. American Journal of Industrial Medicine. 30(1):1–6.

Yang, H., Yang, L., Zhang, J.L. and Chen, J. 2006. Natural course of silicosis in dust-exposed workers. Journal of Huazhong University of Science and Technology. [Med Sci]. 26: 257–260.

Yu, I.T., Tse, L.A., Wong, T.W., Leung, C.C., Tam, C.M, and Chan, A. C.K. 2005. Further evidence for a link between silica dust and esophageal cancer. International Journal of Cancer. 114(3):479–483.

Yu, Q., Fu, G., Lin, H., Zhao, Q., Liu, Y., Zhou, Y., Shi, Y., Zhang, L., Wang, Z., Zhang, Z., Qin, L. and Zhou, T. 2020. Influence of silica particles on mucociliary structure and MUC5B expression in airways of C57BL/6 mice. Experimental Lung Research. 46(7):217–225. doi: 10.1080/01902148.2020.1762804.

XIV. Appendix

Appendix A—Description of MSHA Respirable Crystalline Silica Samples

This document describes the respirable crystalline silica samples used in this rule. The Mine Safety and Health Administration (MSHA) collected these samples from metal/nonmetal (MNM) and coal mines, then analyzed the data to support this rulemaking. Technical details are discussed in the attachments that follow.

MNM Respirable Dust Sample Dataset, 2005–2019

From January 1, 2005, to December 31, 2019, 104,354 valid MNM respirable dust samples were entered into the MSHA Technical Support Laboratory Information Management System (LIMS) database.[114] The dataset includes MNM mine respirable dust personal exposure samples collected by MSHA inspectors. A total of 57,824 samples contained a respirable dust mass of 0.100 mg or greater (referred as ‘‘sufficient-mass dust samples’’), while a total of 46,530 samples contained a respirable dust mass of less than 0.100 mg (referred as ‘‘insufficient-mass dust samples’’).[115]

Respirable dust samples collected by MSHA inspectors are assigned a three-digit ‘‘contaminant code’’ based on the contaminant in the sample. MSHA's contaminant codes group contaminants based on their health effects [116] and are assigned by the MSHA Laboratory based on sample type and analysis results. The codes link information to the sample, such as contaminant description, permissible exposure limit (PEL), and the units of measure for each contaminant sampled.

The MNM respirable crystalline silica dataset includes five contaminant codes.

MNM Respirable Dust Sample Contaminant Codes

- Contaminant code 521—MNM respirable dust samples that were not analyzed for respirable crystalline silica.
- Contaminant code 523—MNM respirable dust samples containing 1 percent or more quartz.
- Contaminant code 525—MNM respirable dust samples containing cristobalite.
- Contaminant code 121—MNM respirable dust samples containing less than 1 percent quartz where the commodity is listed as a ‘‘nuisance particulate’’ in Appendix E of the TLVs® Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973 (reproduced in Table A–1).
- Contaminant code 131—MNM respirable dust samples containing less than 1 percent quartz where the commodity is not listed as a ‘‘nuisance particulate’’ in Appendix E of the 1973 ACGIH TLV® Handbook (reproduced below).

[114] Only valid (non-void) MNM respirable dust samples were included in the LIMS dataset. Voided samples include any samples with a documented reason which occurred during the sampling and/or the MSHA's laboratory analysis for invalidating the results.

[115] Sufficient-mass dust samples are analyzed for their quartz content, whereas insufficient-mass dust samples are not. This is because even if the insufficient-mass dust samples contained only quartz they would not have exceeded the permissible exposure limit (PEL) at that time.

[116] For example, contaminant code 523 indicates that dust from that sample contained 1 percent or more respirable crystalline silica (quartz). Exposure to respirable crystalline silica has been linked to the following health outcomes: silicosis, non-malignant respiratory disease, lung cancer, and renal disease.

Table A-1: Reproduction of TLVs® Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973 Appendix E, Threshold Limit Values Material List: "Some Nuisance Particulates[1]; Threshold Limit Value – 10 mg/m³"

Alundum (Al_2O_3)	Gypsum	Rouge
Calcium Carbonate	Kaolin	Silicon Carbide
Cellulose (paper fiber)	Limestone	Starch
Corundum (Al_2O_3)	Magnesite	Sucrose
Emery	Marble	Tin Oxide
Glass, fibrous[2] or dust	Pentaerythritol	Titanium Dioxide
Glycerin Mist	Plaster of Paris	Vegetable oil mists (except castor, cashew nut, or similar irritant oils)
Graphite (synthetic)	Portland Cement	

Source: American Conference of Governmental Industrial Hygienists (ACGIH). 1973. TLVs® Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973. Cincinnati, Ohio.

Notes:

1. When toxic impurities are not present, e.g., quartz < 1 percent.
2. <5-7 μm in diameter.

This list contains examples of certain materials that are considered "nuisance" particulates when the material is in dust form. This list is not intended to be exclusive. If the miner sampled is exposed to one or more of the listed materials, then the TLV® for "nuisance" dust should be applied.

MNM Respirable Dust Samples With a Mass of at Least 0.100 Milligram (mg) (Sufficient-Mass Dust Samples)

The 57,824 samples that contained at least 0.100 mg of respirable dust were analyzed to quantify their respirable crystalline silica content—mostly respirable quartz but also respirable cristobalite. The respirable crystalline silica concentrations were entered into the MSHA Standardized Information System (MSIS) database (internal facing) and Mine Data Retrieval System (MDRS) database (public facing). MSIS and MDRS differ from LIMS in that some of the fields associated with a sample can be modified or corrected by the inspector who conducted the sampling. These correctable fields include Mine ID, Location Code, and Job Code. Inspectors cannot access or modify the fields in the LIMS database.

Fifty-five samples [117] were removed from the dataset because they were erroneous, had an incorrect flow rate, had insufficient sampling time, or were duplicates. This resulted in a final dataset consisting of 57,769 MNM samples that contained a mass of at least 0.100 mg of respirable dust. The dataset containing the analyzed samples that MSHA retained can be found in the rulemaking docket MSHA–2023–0001.

MNM Respirable Dust Samples With a Mass of Less Than 0.100 mg (Insufficient-Mass Dust Samples)

The LIMS database also included 46,530 MNM respirable dust samples that contained less than 0.100 mg of respirable dust. These samples did not meet the minimum dust mass criterion of 0.100 mg and were not analyzed for respirable crystalline silica by MSHA's Laboratory.

From these 46,530 samples, 167 samples [118] were removed because they were erroneous, had an incorrect flow rate, or had insufficient sampling time. This resulted in 46,363 remaining MNM samples containing less than 0.100 mg of respirable dust. These samples were assigned to contaminant code 521, indicating that the samples were not analyzed for quartz. The dataset containing the unanalyzed samples that MSHA retained can be found in the rulemaking docket MSHA–2023–0001.

All MNM Respirable Dust Samples

After removing the 222 samples mentioned above (55 sufficient-mass and 167 insufficient-mass), the dataset consisted of 104,132 MNM respirable dust samples: 57,769 sufficient-mass samples and 46,363 insufficient-mass samples. A breakdown of the MNM respirable dust samples is included in Table A–2.

[117] There were 55 samples removed: 7 samples had no detected mass gain (denoted as "0 mg"); 1 sample was a partial shift that was not originally marked correctly; 1 sample was removed at the request of the district; 44 samples had flow rates outside the acceptable range of 1.616–1.785 L/min; and 2 samples were duplicates of samples that were already in the dataset. This resulted in the final sample size of 57,769 = 57,824 − (7 + 1 + 1 + 44 + 2).

[118] There were 167 samples removed: 75 samples had a cassette mass less than −0.03 mg (based on instrument tolerances, samples that report a cassette mass between −0.03 mg and 0 mg were treated as having a mass of 0 mg, samples with masses below that threshold of −0.03 mg were excluded); 52 samples had Mine IDs that did not report employment in any year from 2005–2019; 31 samples had flow rates outside the acceptable range of 1.615–1.785 L/min ; six samples had sampling times of less than 30 minutes; and three samples had invalid Job Codes. This resulted in the final sample size of 46,363 = 46,530 − (75 + 52 + 31 + 6 + 3).

Table A-2: Distribution of MNM Respirable Dust Samples

Contaminant Code	Description	Number of Samples
	Total LIMS samples with dust mass ≥ 0.100 mg (sufficient-mass samples)	*57,824*
	Samples removed with dust mass ≥ 0.100 mg	55
	Samples retained with dust mass ≥ 0.100 mg	**57,769**
523	Dust respirable fraction, ≥ 1% quartz	39,772
525	Containing cristobalite	7
121	Nuisance dust, listed, respirable fraction, <1% silica	9,256
131	Unlisted dust, respirable fraction, <1% silica	8,734
	Total LIMS samples with dust mass < 0.100 mg (insufficient-mass samples)	*46,530*
	Samples removed with dust mass < 0.100 mg	167
	Samples retained with dust mass < 0.100 mg	**46,363**
521	Respirable dust samples not analyzed for quartz	46,363
	Total Samples	*104,354*
	Total Samples Removed	222
	Total Samples Retained	**104,132**

Sources: MSHA MDRS/MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220615); MSHA Personal Health Samples Public Dataset.

Coal Respirable Dust Sample Dataset, 2016–2021

From August 1, 2016, to July 31, 2021, 113,607 valid respirable dust samples from coal mines were collected by MSHA inspectors and entered in the LIMS database.[119] For coal mines, the reason the analysis is based on samples collected by inspectors beginning on August 1, 2016, is that this is when Phase III of MSHA's 2014 RCMD Standard went into effect. Samples taken prior to implementation of the RCMD standard would not be representative of current respirable crystalline silica exposure levels in coal mines.

Of these samples collected by MSHA inspectors, 67,963 samples were analyzed for respirable crystalline silica; 45,644 samples were not. The record of a respirable dust sample from coal mines contains a record of the sample type and the occupation of the miner sampled. A coal sample's type is based on the location within the mine as well as the occupation of the miner sampled. Below is a list of coal sample types and descriptions, as well as the mass of respirable dust required for that type of sample to be analyzed for respirable crystalline silica.

- Type 1—Designated occupation (DO). The occupation on a mechanized mining unit (MMU) that has been determined by results of respirable dust samples to have the greatest respirable dust concentration. Designated occupation samples must contain at least 0.100 mg of respirable dust to be analyzed for respirable crystalline silica.
- Type 2—Other designated occupation (ODO). Occupations other than the DO on an MMU that are also designated for sampling, required by 30 CFR part 70. These samples must contain at least 0.100 mg of respirable dust to be analyzed for respirable crystalline silica.
- Type 3—Designated area (DA). Designated area samples are from specific locations in the mine identified by the operator in the mine ventilation plan under 30 CFR 75.371(t), where samples will be collected to measure respirable dust generation sources in the active workings. These samples must contain at least 0.100 mg of respirable dust to be analyzed for respirable crystalline silica.
- Type 4—Designated work position (DWP). A designated work position in a surface coal mine or surface work area of an underground coal mine that is designated for sampling in order to measure respirable dust generation sources in the active workings. Designated work position samples must contain at least 0.200 mg of respirable dust to be analyzed for respirable crystalline silica. There are exceptions for certain occupations: bulldozer operator (MSIS general occupation code 368), high wall drill operator (code 384), high wall drill helper (code 383), blaster/shotfirer (code 307), refuse/backfill truck driver (code 386), or high lift operator/front end loader (code 382). Samples from these occupations must have at least 0.100 mg of respirable dust to be analyzed for respirable crystalline silica.
- Type 5—Part 90 miner. A Part 90 miner is employed at a coal mine and has exercised the option under the old section 203(b) program (36 FR 20601, Oct. 27, 1971) or under 30 CFR 90.3 to work in an area of a mine where the average concentration of respirable dust in the mine atmosphere during each shift to which a miner is exposed is continuously maintained at or below the applicable standard and has not waived these rights. A sample from a Part 90 miner must contain at least 0.100 mg of respirable dust to be analyzed for respirable crystalline silica.
- Type 6—Non-designated area (NDA). Non-designated area samples are taken from locations in the mine that are not identified by the operator in the mine ventilation plan under 30 CFR 75.371(t) as areas where samples will be collected to measure respirable dust generation sources in the active workings. These samples are not analyzed for respirable crystalline silica.
- Type 7—Intake air samples are taken from air that has not yet ventilated the last working place on any split of any working section or any worked-out area, whether pillared or non-pillared, as per 30 CFR 75.301. These samples are not analyzed for respirable crystalline silica.

[119] Only valid (non-void) coal respirable dust samples were included in the LIMS dataset. Voided samples include any samples with a documented reason which occurred during the sampling and/or the MSHA's Laboratory analysis for invalidating the results.

• Type 8—Non-designated work position (NDWP). A work position in a surface coal mine or a surface work area of an underground coal mine that is sampled during a regular health inspection to measure respirable dust generation sources in the active workings but has not been designated for mandatory sampling. For the analysis of respirable crystalline silica, these samples must have at least 0.200 mg of respirable dust. There are exceptions for certain occupations: bulldozer operator (MSIS general occupation code 368), high wall drill operator (code 384), high wall drill helper (code 383), blaster/shotfirer (code 307), refuse/backfill truck driver (code 386), or high lift operator/front end loader (code 382). Samples taken from these occupations must contain at least 0.100 mg respirable dust to be analyzed for respirable crystalline silica.

Coal Respirable Dust Samples Analyzed for Respirable Crystalline Silica

There were 67,963 samples from coal mines collected by MSHA inspectors from underground and surface coal mining operations that were analyzed for respirable crystalline silica. These results were entered first into LIMS, and then into MSIS and MDRS. Results from MSIS were used as they may be updated by the inspectors at later dates.[120] From those 67,963 samples, 4,836 samples were removed as they were environmental samples, voided in MSIS, or had other errors.[121] This resulted in a dataset of 63,127 samples from coal mines that were analyzed for respirable crystalline silica. The dataset containing the analyzed samples that MSHA retained can be found in the rulemaking docket MSHA–2023–0001.

Coal Respirable Dust Samples Not Analyzed for Respirable Crystalline Silica

Similar to MNM respirable dust samples, the LIMS database includes 45,644 coal samples that did not meet the criteria for analysis and were thus not analyzed for respirable crystalline silica content.[122] After removing 13,243 [123] samples that were environmental samples, erroneous, or had voided controls, there were 32,401 samples that were not analyzed for respirable crystalline silica. The dataset containing the unanalyzed samples that MSHA retained can be found in the rulemaking docket MSHA–2023–0001.

All Coal Respirable Dust Samples

In total, 18,079 respirable dust samples from coal mines were removed from the original datasets: 4,836 samples that were analyzed for respirable crystalline silica and 13,243 samples that were not. This created a final dataset of 95,528 samples: 63,127 analyzed samples and 32,401 samples that were not analyzed.[124] A breakdown of respirable dust samples from coal mines is included in Table A–3.

Table A-3: Distribution of Coal Respirable Dust Samples

Sample Type	Number of Samples
Total LIMS Samples Analyzed for Respirable Crystalline Silica Content	*67,963*
Analyzed Samples Removed	4,836
Analyzed Samples Retained	**63,127**
Type 1	10,149
Type 2	42,828
Type 4	4,788
Type 5	365
Type 8	4,997
Total LIMS Samples Not Analyzed for Respirable Crystalline Silica Content	*45,644*
Unanalyzed samples removed	13,243
Unanalyzed samples retained	**32,401**
Total Samples	*113,607*
Total Samples Removed	18,079
Total Samples Retained	**95,528**

Source: MSHA MDRS/MSIS respirable crystalline silica data for the coal industry, August 1, 2016, through July 31, 2021 (version 20220617).

[120] As mentioned in the section concerning samples for MNM mines, MSIS and MDRS differ from LIMS in that some data fields can be modified or corrected by the inspector. These correctable fields include market.

[121] There were 4,836 samples removed: 4,199 samples were environmental and not personal samples (see Sample Type explanation for more detail); 631 samples had been voided after they had been entered into MSIS; and 6 had invalid Job Codes. This resulted in the final sample size of 63,127 = 67,963 − (4,199 + 631 + 6).

[122] In addition to the criteria listed above, samples from Shop Welders (code 319) are not analyzed for respirable crystalline silica as they are instead analyzed for welding fumes.

[123] There were 13,243 samples removed: 6 samples had typographical errors; 14 samples had a cassette mass less than −0.03 mg (based on instrument tolerances, samples that report a cassette mass between −0.03 mg and 0 mg were treated as having a mass of 0 mg); 92 samples had invalid Job Codes; 12,724 were environmental samples; 44 samples had an occupation code of 000 despite having a personal sample 'Sample Type'; 271 samples had controls that were voided; and 92 came from Job Code 319—Welder (see Footnote 119). This resulted in the final sample size of 32,401 = 50,545 − (6 + 14 + 92 + 12,724 + 44 + 271 + 92).

[124] This dataset did not include any other coal mine respirable dust sample types collected by MSHA inspectors—*i.e.,* sample types 3 (designated area samples), types 6 (Non-face occupations) and 7 (Intake air), samples taken on the surface mine shop welder (n=319), and all voided samples. Voided samples are any samples that have a documented reason which occurred during the sampling and/or laboratory analysis for invalidating the results.

Attachment 1. MNM Samples Analyzed for Cristobalite

Cristobalite is one of the three polymorphs of respirable crystalline silica. At the request of the inspector, MNM[125] respirable dust samples that contain at least 0.050 mg of respirable dust are analyzed for cristobalite. Of the 57,769 retained MNM samples that contained at least 0.050 mg of respirable dust, 0.6 percent (or 359 samples) were analyzed for cristobalite. Coal respirable dust samples are not analyzed for cristobalite.[126]

Table A1-1: MNM Respirable Dust Samples Analyzed for Cristobalite

Description	Number of Samples	Percent of Samples
Samples with mass ≥ 0.100 mg	57,769	
Samples analyzed for Cristobalite	359	0.6%
Samples not analyzed for Cristobalite	57,410	99.4%

Sources: MSHA MDRS/MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220615); MSHA Personal Health Samples Public Dataset.

While the samples that were analyzed for cristobalite were assigned to all four contaminant codes seen in this dataset, the majority were assigned contaminant code 523.

Table A1-2: Distribution of MNM Respirable Dust Samples Analyzed for Cristobalite, by Contaminant Code

Code	Contaminant	Number of Samples	Percent of Samples
	Total Samples Analyzed for Cristobalite	**359**	
523	Dust respirable fraction, ≥ 1% quartz	215	59.9%
525	Containing cristobalite	6	1.7%
121	Nuisance dust, listed, respirable fraction, <1% silica	32	8.9%
131	Unlisted dust, respirable fraction, <1% silica	106	29.5%

Sources: MSHA MDRS/MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220615); MSHA Personal Health Samples Public Dataset.

The distribution of the 359 samples by cristobalite mass can be seen in Table A1–3.[127]

Table A1-3: Distribution of Analyzed Samples by Cristobalite Mass

Cristobalite Mass (µg)	Number of Samples	Percent of Samples
5	334	93.1%
11-20	14	3.9%
21-30	7	1.9%
31-40	3	0.8%
> 40	1	0.3%
Total	**359**	**100%**

Sources: MSHA MDRS/MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220615); MSHA Personal Health Samples Public Dataset.

[125] See Attachment 2. Technical Background about Measuring Respirable Crystalline Silica, for more information.

[126] See Attachment 2. Technical Background about Measuring Respirable Crystalline Silica, for more information.

[127] Of the 369 samples that were analyzed for cristobalite, 334 had a value for cristobalite mass that was less than the limit of detection (LOD) for cristobalite, 10µg. As such these samples were assigned a value of 5µg of cristobalite, one half the LOD. See Attachment 2. Technical Background about Measuring Respirable Crystalline Silica, for more information.

The mass of each sample was then used to calculate a cristobalite concentration by dividing the mass of cristobalite by the volume of air sampled (0.816 m^3). The calculated concentrations ranged from 6μg/m^3 to 53μg/m^3.[128]

Table A1-4: Samples Analyzed for Cristobalite by Concentration (μg/m^3)

Cristobalite Concentration (μg/m^3)	Number of Samples	Percent of Samples
6	334	93.1%
12-20	12	3.3%
21-30	5	1.4%
31-40	5	1.4%
41-50	2	0.6%
> 50	1	0.3%
Total	**359**	**100%**

Sources: MSHA MDRS/MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220615); MSHA Personal Health Samples Public Dataset.

Attachment 2. Technical Background About Measuring Respirable Crystalline Silica

In the proposed rule, respirable crystalline silica refers to three polymorphs: quartz, cristobalite, and tridymite. MSHA's Laboratory uses two methods to analyze respirable crystalline silica content in respirable dust samples. The first method, X-ray diffraction (XRD), separately analyzes quartz, cristobalite, and tridymite contents in respirable dust samples that mine inspectors obtain at MNM mine sites (MSHA Method P–2, 2018a). The second method, Fourier transform infrared spectroscopy (FTIR), is used to analyze quartz in respirable dust samples obtained at coal mines (MSHA Method P–7, 2018b and 2020b). Although the XRD method can be expanded from MNM to coal dust samples, MSHA chooses to use the FTIR method for coal dust samples because it is a faster and less expensive method. However, the current MSHA P–7 FTIR method cannot quantify quartz if cristobalite and/or tridymite are present in the sample. The method also corrects the quartz result for the presence of kaolinite, an interfering mineral for quartz analysis when found in coal dust.

Limits of Detection and Limits of Quantification for Silica Sample Data

The Limits of Detection (LOD) and Limits of Quantification (LOQ) are the two terms used to describe a method's capability. The LOD refers to the smallest amount of the target analyte (respirable crystalline silica) that can be detected in the sample and distinguished from zero with an acceptable confidence level that the analyte is actually present. It can also be described as the instrument signal that is needed to report with a specified confidence that the analyte is present. The LOQ refers to the smallest amount of the target analyte that can be repeatedly and accurately quantified in the sample with a specified precision. The LOQ is higher than the LOD. The values of the LOD and LOQ are specific to MSHA's Laboratory as well as the instrumentation and analytical method used to perform the analysis. These values do not change from one batch to another when samples are analyzed on the same equipment using the same method. However, their levels may change over time due to updated analytical methods and technological advances. The values of the LOD and LOQ for the methods (XRD and FTIR) used in analyzing respirable crystalline silica samples are explained in MSHA documents for MNM samples and coal samples (MSHA Method P–2, 2018a; MSHA Method P–7, 2018b and 2020b). MSHA periodically updates these values to reflect progress in its analytical methods. The values of LOD and LOQ were last updated in 2022 for MNM samples and in 2020 for coal samples.

The values of LODs and LOQs for respirable crystalline silica in samples from MSHA inspectors depend on several factors, including the analytical method used (XRD or FTIR) and the silica polymorph analyzed (quartz, cristobalite, or tridymite), as presented in Table A2–1.

For a sample with respirable crystalline silica content less than the method LOD, the maximum concentration is calculated as the respirable crystalline silica mass equivalent to LOD divided by the volume of air sampled. For example, the XRD analysis as performed for a MNM sample, as a method LOD of 5μg. If a such a sample is analyzed using that method and no quartz is detected and that sample is collected at 1.7 L/min air flow rate for 480 minutes (*i.e.,* 8 hours), the air sample volume would be 816 L (= 1.7 L/min * 480 minutes), or 0.816 m^3. The calculated maximum concentration associated with such sample having respirable crystalline silica mass below the method LOD would be 6μg/m^3 (= 5μg/0.816 m^3). The ''half maximum concentration'' is the midpoint between 0 and the calculated maximum respirable crystalline silica concentration, which is 3μg/m^3 (= ½ * 6μg/m^3) in this example.

BILLING CODE 4520–43–P

[128] One sample had a cristobalite concentration of 53μg/m^3. It was sampled in July of 2011 at Mine ID 4405407 and cassette number 610892. The commodity being mined was Stone: Crushed, Broken Quartzite. The occupation of the miner being sampled was Miners in Other Occupations: Job Code 513—Building and Maintenance.

Table A2-1: Calculated Maximum Concentration for Samples Below LOD, by Analytical Method and Respirable Crystalline Silica Polymorph

Sample Dates	MSHA Analytical Method (Method Name[1])	Respirable Crystalline Silica Analysis Type (polymorph)	Air Volume for Sample (flow rate)	Limit of Quantification (µg per filter)	Limit of Detection (µg per filter)	Calculated Maximum Concentration ("Half maximum concentration)
MNM Mines						
01/01/2005 - 12/31/2019	XRD (P-2-2018)	Quartz	816 L=0.816 m^3 in 8 hours (1.7 L/min)	20 µg	5 µg	6 µg/m^3 (half = 3 µg/m^3)
01/01/2005 - 12/31/2019	XRD (P-2-2018)	Cristobalite	816 L=0.816 m^3 in 8 hours (1.7 L/min)	40 µg	10 µg	12 µg/m^3 (half = 6 µg/m^3)
Coal Mines						
08/01/2016 - 08/31/2020	FTIR (P-7-2018)	Quartz	*X* L= Sampling time (min) x 2.0 L/min / 1000 m^3	20 µg	4 µg	Value is variable based on sampling time (min)
09/01/2020 - 07/31/2021	FTIR (P-7-2020)	Quartz	*X* L= Sampling time (min) x 2.0 L/min / 1000 m^3	12 µg	3 µg	

Notes:
1. Samples in the designated sampling years are collected and analyzed using the corresponding analytical methods. The values of LOQ and LOD are determined by the analytical method, polymorph, and air volume for each sample. The analytical methods used are P-2-2018 for MNM, and P-7-2018 or P-7-2020 for coal, respectively. For example, method P-2-2018 is used in measuring both quartz and cristobalite for MNM samples taken from January 1, 2015, to December 31, 2019. The values of LOQ are different for quartz and cristobalite in MNM samples. MSHA updated its methods for coal in 2020 (Method P-7-2020) and MNM in 2022 (method P-2-2022).
2. As of the 2018 SOP the LOQ for cristobalite was 40 µg based on the instrumentation and software in use at the time. The current LOQ as updated in the 2022 SOP is 20 µg, as based on the instrumentation and software currently in use.

BILLING CODE 4520–43–C

The air volume is treated differently for MNM and coal samples under the existing standards. In the case of MNM samples, 8-hour equivalent time weighted averages (TWAs) are calculated using 480 minutes (8 hours) and a flow rate of 1.7 L/min, even if samples are collected for a longer duration. In contrast, coal TWAs are calculated using the full duration of the shift and a flow rate of 2.0 L/min and converted to an MRE equivalent concentration under existing standards.

Assumptions for Analyzed Samples

Samples from MNM mines that contain at least 0.100 mg of dust mass are analyzed for the presence of quartz and/or cristobalite. For samples from coal mines, the minimum amount of respirable dust for a sample to be analyzed for respirable crystalline silica is determined by sample type and the occupation of the miner sampled. For Sample Types 1, 2, and 5, the sample must contain at least 0.100 mg of respirable dust. For Sample Types 4 and 8, the sample must contain at least 0.200 mg of respirable dust unless it comes from one of the following occupations: bulldozer operator (MSIS general occupation code 368), high wall drill operator (code 384), high wall drill helper (code 383), blaster/shotfirer (code 307), refuse/backfill truck driver (code 386), and high lift operator/front end loader (code 382). Samples taken from these occupations must contain at least 0.100 mg respirable dust to be analyzed for respirable crystalline silica.

MSHA makes separate assumptions based on the mass of respirable crystalline silica for a sample, whether it is above or below the method LOD. For all samples reporting a mass of respirable crystalline silica greater or equal to the method LOD, MSHA used the reported values to calculate the respirable crystalline silica concentration for the sample. For samples with values below the method LOD, including samples reported as containing 0 µg of silica, MSHA used ½ of the LOD to calculate the respirable crystalline silica concentration of the sample. MSHA understands that its assumptions regarding samples with respirable crystalline silica mass below the method LOD will have a minimal impact on the assessment.[129]

[129] In its Final Regulatory Economic Analysis (FREA) for its 2016 silica rule, OSHA observed: ". . . that XRD analysis of quartz from samples prepared from reference materials can achieve LODs and LOQs between 5 and 10 µg was not disputed in the [rulemaking] record." (OSHA, 2016).

Table A2-2: MSHA's Assumptions of Values Used to Calculate Concentration of Quartz and Cristobalite

Measured Mass	Value Used to Calculate RCS Concentration
Quartz	
≥LOQ	Measured Value
≥LOD and <LOQ	Measured Value
>0 μg/m^3 and <LOD	½ LOD
0 μg/m^3	½ LOD
Cristobalite	
≥LOQ	Measured Value
≥LOD and <LOQ	Measured Value
>0 μg/m^3 and <LOD	½ LOD
0 μg/m^3	½ LOD

Source: MSHA.

The reported value of respirable crystalline silica mass from an MNM or coal sample can fall under one of four groups: (1) at or above the method LOQ, (2) at or above the method LOD but below the LOQ, (3) greater than 0 μg but less than the method LOD, or (4) equal to 0 μg. MSHA treats these samples differently based on their respirable crystalline silica mass.

Quartz Mass at or Above the Method LOQ

For MNM and coal samples reporting quartz mass at or above the method LOQs, MSHA uses the values reported by the MSHA's Laboratory.

Quartz Mass Between Method LOD and LOQ

For MNM and coal samples reporting quartz mass at or above the method LOD but below the LOQ, MSHA uses the values reported by the MSHA's Laboratory.

Quartz Mass Between the Method LOD and 0 μg

A review of respirable crystalline silica samples in LIMS reveals that some samples had a respirable crystalline silica mass below the LOD of the analytical methods but greater than 0 μg. Values in this range (*i.e.,* below the method LOD but greater than 0 μg) cannot reliably indicate the presence of respirable crystalline silica. The mass of silica in these is too small to reliably detect, but the concentration of silica could be up to the calculated maximum concentration based on the method LOD. For example, consider a sample from an MNM mine that was analyzed for quartz and had a reported quartz mass of 4 μg. This falls below the LOD of 5 μg but above 0 μg, and as such the sample could actually contain anywhere from 0 μg of quartz up to the LOD value of 5 μg of quartz.

In these cases, MSHA used ½ the LOD value to calculate respirable crystalline silica concentration. MSHA explored other options to treat these samples such as treating the reported silica mass as 0 μg/m³ (lower bound) as well as assuming the sample silica mass is just below the LOD and assigning each sample a value of the method LOD (upper bound). The use of the ½ LOD value is considered a reasonable assumption since using either the lower bound of 0 μg/m³ or the upper bound of the associated method's LOD could under or overestimate exposures, respectively. The assumption is not expected to impact the assessment of silica concentration because any sample results with respirable crystalline silica mass below the method LODs (between 3–10 μg/m³) would also have been well below the lowest exposure profile range (<25 μg/m³).

Quartz Mass of 0 μg

A portion of the MNM and coal samples below the LOD are listed as having respirable crystalline silica (specifically quartz) mass levels of 0 μg. For these samples, instead of treating the mass of silica in the sample as a true zero, MSHA replaced the value with ½ the LOD of the associated method. Although the respirable crystalline silica mass of these samples is less than the LOD, it is likely that the sample still contains a small amount of respirable crystalline silica. Hence, MSHA assumes a value of ½ LOD in its calculation of respirable crystalline silica concentration for these samples. This assumption is considered to be reasonable because using the lower bound of 0 μg/m³ for these samples could underestimate the respirable crystalline silica concentration while using the upper bound of method LODs could overestimate the respirable crystalline silica concentration.

Table A2–3 presents an example for quartz, one of the respirable crystalline silica polymorphs. This table shows the LOD of quartz mass and the possible range of quartz concentrations for samples reporting a quartz mass of 0 μg. These adjusted concentrations are expected to have a limited impact of the assessment of respirable crystalline silica concentration, as supported by MSHA's sensitivity analyses.

Table A2-3: Recast Concentration of Samples with 0 μg/m³ Quartz

Sample Dates	Quartz Mass LOD (Value Less than LOD listed)	Range of Concentrations (μg/m³)	Recast Concentration
MNM			
01/01/2005 - 12/31/2019	5 μg (0 μg)	0 μg/m³	Recast using ½ LOD
01/01/2005 - 12/31/2019	5 μg (1 to <5 μg)	1 to <6 μg/m³	Recast using ½ LOD
Coal			
08/01/2016 - 08/31/2020	3 μg (0 μg)	0 μg/m³	Recast using ½ LOD
08/01/2016 - 08/31/2020	3 μg (1 to <3 μg)	1 to 2 μg/m³	Recast using ½ LOD
09/01/2020 - 07/31/2021	3 μg (0 μg)	0 μg/m³	Recast using ½ LOD
09/01/2020 - 07/31/2021	3 μg (1 to <3 μg)	1 to 2 μg/m³	Recast using ½ LOD

Sources: MSHA MDRS/MSIS respirable crystalline silica database January 1, 2005, through December 31, 2019, for MNM, August 1, 2016 - July 31, 2021, for Coal.

Cristobalite Measurement

Respirable dust samples from MNM mines are rarely analyzed for cristobalite by MSHA, and respirable coal dust samples are not analyzed for the presence of cristobalite. MNM samples are analyzed for the presence of cristobalite only when requested by MSHA inspectors because the geological or work conditions indicate this specific polymorph may be present. The LIMS database includes samples for which cristobalite was analyzed, either with or without quartz analysis. MSHA uses similar assumptions for cristobalite and quartz.

The cristobalite LOD for these samples is 10 μg. The MSHA Laboratory-reported values are used for analyzed dust samples with cristobalite mass values equal to or above the method LODs. Samples that were analyzed for cristobalite and had a cristobalite mass value below the method LOD were assigned values of ½ LOD, or 5 μg. For example, 267 samples, or 74.4 percent of the 359 samples that were analyzed for cristobalite, reported a value of 0 μg of cristobalite; these were assigned a value of 5 μg.

When a sample is analyzed for two polymorphs (*i.e.,* both quartz and cristobalite), detectable quartz and cristobalite are summed to generate the total respirable crystalline silica. If only one of these polymorphs is detected, the sample concentration is based on the detected polymorph. If the concentrations of both polymorphs (quartz and cristobalite) are reported as 0 μg/m³, ½ the LOD mass is assumed in calculating the concentrations and the resulting concentrations are summed.

Unanalyzed Samples

There are also samples whose dust mass fell below their associated mass threshold, and as such, they were not analyzed for the presence of quartz and/or cristobalite. The respirable dust mass for a sample was considered to be 0 μg when the net mass gain of dust was 0 μg or less.

References

MSHA. 2018. P–2: X-Ray Diffraction Determination of Quartz and Cristobalite in Respirable Metal/Nonmetal Mine Dust.

MSHA. 2018a. P–7: Infrared Determination of Quartz in Respirable Coal Mine Dust.

MSHA. 2020b. P–7: Determination of Quartz in Respirable Coal Mine Dust by Fourier Transform Infrared Spectroscopy.

OSHA, 2016. Final Regulatory Economic Analysis (FEA) for OSHA's Final Rule on Respirable Crystalline Silica, Chapter IV.3.2.3—Sensitivity of Sampling and Analytical Methods.

Appendix B—Mining Commodity Groups

For this final rule, the mining industries are grouped into six commodities—Coal, Metal, Nonmetal, Stone, Crushed Limestone, and Sand and Gravel. The table below shows the six commodity groupings based on the Standard Industrial Classification (SIC) codes and the 2022 North American Industry Classification System (NAICS) codes. The SIC system is a predecessor of NAICS using industry titles to standardize industry classification. The NAICS is widely used by Federal statistical agencies, including the Small Business Administration (SBA), for classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

BILLING CODE 4520–43–P

Table B-1: SIC Code Industry and 2022 NAICS Code Industry in Mining Sector

Mining Commodity Group	SIC Code Industry	2022 NAICS Code	2022 NAICS Code Industry
Nonmetal	Oil Shale, Oil Sand, Oil Mining	211120	Crude Petroleum and Natural Gas Extraction
Nonmetal	Natural Gas	211130	Natural Gas Extraction
Coal	Bituminous Coal, Lignite, and Anthracite Coal	212114	Surface Coal Mining
Coal	Bituminous and Anthracite Coal	212115	Underground Coal Mining
Metal	Iron Ore, Magnetite	212210	Iron Ore Mining
Metal	Gold Ore, Silver Ore	212220	Gold Ore and Silver Ore Mining
Metal	Copper Ore NEC, Nickel, Lead-Zinc Ore, Zinc	212230	Copper, Nickel, Lead, and Zinc Mining (partial: Copper and Nickel only)
Metal	Chromite Chromium Ore, Cobalt Ore, Columbium Tantalum Ore, Manganese Ore, Molybdenum Ore, Tungsten Ore, Miscellaneous Metal Ore NEC, Aluminum Ore-Bauxite, Antimony Ore, Beryl-Beryllium Ore, Mercury Ore, Platinum Group Ore, Rare Earths Ore, Tin Ore, Titanium Ore, Zirconium Ore, Uranium-Vanadium Ore, Uranium Ore, Vanadium Ore	212290	Other Metal Ore Mining
Stone	Dimension Stone NEC, Dimension Granite, Dimension Limestone, Dimension Marble, Dimension Sandstone, Dimension Slate, Dimension Traprock, Dimension Basalt, Dimension Mica, Dimension Quartzite	212311	Dimension Stone Mining and Quarrying
Crushed Limestone	Crushed, Broken Limestone NEC	212312	Crushed and Broken Limestone Mining and Quarrying
Stone	Crushed, Broken Granite	212313	Crushed and Broken Granite Mining and Quarrying
Stone	Crushed, Broken Stone NEC; Crushed, Broken Marble; Crushed, Broken Sandstone; Crushed, Broken Slate; Crushed, Broken Traprock; Crushed, Broken Basalt; Crushed, Broken Mica; Crushed, Broken Quartzite	212319	Other Crushed and Broken Stone Mining and Quarrying
Sand and Gravel	Construction Sand and Gravel, Common Sand	212321	Construction Sand and Gravel Mining

Mining Commodity Group	SIC Code Industry	2022 NAICS Code	2022 NAICS Code Industry
Sand and Gravel	Industrial Sand NEC, Ground Silica, Ground Cristobalite, Ground Quartz	212322	Industrial Sand Mining
Nonmetal	Kaolin and Ball Clay, Clay, Ceramic, and Refractory Minerals, Aplite, Bentonite, Brucite, Common Clays NEC, Feldspar, Fire Clay, Fullers Earth, Kyanite, Magnesite, Common Shale	212323	Kaolin, Clay, and Ceramic and Refractory Minerals Mining
Nonmetal	Miscellaneous Nonmetallic Mineral NEC, Asbestos, Cryolite, Diatomaceous Earth (Diatomite), Gilsonite, Graphite, Gypsum, Leonardite, Mica, Perlite, Pumice, Pyrophyllite, Shell, Crushed Dimension Soapstone, Talc, Tripoli, Vermiculite, Zeolites, Wollastonite, Gemstones, Agate, Amethyst, Emerald, Garnet, Olivine, Crystal Quartz, Sapphire, Turquoise, Potash, Soda, and Borate Minerals NEC, Boron Minerals, Potash, Sodium Compounds, Trona, Potassium Compounds, Phosphate Rock, Colloidal Phosphates, Chemical and Fertilizer Mineral NEC, Barite Barium Ore, Fluorspar, Lithium Minerals, Pigment Minerals, Pyrites, Salt, Sulfur, Brine Evaporated Salt	212390	All Other Nonmetallic Mineral Mining
Stone	Cement	327310	Cement Manufacturing
Stone	Lime	327410	Agricultural Lime Manufacturing
Metal	Alumina	331313	Alumina Refining and Primary Aluminum Production

BILLING CODE 4520–43–C

Appendix C—Occupational Categories for Respirable Crystalline Silica Sample Collection

This Appendix explains how MSHA categorized MNM and coal samples in constructing respirable crystalline silica exposure profile tables for the final rule. MSHA developed respirable crystalline silica exposure profile tables using its inspectors' sampling results. One set of exposure profile tables displays the analysis of 15 years of respirable crystalline silica sampling data collected from MNM mines (Attachment 1), and the other set displays the analysis of 5 years of respirable crystalline silica samples collected from coal mines (Attachment 2).[130] In the MNM tables, the respirable crystalline silica concentration information is broken out by 5 commodities (*e.g.,* ''Metal,'' ''Crushed Limestone,'' etc.) and then by 11 occupational categories (*e.g.,* ''Drillers,'' ''Stone Cutting Operators,'' etc.). The data for coal mining is disaggregated by 2 locations (''Underground'' and ''Surface'') and then by 9 occupational categories (*e.g.,* ''Crusher Operators,'' ''Continuous Mining Machine Operators,'' etc.).

Job Codes and Respirable Dust Sampling

MSHA inspectors use job codes to label samples of respirable dust when they conduct health inspections.[131] Following the sampling strategy outlined in the most recent MSHA Health Inspection Procedures Handbook (December 2020; PH20–V–4), the inspectors determine potential airborne contaminants to which miners may be exposed, including respirable dust, and then take samples from the appropriate miners or working areas at a mine. Using gravimetric samplers, the inspectors collect respirable dust samples at MNM and coal mines. When submitting the collected samples to MSHA's Laboratory for analysis, the inspectors label their samples with the three-digit job code that best describes the duties that each miner was performing during the sampling period.

The three-digit job codes are taken from MSHA's Inspection Application System (IAS), which includes 220 job codes for coal mines and 121 job codes for MNM mines. Attachments 3 and 4 list the complete list of IAS job codes for coal and MNM operations, respectively.

Coal Job Codes: The coal job codes have generally been consistent over time, with new codes added when needed. In the three-digit coal job code, the first digit generally identifies where the work is taking place in the mine: 0 (Underground Section Workers—Face); 1 (General Underground—Non-Face); 2 (Underground Transportation—Non-Face); 3 (Surface); 4 (Supervisory and Staff); 5 (MSHA—State); and 6 (Shaft and Slope Sinking). The coal codes starting with 6 were added in 2020 to better delineate the samples for miners conducting shaft and slope sinking activities. An example is presented below in Table C–1. IAS has the same job code for the duties of a coal ''supervisor/foreman'' as two predecessor documents—the ''Job Code Pocket Cards'' for coal mining, used by MSHA's predecessor, the Mining Enforcement and Safety Administration (MESA) (see Attachment 5), and a Fall 1983 Mine Safety and Health publication.

Table C-1: Example of Consistent Coal Job Classifications - Occupations Classified as "Supervisor/Foreman"

Occupation / Activity	MESA Pocket Card	1983 Publication[1]	2022 IAS
	Job Code	Job Code	Job Code
Section Foreman	049	049	049
Bullgang Foreman/Labor Foreman	149	149	149
Maintenance Foreman	418	418	418
Assist Mine Foreman/Assist Mine Manager	430	430	430
Mine Foreman/Mine Manager	449	449	449
Fire Boss Pre-Shift Examiner	462	462	462
Superintendent	481	481	481
Outside Foreman	489	489	489
Preparation Plant Foreman	494	494	494

Source: Fall 1983 Mine Safety and Health publication (page 6).

MNM Job Codes: Many of the 121 MNM job codes are similar to the coal job codes, as noted in Attachment 4. One major difference is that unlike the coal job codes, MNM job codes are not based on the location of the work/job. The first digit of the three-digit MNM job code does not indicate whether a job is located at an underground or surface area of the mine. For example, a ''MNM Diamond Drill Operator'' (Job Code 034) could be working on the surface or underground, whereas a ''Coal Drill Operator'' would have a different job code based on the miner's location within a mine (Job Code 034—underground at the face; Job Code 334—at the surface).

Occupational Categories for the Respirable Crystalline Silica Rulemaking

Some of the original work to group the MNM job codes into occupational categories was completed in 2010 in support of earlier rulemaking efforts. The MNM occupational categories were developed first and were later updated with additional sampling data as it became available. The coal occupational categories were developed several years later and were generally modeled after the MNM tables; however, coal occupational categories are first divided based on surface and underground locations because occupational activities at different locations of a mine can have differing impacts on coal miners' exposures to respirable crystalline silica. Originally, MSHA used 9 coal and 14 MNM occupational categories for its respirable crystalline silica data analyses.

For the respirable crystalline silica exposure profile tables in the proposed

[130] For coal mines, the analysis is based on samples collected by inspectors beginning on August 1, 2016, when Phase III of MSHA's 2014 RCMD standard went into effect. Samples taken prior to implementation of the RCMD standard would not be representative of current respirable crystalline silica exposure levels in coal mines.

[131] The job codes have been referred to as both job codes and occupation codes by MSHA. For example, in the Mine Data Retrieval System, they are called job codes; in other materials, including MSHA's Inspection Application System (IAS), they are called occupational codes. For the purposes of this document, the term job code has been used to clearly differentiate the job codes from the occupational categories.

respirable crystalline silica rule, MSHA made no change to the 9 coal occupational categories, but condensed the 14 MNM occupational categories to 11. These occupational categories are meant to reasonably group multiple job codes with similar occupational activities/tasks and engineering controls. The grouping of job codes into occupational categories purposely focused on the occupational activities/tasks and exposure risk of the miner performing a particular job rather than the type of mining equipment utilized by the miner. The creation of occupational categories based on the types of equipment utilized by miners would have failed to accurately characterize the risk of individual miners.

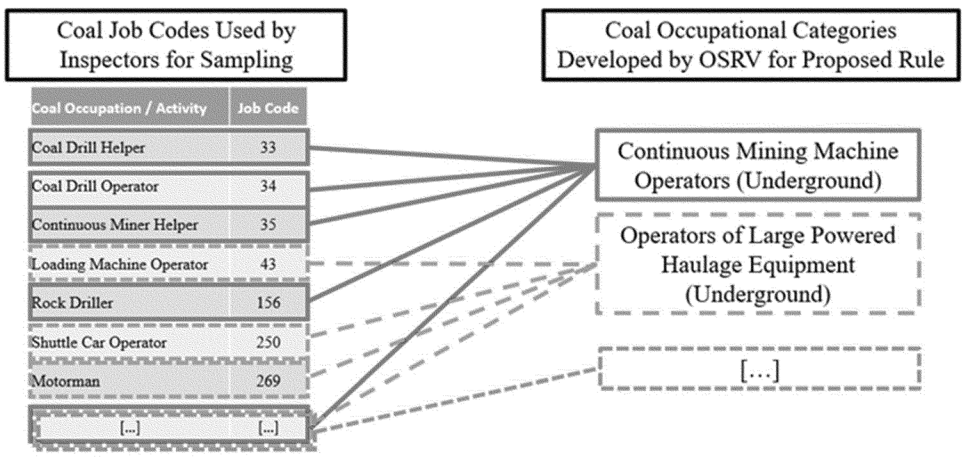
Coal Occupational Categories

There are 220 job codes for coal miners in IAS.[132] Overall, 209 job codes are included in the 9 occupational categories. Some job codes were excluded, primarily because sampling data were not available for those job codes. The codes that have been excluded are:

- Job code 0 ''Area,'' because area samples are not specific to any one occupation.
- Job code 398 ''Groundman,'' because there were no sample data for this code in the respirable crystalline silica sampling dataset.
- Job codes 590 ''Education Specialist,'' 591 ''Mineral Industrial Safety Officer,'' 592 ''Mine Safety Instructor,'' and 594 ''Training Specialist,'' because there were no coal respirable crystalline silica (quartz) data for these codes for the timeframe selected.
- Job codes 602 ''Electrician,'' 604 ''Mechanic,'' 609 ''Supply Person,'' 632 ''Ventilation Worker,'' and 635 ''Continuous Miner Operator Helper,'' because there were no sample data for these codes in the respirable crystalline silica sampling dataset.

The remaining 209 coal job codes are first divided by the job location—underground or surface—because potential respirable crystalline silica exposures at coal mines can vary depending on where a miner works at a given mine. (Three job codes are used in both underground and surface locations: job codes 402 ''Master Electrician,'' 404 ''Master Mechanic,'' and 497 ''Clerk/Timekeeper.'') The underground and surface job codes are further grouped on the basis of the types of tasks and typical engineering controls. For example, as shown in Figure C–1, the underground ''Continuous Mining Machine Operators'' occupational category includes 14 different occupations that involve drilling activities—occupations such as ''Coal Drill Helper,'' ''Coal Drill Operator,'' and ''Rock Driller.'' The underground ''Operators of Large Powered Haulage Equipment'' occupational category has 12 similar occupations including ''Loading Machine Operator,'' ''Shuttle Car Operator,'' and ''Motorman.''

Figure C–1: Examples of the Grouping of Coal Job Codes Into Coal Occupational Categories



There are five categories of underground occupations and four categories of surface occupations.

The five underground occupational categories include:

(1) Continuous Mining Machine Operators (*e.g.,* Coal Drill Helper and Coal Drill Operator);

(2) Operators of Large Powered Haulage Equipment (*e.g.,* Shuttle Car, Tractor, Scoop Car);

(3) Longwall Workers (*e.g.,* Headgate Operator and Jack Setter (Longwall));

(4) Roof Bolters (*e.g.,* Roof Bolter and Roof Bolter Helper); and

(5) Underground Miners (*e.g.,* Electrician, Mechanic, Belt Man/Conveyor Man, and Laborer, etc.).

The four surface occupational categories include:

(1) Drillers (*e.g.,* Coal Drill Operator, Coal Drill Helper, and Auger Operator);

(2) Operators of Large Powered Haulage Equipment (*e.g.,* Backhoe, Forklift, and Shuttle Car);

(3) Crusher Operators (*e.g.,* Crusher Attendant, Washer Operator, and Scalper-Screen Operator); and

(4) Mobile Workers (*e.g.,* Electrician, Mechanic, Blaster, Cleanup Man, Mine Foreman, etc.).

Attachments 1 and 3 provide the full lists of occupational categories and coal job codes.

MNM Occupational Categories

From the 121 MNM job codes in IAS, 120 job codes are included in the occupational categories and 1 job code is excluded. The code that has been excluded is:

- Job code 413 ''Janitor,'' because there were no sample data for this code in the respirable crystalline silica sampling dataset.

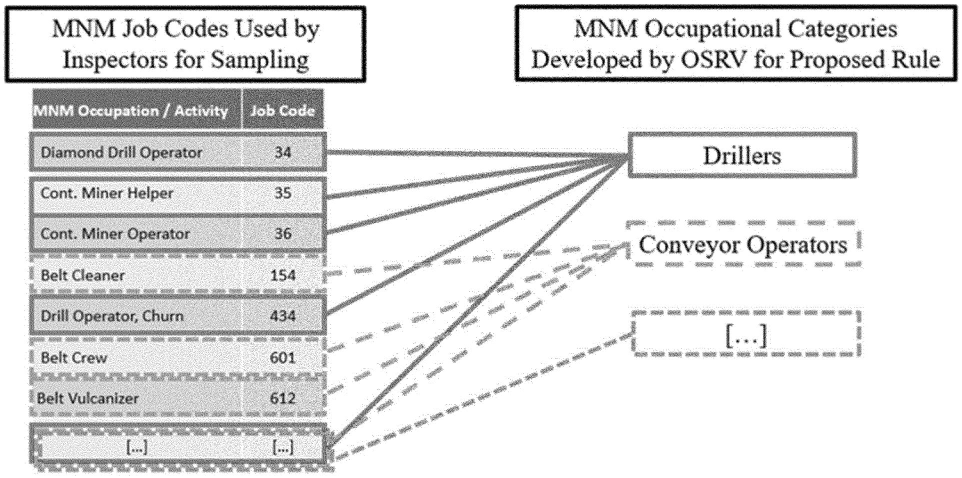
Of the 120 job codes included, 1 job code was listed in both the ''Crushing Equipment and Plant Operators'' occupational category and the ''Kiln, Mill and Concentrator Workers'' category. The code that was used twice is:

- Job Code 388 ''Screen/Scalper Operators,'' because MNM job codes do not indicate the location where the work is taking place and this work can be conducted either in a plant or on the surface of the mine.

The final 121 MNM job codes (with job code 388 included twice) were first grouped into 14 occupational categories based on the types of tasks and typical engineering controls used. For example, as seen in Figure C–2, the ''Drillers'' occupational category includes the 20 different occupations that involve drilling activities, such as ''Diamond Drill Operator,'' ''Drill Operator Churn,'' and ''Continuous Miner Operator.'' ''Belt Cleaner,'' ''Belt Crew,'' and ''Belt Vulcanizer'' are included in the occupational category, ''Conveyor Operators.'' Similar tasks were grouped together because the work activities and respirable crystalline silica exposures were anticipated to be comparable.

Figure C–2: Examples of the Grouping of MNM Job Codes Into MNM Occupational Categories

[132] IAS also contains 272 coal job codes that are used to fill out a Mine Accident, Injury and Illness Report (MSHA Form 7000–1). These codes were not included in the respirable crystalline silica exposure profile tables and are not discussed further in this document.



The 14 occupational categories were:

(1) Bagging Machines;
(2) Stone Saws;
(3) Stone Trimmers, Splitters;
(4) Truck Loading Stations;
(5) Mobile Workers (*e.g.,* Laborers, Electricians, Mechanics, and Supervisors);
(6) Conveyors;
(7) Crushers;
(8) Dry Screening Plants;
(9) Kilns/Dryers, Rotary Mills, Ball Mills, and Flotation/Concentrators;
(10) Large Powered Haulage Equipment (*e.g.,* Trucks, FELs, Bulldozers, and Scalers);
(11) Small Powered Haulage Equipment (*e.g.,* Bobcats and Forklifts);
(12) Jackhammers;
(13) Drills; and
(14) Other Occupations.

After additional consideration, it was determined that the original 14 categories could be further condensed into the final 11 categories since some of the occupational categories contained job codes where the types of tasks and engineering and administrative controls were similar enough to be combined.

The final 11 occupational categories include:

(1) Drillers (*e.g.,* Diamond Drill Operator, Wagon Drill Operator, and Drill Helper);
(2) Stone Cutting Operators (*e.g.,* Jackhammer Operator, Cutting Machine Operator, and Cutting Machine Helper);
(3) Operators of Large Powered Haulage Equipment (*e.g.,* Trucks, Bulldozers, and Scalers);
(4) Conveyor Operators (*e.g.,* Belt Cleaner, Belt Crew, and Belt Vulcanizer);
(5) Crushing Equipment and Plant Operators (Crusher Operator/Worker, Scalper Screen Operator, and Dry Screen Plant Operator);
(6) Kiln, Mill, and Concentrator Workers (*e.g.,* Ball Mill Operator, Leaching Operator, and Pelletizer Operator);
(7) Operators of Small Powered Haulage Equipment (*e.g.,* Bobcats, Shuttle Car, and Forklifts);
(8) Packaging Equipment Operators (*e.g.,* Bagging Operator and Packaging Operations Worker);
(9) Truck Loading Station Tenders (*e.g.,* Dump Operator and Truck Loader);
(10) Mobile Workers (Laborers, Electricians, Mechanics, and Supervisors, etc.); and
(11) Miners in Other Occupations (Welder, Dragline Operator, Shotcrete/Gunite Man, and Dredge/Barge Operator, etc.).

The sampling data for each of the 11 occupational categories were then summarized by commodity group (''Metal,'' ''Nonmetal,'' ''Stone,'' ''Crushed Limestone,'' and ''Sand and Gravel'') based on the material being extracted.[133] The available sampling data were then collated for each occupation and commodity and summarized by concentration ranges in the exposure profile tables for MNM mines.

BILLING CODE 4520–43–P

[133] Crushed Limestone and Sand and Gravel were considered separately because these commodities make up a large percentage of inspection samples. Watts *et al.* (2012). Respirable crystalline silica [Quartz] Concentration Trends in Metal and Nonmetal Mining, J Occ Environ Hyg 9:12, 720–732.

Attachment 1: Tables for MNM Respirable Crystalline Silica Samples

Table C1-1: Summary Statistics of Respirable Crystalline Silica in Metal/Nonmetal (MNM) Sector from 2005 to 2019, by Commodity and Occupational Category

Commodity	Occupation	Number of Samples	ISO Concentration, µg/m³		
			Mean (µg/m³)	Median (µg/m³)	Max (µg/m³)
Metal	Drillers	352	31.0	16.0	549
	Stone Cutting Operators	10	92.0	81.5	195
	Operators of Large Powered Haulage Equipment	673	28.5	17.0	426
	Conveyor Operators	29	57.4	29.0	382
	Crushing Equipment and Plant Operators	628	79.3	50.0	1,263
	Kiln, Mill, and Concentrator Workers	467	35.4	20.0	588
	Operators of Small Powered Haulage Equipment	38	104.4	7.0	3,361
	Packaging Equipment Operators	88	36.4	9.0	371
	Truck Loading Station Tenders	21	31.2	15.0	179
	Mobile Workers	1,004	52.0	26.0	3,588
	Miners in Other Occupations	189	67.5	25.0	1,690
	Metal OVERALL (All Occupations)	**3,499**	**49.1**	**25.0**	**3,588**
Nonmetal	Drillers	194	22.0	6.0	353
	Stone Cutting Operators	81	39.1	7.0	566
	Operators of Large Powered Haulage Equipment	922	16.9	7.0	449
	Conveyor Operators	31	10.2	6.0	37
	Crushing Equipment and Plant Operators	586	27.8	13.0	613
	Kiln, Mill, and Concentrator Workers	423	24.0	13.0	384
	Operators of Small Powered Haulage Equipment	237	25.4	10.0	190
	Packaging Equipment Operators	1,390	36.2	18.0	2,124
	Truck Loading Station Tenders	42	15.1	3.0	134
	Mobile Workers	1,053	25.3	10.0	574
	Miners in Other Occupations	206	14.4	3.0	191
	Nonmetal OVERALL (All Occupations)	**5,165**	**26.4**	**11.0**	**2,124**
Stone	Drillers	707	35.3	16.0	1,148
	Stone Cutting Operators	1,969	73.7	48.0	999
	Operators of Large Powered Haulage Equipment	3,223	20.2	9.0	559
	Conveyor Operators	44	41.1	23.0	309
	Crushing Equipment and Plant Operators	2,764	35.8	20.0	613
	Kiln, Mill, and Concentrator Workers	308	29.0	10.0	675
	Operators of Small Powered Haulage Equipment	404	34.3	20.0	315

Commodity	Occupation	Number of Samples	ISO Concentration, μg/m³		
			Mean (μg/m³)	Median (μg/m³)	Max (μg/m³)
	Packaging Equipment Operators	508	30.0	7.0	1,130
	Truck Loading Station Tenders	113	19.9	3.0	190
	Mobile Workers	4,778	36.2	17.0	1,548
	Miners in Other Occupations	597	24.7	12.0	347
	Stone OVERALL (All Occupations)	**15,415**	**36.6**	**17.0**	**1,548**
Crushed Limestone	Drillers	670	25.5	7.0	1,306
	Stone Cutting Operators	143	75.8	38.0	574
	Operators of Large Powered Haulage Equipment	5,522	15.8	7.0	567
	Conveyor Operators	24	27.7	12.0	164
	Crushing Equipment and Plant Operators	3,593	23.2	11.0	613
	Kiln, Mill, and Concentrator Workers	162	11.0	3.0	81
	Operators of Small Powered Haulage Equipment	162	25.7	10.0	342
	Packaging Equipment Operators	270	11.9	3.0	113
	Truck Loading Station Tenders	122	11.7	3.0	112
	Mobile Workers	3,931	27.8	11.0	4,289
	Miners in Other Occupations	585	17.3	6.0	613
	Crushed Limestone OVERALL (All Occupations)	**15,184**	**21.7**	**10.0**	**4,289**
Sand and Gravel	Drillers	169	46.6	20.0	959
	Stone Cutting Operators	243	94.3	55.0	1,095
	Operators of Large Powered Haulage Equipment	6,676	22.3	12.0	613
	Conveyor Operators	87	69.9	28.0	1,605
	Crushing Equipment and Plant Operators	3,994	42.9	25.0	613
	Kiln, Mill, and Concentrator Workers	442	81.5	44.0	1,800
	Operators of Small Powered Haulage Equipment	269	61.4	29.0	580
	Packaging Equipment Operators	724	75.1	51.0	652
	Truck Loading Station Tenders	155	59.3	37.0	613
	Mobile Workers	4,450	46.4	23.0	3,676
	Miners in Other Occupations	1,297	28.0	11.0	613
	Sand and Gravel OVERALL (All Occupations)	**18,506**	**38.7**	**20.0**	**3,676**
	MNM OVERALL	**57,769**	**33.2**	**15.0**	**4,289**

Source: MSHA MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220812). All samples were of sufficient mass to be analyzed for respirable crystalline silica.

Notes:

Summary of personal samples presented as ISO 8-hour TWA concentrations. The proposed permissible exposure limit (PEL) for all mines is 50 μg/m^3 as an 8-hour time-weighted average (8-hour TWA) sample collected according to the ISO standard 7708:1995: *Air Quality—Particle Size Fraction Definitions for Health-Related Sampling*.

1. The compliance samples summarized in this table were collected by MSHA inspectors as 8-hour TWAs using ISO-compliant sampling equipment with an air flow rate of 1.7 L/min, with results comparable to the proposed PEL.
2. When the mass of respirable crystalline silica collected was too small to be reliably detected by the laboratory, a mass of 2.5 μg for quartz and 5 μg for cristobalite (1/2 the respective limits of detection for these two forms of crystalline silica) were assumed and used to calculate sample results.
3. The procedure to calculate the ISO 8-hour TWA concentration (μg/m^3) is:

$$\text{8-hour TWA} = \frac{quartz\ mass}{(480\ minutes)\ x\ (air\ flow\ rate)}\ x\ 1000\ \frac{L}{m^3}$$

where: quartz mass is in micrograms (μg); normalized sampling time is 8 hours (480 minutes); flow rate = 1.7 L/min; 1000 Liters (L) per cubic meter (m^3)

Table C1-2: Sample Count Distribution of Respirable Crystalline Silica Exposure in Metal/Nonmetal (MNM) Sector from 2005 to 2019, by Commodity and Occupational Category

Commodity	Occupation	Number of Samples	Sample Counts in ISO Concentration Ranges, µg/m³					
			≤ 25	> 25 to ≤ 50	> 50 to ≤ 100	> 100 to ≤ 250	> 250 to ≤ 500	> 500
Metal	Drillers	352	220	74	42	13	2	1
	Stone Cutting Operators	10	1	2	3	4	0	0
	Operators of Large Powered Haulage Equipment	673	423	142	80	26	2	0
	Conveyor Operators	29	12	8	4	4	1	0
	Crushing Equipment and Plant Operators	628	173	143	165	115	26	6
	Kiln, Mill, and Concentrator Workers	467	276	99	68	18	5	1
	Operators of Small Powered Haulage Equipment	38	30	5	1	1	0	1
	Packaging Equipment Operators	88	60	8	11	8	1	0
	Truck Loading Station Tenders	21	13	5	1	2	0	0
	Mobile Workers	1,004	500	227	164	82	24	7
	Miners in Other Occupations	189	98	33	32	18	4	4
	Metal SUBTOTAL (All Occupations)	**3,499**	**1,806**	**746**	**571**	**291**	**65**	**20**
Nonmetal	Drillers	194	144	29	13	7	1	0
	Stone Cutting Operators	81	58	8	6	6	2	1
	Operators of Large Powered Haulage Equipment	922	768	94	38	19	3	0
	Conveyor Operators	31	27	4	0	0	0	0
	Crushing Equipment and Plant Operators	586	384	108	68	22	3	1
	Kiln, Mill, and Concentrator Workers	423	292	81	40	9	1	0
	Operators of Small Powered Haulage Equipment	237	166	30	31	10	0	0
	Packaging Equipment Operators	1,390	808	276	210	83	9	4
	Truck Loading Station Tenders	42	35	4	2	1	0	0

Commodity	Occupation	Number of Samples	Sample Counts in ISO Concentration Ranges, µg/m³					
			≤ 25	> 25 to ≤ 50	> 50 to ≤ 100	> 100 to ≤ 250	> 250 to ≤ 500	> 500
	Mobile Workers	1,053	782	129	93	38	10	1
	Miners in Other Occupations	206	176	17	12	1	0	0
	Nonmetal SUBTOTAL (All Occupations)	**5,165**	**3,640**	**780**	**513**	**196**	**29**	**7**
Stone	Drillers	707	423	149	90	35	8	2
	Stone Cutting Operators	1,969	618	423	548	280	77	23
	Operators of Large Powered Haulage Equipment	3,223	2,443	456	243	75	5	1
	Conveyor Operators	44	23	10	8	2	1	0
	Crushing Equipment and Plant Operators	2,764	1,582	606	386	164	22	4
	Kiln, Mill, and Concentrator Workers	308	219	42	31	11	3	2
	Operators of Small Powered Haulage Equipment	404	228	87	67	18	4	0
	Packaging Equipment Operators	508	393	57	25	22	6	5
	Truck Loading Station Tenders	113	85	11	14	3	0	0
	Mobile Workers	4,778	2,860	946	635	285	38	14
	Miners in Other Occupations	597	419	100	54	23	1	0
	Stone SUBTOTAL (All Occupations)	**15,415**	**9,293**	**2,887**	**2,101**	**918**	**165**	**51**
Crushed Limestone	Drillers	670	535	64	46	16	5	4
	Stone Cutting Operators	143	50	30	34	19	8	2
	Operators of Large Powered Haulage Equipment	5,522	4,613	564	254	82	7	2
	Conveyor Operators	24	17	3	2	2	0	0
	Crushing Equipment and Plant Operators	3,593	2,650	537	304	80	17	5
	Kiln, Mill, and Concentrator Workers	162	146	10	6	0	0	0
	Operators of Small Powered Haulage Equipment	162	114	24	16	7	1	0
	Packaging Equipment Operators	270	240	17	11	2	0	0

Commodity	Occupation	Number of Samples	Sample Counts in ISO Concentration Ranges, µg/m³					
			≤ 25	> 25 to ≤ 50	> 50 to ≤ 100	> 100 to ≤ 250	> 250 to ≤ 500	> 500
	Truck Loading Station Tenders	122	110	6	5	1	0	0
	Mobile Workers	3,931	2,831	593	344	128	21	14
	Miners in Other Occupations	585	502	46	26	6	4	1
	Crushed Limestone SUBTOTAL (All Occupations)	**15,184**	**11,808**	**1,894**	**1,048**	**343**	**63**	**28**
Sand and Gravel	Drillers	169	99	35	22	8	3	2
	Stone Cutting Operators	243	64	48	79	32	12	8
	Operators of Large Powered Haulage Equipment	6,676	4,891	1,127	502	133	20	3
	Conveyor Operators	87	41	25	7	11	2	1
	Crushing Equipment and Plant Operators	3,994	2,004	1,014	625	288	53	10
	Kiln, Mill, and Concentrator Workers	442	132	117	118	45	20	10
	Operators of Small Powered Haulage Equipment	269	114	69	51	24	6	5
	Packaging Equipment Operators	724	169	188	229	107	22	9
	Truck Loading Station Tenders	155	59	32	39	22	2	1
	Mobile Workers	4,450	2,341	988	675	343	75	28
	Miners in Other Occupations	1,297	936	198	105	37	16	5
	Sand and Gravel SUBTOTAL (All Occupations)	**18,506**	**10,850**	**3,841**	**2,452**	**1,050**	**231**	**82**
	MNM OVERALL	**57,769**	**37,397**	**10,148**	**6,685**	**2,798**	**553**	**188**

Source: MSHA MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220812). All samples were of sufficient mass to be analyzed for respirable crystalline silica.

Note:

1. Personal samples were collected using ISO-compliant sampling equipment and calculated as an 8-hour time-weighted average (8-hour TWA). Samples were collected using an air flow rate of 1.7 L/min and reported as 8-hour TWAs. See notes in Summary table C2-1 for additional details.

Table C1-3: Percentage Distribution of Respirable Crystalline Silica Exposure in Metal/Nonmetal (MNM) Sector from 2005 to 2019, by Commodity and Occupational Category

Commodity	Occupation	Number of Samples	Percentage (%) of Samples in ISO Concentration Ranges, $\mu g/m^3$						
			≤ 25	> 25 to ≤ 50	> 50 to ≤ 100	> 100 to ≤ 250	> 250 to ≤ 500	> 500	Total
Metal	Drillers	352	62.5%	21.0%	11.9%	3.7%	0.6%	0.3%	100%
	Stone Cutting Operators	10	10.0%	20.0%	30.0%	40.0%	0.0%	0.0%	100%
	Operators of Large Powered Haulage Equipment	673	62.9%	21.1%	11.9%	3.9%	0.3%	0.0%	100%
	Conveyor Operators	29	41.4%	27.6%	13.8%	13.8%	3.4%	0.0%	100%
	Crushing Equipment and Plant Operators	628	27.5%	22.8%	26.3%	18.3%	4.1%	1.0%	100%
	Kiln, Mill, and Concentrator Workers	467	59.1%	21.2%	14.6%	3.9%	1.1%	0.2%	100%
	Operators of Small Powered Haulage Equipment	38	78.9%	13.2%	2.6%	2.6%	0.0%	2.6%	100%
	Packaging Equipment Operators	88	68.2%	9.1%	12.5%	9.1%	1.1%	0.0%	100%
	Truck Loading Station Tenders	21	61.9%	23.8%	4.8%	9.5%	0.0%	0.0%	100%
	Mobile Workers	1,004	49.8%	22.6%	16.3%	8.2%	2.4%	0.7%	100%
	Miners in Other Occupations	189	51.9%	17.5%	16.9%	9.5%	2.1%	2.1%	100%
	Metal SUBTOTAL (All Occupations)	**3,499**	**51.6%**	**21.3%**	**16.3%**	**8.3%**	**1.9%**	**0.6%**	**100%**
Nonmetal	Drillers	194	74.2%	14.9%	6.7%	3.6%	0.5%	0.0%	100%
	Stone Cutting Operators	81	71.6%	9.9%	7.4%	7.4%	2.5%	1.2%	100%
	Operators of Large Powered Haulage Equipment	922	83.3%	10.2%	4.1%	2.1%	0.3%	0.0%	100%
	Conveyor Operators	31	87.1%	12.9%	0.0%	0.0%	0.0%	0.0%	100%
	Crushing Equipment and Plant Operators	586	65.5%	18.4%	11.6%	3.8%	0.5%	0.2%	100%
	Kiln, Mill, and Concentrator Workers	423	69.0%	19.1%	9.5%	2.1%	0.2%	0.0%	100%
	Operators of Small Powered Haulage Equipment	237	70.0%	12.7%	13.1%	4.2%	0.0%	0.0%	100%
	Packaging Equipment Operators	1,390	58.1%	19.9%	15.1%	6.0%	0.6%	0.3%	100%

Commodity	Occupation	Number of Samples	Percentage (%) of Samples in ISO Concentration Ranges, µg/m³						
			≤ 25	> 25 to ≤ 50	> 50 to ≤ 100	> 100 to ≤ 250	> 250 to ≤ 500	> 500	Total
	Truck Loading Station Tenders	42	83.3%	9.5%	4.8%	2.4%	0.0%	0.0%	100%
	Mobile Workers	1,053	74.3%	12.3%	8.8%	3.6%	0.9%	0.1%	100%
	Miners in Other Occupations	206	85.4%	8.3%	5.8%	0.5%	0.0%	0.0%	100%
	Nonmetal SUBTOTAL (All Occupations)	**5,165**	**70.5%**	**15.1%**	**9.9%**	**3.8%**	**0.6%**	**0.1%**	**100%**
Stone	Drillers	707	59.8%	21.1%	12.7%	5.0%	1.1%	0.3%	100%
	Stone Cutting Operators	1,969	31.4%	21.5%	27.8%	14.2%	3.9%	1.2%	100%
	Operators of Large Powered Haulage Equipment	3,223	75.8%	14.1%	7.5%	2.3%	0.2%	0.0%	100%
	Conveyor Operators	44	52.3%	22.7%	18.2%	4.5%	2.3%	0.0%	100%
	Crushing Equipment and Plant Operators	2,764	57.2%	21.9%	14.0%	5.9%	0.8%	0.1%	100%
	Kiln, Mill, and Concentrator Workers	308	71.1%	13.6%	10.1%	3.6%	1.0%	0.6%	100%
	Operators of Small Powered Haulage Equipment	404	56.4%	21.5%	16.6%	4.5%	1.0%	0.0%	100%
	Packaging Equipment Operators	508	77.4%	11.2%	4.9%	4.3%	1.2%	1.0%	100%
	Truck Loading Station Tenders	113	75.2%	9.7%	12.4%	2.7%	0.0%	0.0%	100%
	Mobile Workers	4,778	59.9%	19.8%	13.3%	6.0%	0.8%	0.3%	100%
	Miners in Other Occupations	597	70.2%	16.8%	9.0%	3.9%	0.2%	0.0%	100%
	Stone SUBTOTAL (All Occupations)	**15,415**	**60.3%**	**18.7%**	**13.6%**	**6.0%**	**1.1%**	**0.3%**	**100%**
Crushed Limestone	Drillers	670	79.9%	9.6%	6.9%	2.4%	0.7%	0.6%	100%
	Stone Cutting Operators	143	35.0%	21.0%	23.8%	13.3%	5.6%	1.4%	100%
	Operators of Large Powered Haulage Equipment	5,522	83.5%	10.2%	4.6%	1.5%	0.1%	0.0%	100%
	Conveyor Operators	24	70.8%	12.5%	8.3%	8.3%	0.0%	0.0%	100%
	Crushing Equipment and Plant Operators	3,593	73.8%	14.9%	8.5%	2.2%	0.5%	0.1%	100%
	Kiln, Mill, and Concentrator Workers	162	90.1%	6.2%	3.7%	0.0%	0.0%	0.0%	100%

Commodity	Occupation	Number of Samples	Percentage (%) of Samples in ISO Concentration Ranges, µg/m³						
			≤ 25	> 25 to ≤ 50	> 50 to ≤ 100	> 100 to ≤ 250	> 250 to ≤ 500	> 500	Total
	Operators of Small Powered Haulage Equipment	162	70.4%	14.8%	9.9%	4.3%	0.6%	0.0%	100%
	Packaging Equipment Operators	270	88.9%	6.3%	4.1%	0.7%	0.0%	0.0%	100%
	Truck Loading Station Tenders	122	90.2%	4.9%	4.1%	0.8%	0.0%	0.0%	100%
	Mobile Workers	3,931	72.0%	15.1%	8.8%	3.3%	0.5%	0.4%	100%
	Miners in Other Occupations	585	85.8%	7.9%	4.4%	1.0%	0.7%	0.2%	100%
	Crushed Limestone SUBTOTAL (All Occupations)	**15,184**	**77.8%**	**12.5%**	**6.9%**	**2.3%**	**0.4%**	**0.2%**	**100%**
Sand and Gravel	Drillers	169	58.6%	20.7%	13.0%	4.7%	1.8%	1.2%	100%
	Stone Cutting Operators	243	26.3%	19.8%	32.5%	13.2%	4.9%	3.3%	100%
	Operators of Large Powered Haulage Equipment	6,676	73.3%	16.9%	7.5%	2.0%	0.3%	0.0%	100%
	Conveyor Operators	87	47.1%	28.7%	8.0%	12.6%	2.3%	1.1%	100%
	Crushing Equipment and Plant Operators	3,994	50.2%	25.4%	15.6%	7.2%	1.3%	0.3%	100%
	Kiln, Mill, and Concentrator Workers	442	29.9%	26.5%	26.7%	10.2%	4.5%	2.3%	100%
	Operators of Small Powered Haulage Equipment	269	42.4%	25.7%	19.0%	8.9%	2.2%	1.9%	100%
	Packaging Equipment Operators	724	23.3%	26.0%	31.6%	14.8%	3.0%	1.2%	100%
	Truck Loading Station Tenders	155	38.1%	20.6%	25.2%	14.2%	1.3%	0.6%	100%
	Mobile Workers	4,450	52.6%	22.2%	15.2%	7.7%	1.7%	0.6%	100%
	Miners in Other Occupations	1,297	72.2%	15.3%	8.1%	2.9%	1.2%	0.4%	100%
	Sand and Gravel SUBTOTAL (All Occupations)	**18,506**	**58.6%**	**20.8%**	**13.2%**	**5.7%**	**1.2%**	**0.4%**	**100%**
	MNM OVERALL	**57,769**	**64.7%**	**17.6%**	**11.6%**	**4.8%**	**1.0%**	**0.3%**	**100%**

Source: MSHA MSIS respirable crystalline silica data for the MNM industry, January 1, 2005, through December 31, 2019 (version 20220812). All samples were of sufficient mass to be analyzed for respirable crystalline silica.

Note:

1. Personal samples were collected using ISO-compliant sampling equipment and calculated as an 8-hour time-weighted average (8-hour TWA). Samples were collected using an air flow rate of 1.7 L/min and reported as 8-hour TWAs. See notes in Summary table C2-1 for additional details.

Attachment 2: Tables for Coal Respirable Crystalline Silica Samples

Table C2-1: Summary Statistics of Respirable Crystalline Silica Exposure in Coal Sector from 2016 to 2021, by Location and Occupational Category

Location	Occupation	Number of Samples	ISO Concentration (8-hour TWA, µg/m³)		
			Mean	Median	Max
Underground	Continuous Mining Machine Operators (Underground)	9,910	24.6	18.5	390.5
	Operators of Large Powered Haulage Equipment (Underground)	21,777	17.7	13.6	476.8
	Longwall Workers (Underground)	3,176	32.9	22.2	453.4
	Roof Bolters (Underground)	14,306	26.5	20.9	778.6
	Underground Miners (Underground)	3,926	15.7	11.1	324.0
	Underground OVERALL (All Occupations)	**53,095**	**22.1**	**16.0**	**778.6**
Surface	Drillers (Surface)	1,762	36.5	20.9	747.8
	Operators of Large Powered Haulage Equipment (Surface)	5,313	19.9	9.9	721.9
	Crusher Operators (Surface)	631	9.6	6.2	117.0
	Mobile Workers (Surface)	2,326	12.6	8.6	288.3
	Surface OVERALL (All Occupations)	**10,032**	**20.5**	**11.1**	**747.8**
	COAL OVERALL	**63,127**	**21.9**	**16.0**	**778.6**

Source: MSHA MSIS respirable crystalline silica data for the Coal Industry, August 1, 2016, through July 31, 2021 (version 20220617). All samples were of sufficient mass to be analyzed for respirable crystalline silica.

Notes: Summary of personal samples presented as ISO 8-hour TWA concentrations. The proposed permissible exposure limit (PEL) for all mines is 50 µg/m³ as an 8-hour time-weighted average (8-hour TWA) sample collected according to the ISO standard 7708:1995: *Air Quality—Particle Size Fraction Definitions for Health-Related Sampling*.

1. The compliance samples summarized in this table were collected by MSHA inspectors for the entire duration of each miner's work shift using sampling equipment with an air flow rate of 2 L/min, with results reported as MRE TWA concentrations. For this rulemaking analysis, MSHA recalculated the samples as ISO-equivalent 8-hour TWA concentrations, comparable to the proposed PEL (since samples were not collected using an ISO-compliant sampling method). The procedure to calculate an ISO-equivalent concentration from an MRE TWA sample concentration involves normalizing the sample concentration to an 8-hour TWA and applying the empirically derived conversion factor of 0.857 recommended by NIOSH (1995a) using the following equation:
2. ISO 8-hour TWA concentration = $(MRE\ TWA\ in\ \mu g/m^3)\ x\ \frac{(original\ sampling\ time)}{(480\ minutes)}\ x\ 0.857$

   where: both concentrations (ISO 8-hour TWA and MRE TWA) are concentrations presented as µg/m3; sampling time in minutes.
3. When the mass of respirable crystalline silica collected was too small to be reliably detected by the laboratory, a mass of 1.5 µg (1/2 the limit of detection) was assumed and used to calculate sample results.

Table C2-2: Sample Count Distribution of Respirable Crystalline Silica Exposure in Coal Sector from 2016 to 2021, by Location and Occupational Category

Location	Occupation	Number of Samples	Sample Counts in ISO Concentration Ranges, 8-hour TWA, µg/m³						
			≤ 25 µg/m³	> 25 to ≤ 50 µg/m³	> 50 to ≤ 85.7 µg/m³	> 85.7 to ≤ 100 µg/m³	> 100 to ≤ 250 µg/m³	> 250 to ≤ 500 µg/m³	> 500 µg/m³
Underground	Continuous Mining Machine Operators (Underground)	9,910	6,750	2,366	572	67	144	11	0
	Operators of Large Powered Haulage Equipment (Underground)	21,777	17,938	3,110	576	51	95	7	0
	Longwall Workers (Underground)	3,176	1,767	857	356	62	125	9	0
	Roof Bolters (Underground)	14,306	8,768	4,194	1,093	106	141	3	1
	Underground Miners (Underground)	3,926	3,396	398	96	11	22	3	0
	Underground OVERALL (All Occupations)	**53,095**	**38,619**	**10,925**	**2,693**	**297**	**527**	**33**	**1**
Surface	Drillers (Surface)	1,762	1,019	422	180	30	90	17	4
	Operators of Large Powered Haulage Equipment (Surface)	5,313	4,268	627	219	45	132	18	4
	Crusher Operators (Surface)	631	588	28	13	1	1	0	0
	Mobile Workers (Surface)	2,326	2,102	164	45	3	11	1	0
	Surface OVERALL (All Occupations)	**10,032**	**7,977**	**1,241**	**457**	**79**	**234**	**36**	**8**
	COAL OVERALL	**63,127**	**46,596**	**12,166**	**3,150**	**376**	**761**	**69**	**9**

Source: MSHA MSIS respirable crystalline silica data for the coal industry, August 1, 2016, through July 31, 2021 (version 20220617). All samples were of sufficient mass to be analyzed for respirable crystalline silica.

Note:

1. Personal samples presented in terms of ISO concentrations, normalized to 8-hour time-weighted averages (TWAs). The samples were originally collected for the entire duration of each miner's work shift, using an air flow rate of 2 L/min. See notes in Summary table C1-1 for additional details.

Table C2-3: Percentage Distribution of Respirable Crystalline Silica Exposure in Coal Sector from 2016 to 2021, by Location and Occupational Category

Location	Occupation	Number of Samples	Percentage (%) of Samples in ISO Concentration Ranges, 8-hour TWA, µg/m³							Total
			≤ 25	> 25 to ≤ 50	> 50 to ≤ 85.7	> 85.7 to ≤ 100	> 100 to ≤ 250	> 250 to ≤ 500	> 500	
Underground	Continuous Mining Machine Operators (Underground)	9,910	68.1%	23.9%	5.8%	0.7%	1.5%	0.1%	0%	100%
	Operators of Large Powered Haulage Equipment (Underground)	21,777	82.4%	14.3%	2.6%	0.2%	0.4%	<0.1%	0%	100%
	Longwall Workers (Underground)	3,176	55.6%	27%	11.2%	2%	3.9%	0.3%	0%	100%
	Roof Bolters (Underground)	14,306	61.3%	29.3%	7.6%	0.7%	1%	<0.1%	<0.1%	100%
	Underground Miners (Underground)	3,926	86.5%	10.1%	2.4%	0.3%	0.6%	0.1%	0%	100%
	Underground OVERALL (All Occupations)	**53,095**	**72.7%**	**20.6%**	**5.1%**	**0.6%**	**1%**	**0.1%**	**<0.1%**	**100%**
Surface	Drillers (Surface)	1,762	57.8%	24%	10.2%	1.7%	5.1%	1%	0.2%	100%
	Operators of Large Powered Haulage Equipment (Surface)	5,313	80.3%	11.8%	4.1%	0.8%	2.5%	0.3%	0.1%	100%
	Crusher Operators (Surface)	631	93.2%	4.4%	2.1%	0.2%	0.2%	0%	0%	100%
	Mobile Workers (Surface)	2,326	90.4%	7.1%	1.9%	0.1%	0.5%	<0.1%	0%	100%
	Surface OVERALL (All Occupations)	**10,032**	**79.5%**	**12.4%**	**4.6%**	**0.8%**	**2.3%**	**0.4%**	**0.1%**	**100%**
	COAL OVERALL	**63,127**	**73.8%**	**19.3%**	**5%**	**0.6%**	**1.2%**	**0.1%**	**<0.1%**	**100%**

Source: MSHA MSIS respirable crystalline silica data for the coal industry, August 1, 2016, through July 31, 2021 (version 20220617). All samples were of sufficient mass to be analyzed for respirable crystalline silica.

Note:

1. Personal samples presented in terms of ISO concentrations, normalized to 8-hour time-weighted averages (TWAs). The samples were originally collected for the entire duration of each miner's work shift, using an air flow rate of 2 L/min. See notes in Summary table C1-1 for additional details.

Attachment 3: Coal Job Codes

The complete list of job codes that are found in IAS, as of March 11, 2022, are included below, with Table C3-1 listing job codes for coal miners. For coal, the first digit of the job code identifies where the work is taking place. For example, codes starting with 0 represent jobs that occur at the underground face of the mine. Job codes that start with 6 were added in 2020.

0 – Underground Section Workers (Face)
1 – General Underground (Non-Face)
2 – Underground Transportation (Non-Face)
3 – Surface
4 – Supervisory and Staff
5 – MSHA – State
6 – Shaft and Slope Sinking

Table C3-1: Coal Job Codes

Job Code	Occupation / Activity
Underground Section Workers (Face)	
000	Area
001	Belt Man/Conveyor Man
002	Electrician
003	Electrician Helper
004	Mechanic
005	Mechanic Helper
006	Rock Duster
007	Blaster/Shooter/Shotfirer
008	Stopping Builder/Ventilation Man/Mason
009	Supply Man
010	Auger (Jack Setter) (Intake Side)
011	Wireman
012	Roof Bolter (Twin Head) (Intake Side)
013	Shuttle Car Operator (Off Standard Side)
014	Roof Bolter (Twin Head) (Return Side)
015	Fan Attendant
016	Laborer
017	Auger (Timberman) (Return Side)
018	Auger (Timberman) (Intake Side)
019	Roof Bolter (Mounted) (Intake Side)
031	Shotfirer Helper
032	Brattice Man
033	Coal Drill Helper
034	Coal Drill Operator
035	Continuous Miner Helper
036	Continuous Miner Operator
037	Cutting Machine Helper

Table C3-1: Coal Job Codes

Job Code	Occupation / Activity
038	Cutting Machine Operator
039	Hand Loaders
040	Headgate Operator
041	Jack Setter (Longwall)
042	Loading Machine Helper
043	Loading Machine Operator
044	Longwall Operator (Tailgate Side)
045	Rockman
046	Roof Bolter (Single Head)
047	Roof Bolter Helper (Single Head)
048	Roof Bolter (Mounted) (Return Side)
049	Section Foreman
050	Shuttle Car Operator (Standard Side)
051	Stall Driver
052	Tailgate Operator
053	Utility Man
054	Scoop Car Operator
055	Auger (Jack Setter) (Return Side)
060	Longwall (Return-Side Face Worker)
061	Longwall (Return-Side Fixed)
064	Longwall Operator (Headgate Side)
070	Auger Operator
071	Auger Helper
072	Mobile Bridge Operator
073	Shuttle Car Operator (Off Standard)
074	Tractor Operator/Motorman
General Underground (Non-Face)	
101	Belt Man/Conveyor Man

Table C3-1: Coal Job Codes

Job Code	Occupation / Activity
102	Electrician
103	Electrician Helper
104	Mechanic
105	Mechanic Helper
106	Rock Duster
108	Stopping Builder/Ventilation Man/Mason
109	Supply Man
110	Timberman
111	Wireman
112	Belt Vulcanizer
113	Cleanup Man
114	Coal Sampler
115	Fan Attendant
116	Laborer
117	Rodman
118	Oiler/Greaser
119	Welder
122	Coal Dump Operator
123	Transit Man
146	Roof Bolter
149	Bullgang Foreman/Labor Foreman
154	Belt Cleaner
155	Chainman
156	Rock Driller
157	Pumper
158	Rock Machine Operator
159	Water Line Man
160	Shopman
Underground Transportation (Non-Face)	
201	Belt Man/Conveyor Man
216	Trackman
220	Cager
221	Hoistman
240	Loader Head/Roscoe Operator
250	Shuttle Car Operator
261	Battery Station Operator
262	Brakeman/Roperider
263	Track Foreman
265	Dispatcher
269	Motorman
276	Driver
277	Buggy Pusher
Surface	

Table C3-1: Coal Job Codes

Job Code	Occupation / Activity
301	Conveyor Operator
302	Electrician
303	Electrician Helper
304	Mechanic
305	Mechanic Helper
306	Welder (Non-Shop)
307	Blaster/Shooter/Shotfirer
308	Mason
309	Supply Man
310	Scrapper Operator
311	Wireman
312	Belt Vulcanizer
313	Cleanup Man
314	Coal Sampler
315	Fan Attendant
316	Laborer/Blacksmith
317	Rodman
318	Oiler/Greaser
319	Welder (Shop)
320	Cage Attendant/Cager
321	Hoist Engineer/Operator
322	Coal Strip Operator
323	Transit Man
324	Backhoe Operator
325	Diester Table Operator
326	Forklift Operator
327	Pumper
328	Utility Man
329	Vacuum Filter Operator
330	Face Worker-Shaft/Slope Sinking
331	Clam Operator
333	Coal Drill Helper
334	Coal Drill Operator
340	Boom Operator
341	Belt Man/Conveyor Man
342	Bit Sharpener
343	Car Trimmer/Car Loader
344	Car Shake-Out Operator
345	Crusher Attendant
347	Froth Cell Operator
348	Machinist
349	Rotary Dump Operator
350	Shuttle Car Operator
351	Scoop Operator

Table C3-1: Coal Job Codes

Job Code	Occupation / Activity
352	Steel Worker
354	Sweeper Operator
355	Chainman
356	Rock Driller
357	Washer Operator
358	Water Circuit Operator
359	Self-Propelled Compactor Operator
360	Shopman Repair Cars
362	Brakeman
365	Dispatcher
366	Waterboy
367	Coal Shovel Operator
368	Bulldozer Operator
369	Motorman/Locomotive Operator
370	Auger Operator
371	Auger Helper
372	Barge Attendant
373	Car Dropper
374	Cleaning Plant Operator
375	Road Grader Operator
376	Coal Truck Driver
377	Road Roller Operator
378	Crane Operator/Dragline Operator
379	Dryer Operator
380	Fine Coal Plant Operator
381	Hoist Operator Helper
382	Highlift Operator/Front End Loader
383	Highwall Drill Helper
384	Highwall Drill Operator
385	Lampman
386	Refuse Truck Driver/Backfill Truck Drive
387	Rotary Bucket Excavator Operator
388	Scalper-Screen Operator
390	Silo Operator
391	Stripping Shovel Operator
392	Tipple Operator
393	Weighman
394	Carpenter
395	Water Truck Operator
396	Watchman
397	Yard Engine Operator
398	Groundman

Table C3-1: Coal Job Codes

Job Code	Occupation / Activity
Supervisory And Staff	
402	Master Electrician
404	Master Mechanic
414	Dust Sampler
418	Maintenance Foreman
423	Surveyor
430	Assist Mine Foreman/Assist Mine Manager
449	Mine Foreman/Mine Manager
456	Engineers (Electricity/Ventilation/Minin
462	Fire Boss Pre-Shift Examiner
464	Inspector
481	Superintendent
489	Outside Foreman
494	Preparation Plant Foreman
495	Safety Director
496	Union Representative
497	Clerk/Timekeeper
MSHA – State	
590	Education Specialist
591	Mineral Industrial Safety Officer
592	Mine Safety Instructor
593	Safety Representative
594	Training Specialist
Shaft and Slope Sinking	
602	Electrician
604	Mechanic
607	Blaster/Shooter/Shot Firer
609	Supply Person
612	(Intake) Twin Head Roof Bolter
614	(Return) Twin Head Roof Bolter
616	Laborer
631	Blaster/Shooter/Shot Firer Helper
632	Ventilation Worker
635	Continuous Miner Operator Helper
636	Continuous Miner Operator
646	Single Head Roof Bolter
647	Single Head Roof Bolter Helper
649	Foreman
650	(Standard Side) Shuttle Car Operator
654	Scoop Car Operator/Mucker
656	Rock Driller
673	(Off Standard Side) Shuttle Car Operator

Attachment 4: MNM Job Codes

The complete list of job codes that are found in IAS, as of March 11, 2022, are included below with Table C4-1 outlining job codes for MNM miners.

Table C4-1: MNM Job Codes

Job Code	Occupation / Activity
028	Scoop Tram Operator
029	Mucking Machine Operator
030	Slusher
032	Brattice Man
034	Diamond Drill Operator
035	Continuous Miner Helper
036	Continuous Miner Operator
037	Cutting Machine Helper
038	Cutting Machine Operator
039	Hand Loader (Load Only)
041	Jacksetter
043	Gathering Arm Loader Operator
045	Hangup Man, Chute Blaster
046	Rock Bolter, Roof Bolter
048	Roof Bolter Mounted
053	Utility Man
057	Stope Miner
058	Drift Miner
059	Raise Miner
079	Crusher Operator, Crusher Worker, Pan-Feeder Operator
134	Jet-Piercing Channeler Operator
154	Belt Cleaner, Belt Picker
179	Ball, Rod Or Pebble Mill Operator
216	Track Man; Track Gang
234	Jet-Piercing Drill Operator
261	Battery Station Operator
279	Hammer Mill Operator
331	Clam-Shell Operator
334	Wagon Drill Operator
342	Bit Grinder; Bit Sharpener
344	Car Shake-Out Operator
352	Iron Worker, Metal Worker
367	Shovel Operator
368	Bulldozer Operator
372	Barge Attendant, Boat Operator, Dredge Operator
375	Road Grader Operator

Table C4-1: MNM Job Codes

Job Code	Occupation / Activity
376	Truck Driver
378	Mobile Crane Operator
379	Dryer Operator, Kiln Operator
385	Lampman
387	Rotary Bucket Excavator Operator
388	Scalper-Screen Operator
389	Forklift Operator
392	Toplander, Skip Dumper, Tipple Operator
393	Weighman, Scale Man
394	Carpenter
397	Yard Engineer Operator
399	Dimension Stone Cutter And Polisher; Rock Sawer
413	Janitor
416	Salvage Crew
420	Aerial Tram Operator
434	Churn Drill Operator
456	Engineer (Electrical, Ventilation, Mining, Etc.)
479	Hydrating Plant Operator
488	Dry Screening Plant Operator
513	Building Repair And Maintenance
514	Laboratory Technician
516	Tamping Machine Operator
534	Jacking Or Stoper Drill Operator
579	Slurry, Mixing Or Pumping Operations Worker
588	Sizing And Washing Operations Worker
601	Conveyor Belt Crew
602	Electrician
603	Electrician Helper
604	Mechanic
607	Jackhammer Operator, Chipping Hammer Operator
608	Mason
609	Supply Man, Nipper
612	Belt Vulcanizer
613	Cleanup Man

Table C4-1: MNM Job Codes

Job Code	Occupation / Activity
614	Sampler, Dust Sampler
616	Laborer, Bullgang
618	Greaser, Oiler
619	Welder (Welding, Cutting, Brazing, Hard Surfacing, Soldering)
622	Dump Operator
623	Surveyor, Transit Man
634	Rotary (Electrical Or Hydraulic) Drill Operator
649	Administrative, Supervisory, Management Personnel
660	Machinist
663	Shaft Miner, Shaft Sinker
668	Tractor Operator
669	Bin Puller; Truck Loader
673	Leaching Operations Worker
674	Warehouseman; Supply Handler
678	Dragline Operator
679	Flotation Mill Operator; Concentrator Operator
682	Scraper-Loader Operator
706	Shotcrete Man, Gunite Man
708	Ventilation Crew
710	Ground Control (Wood And Steel), Timberman
716	Cement Man, Concrete Worker
726	Grizzley Man, Grizzley Tender
728	Complete Load/Haul/Dump Cycle
734	Rotary (Pneumatic) Drill Operator
739	Hand Trimmer (Load And Dump)
747	Scaling (Hand)
750	Shuttle Car Operator (Electrical)
759	Raise Borer Operator
763	Shaft Repairer
765	Sandfiller (Dry Operations)
766	Sandfiller (Wet Operations)
778	Backhoe Operator
779	Pelletizing Operations Worker
782	Front-End Loader Operator
804	Plumber, Pipe Fitter, Millwright

Table C4-1: MNM Job Codes

Job Code	Occupation / Activity
807	Powder Gang, Powderman, Powder Monkey, Shooter, Shotfitter, Blaster
825	Bobcat Operator
833	Drill Helper, Chuck Tender
847	Scaling (Mechanical)
850	Ramcar Operator
878	Overhead Crane Operator
879	Bagging Or Packaging Operations Worker
894	Painter
920	Cager, Cage Attendant, Station Attendant
921	Hoist Operator
930	Skip Tender
934	Jumbo Percussion Drill Operator
950	Shuttle Car Operator (Electrical)
962	Trip Rider, Swamper
969	Motorman
979	Packaging Operations Worker

Attachment 5. Examples of Job Code Pocket Cards

Inspectors previously received pocket-sized job code cards for use in filling out forms with the correct job code. Now, a drop-down menu in IAS is used to select the codes. Table C5-1 contains Underground Coal Mining Occupation Codes from Coal Job Code Cards used by MESA between 1973 and 1977. Table C5-2 contains Surface Occupation Codes from Coal Job Codes used by MESA between 1973 and 1977.

Table C5-1 Coal Job Code Cards, Underground Coal Mining Occupation Codes

Table C5-1: Coal Job Code Cards (MESA, 1973-1977)
Underground Coal Mining Occupation Codes

Job Code	Occupation / Activity
Section Workers (Face)	
071	Auger Helper
070	Auger Operator
031	Beater
001	Belt Man/Conveyor Man
007	Blaster
032	Brattice Man
013	Cleanup Man
033	Coal Drill Helper
034	Coal Drill Operator
035	Continuous Miner Helper
036	Continuous Miner Operator
037	Cutting Machine Helper
038	Cutting Machine Operator
002	Electrician
003	Electrician Helper
015	Fan Attendant
039	Hand Loaders
040	Headgate Operator
010	Jack Setter (Auger – intake side)
055	Jack Setter (Auger – return side)
041	Jack Setter (Longwall)
016	Laborer
042	Loading Machine Helper
043	Loading Machine Operator
008	Mason
004	Mechanic
005	Mechanic Helper
010	Prepman
006	Rock Duster
045	Rockman
046	Roof Bolter
047	Roof Bolter Helper

Table C5-1: Coal Job Code Cards (MESA, 1973-1977)
Underground Coal Mining Occupation Codes

Job Code	Occupation / Activity
048	Roof Bolter Mounted
054	Scoop Car Operator
049	Section Foreman
044	Sheer Operator/Plow Operator Longwall
007	Shooter
031	Shotfire Helper
007	Shotfirer
050	Shuttle Car Operator
051	Stall Driver
008	Stopping Builder
009	Supply Man
052	Tailgate Operator
010	Timberman
053	Utility Man
008	Ventilation Man
011	Wireman
General Underground (Non-Face)	
154	Belt Cleaner
101	Belt Man/Conveyor Man
112	Belt Vulcanizer
149	Bullgang Foreman
155	Chainman
113	Cleanup Man
122	Coal Dump Operator
114	Coal Sampler
102	Electrician
103	Electrician Helper
115	Fan Attendant
118	Greaser
149	Labor Foreman
116	Laborer
108	Mason
104	Mechanic

Table C5-1: Coal Job Code Cards (MESA, 1973-1977)
Underground Coal Mining Occupation Codes

Job Code	Occupation / Activity
105	Mechanic Helper
118	Oiler
157	Pumper
156	Rock Driller
106	Rock Duster
158	Rock Machine Operator
117	Rodman
146	Roof Bolter
160	Shopman
108	Stopping Builder
109	Supply Man
110	Timberman
123	Transmit Man
108	Ventilation Man
159	Water Line Man
119	Welder

Table C5-1: Coal Job Code Cards (MESA, 1973-1977)
Underground Coal Mining Occupation Codes

Job Code	Occupation / Activity
111	Wireman
Underground Transportation (Non-Face)	
261	Battery Station Operator
201	Belt Man/Conveyor Man
262	Brakeman
277	Buggy Pusher
220	Cager
265	Dispatcher
276	Driver
221	Hoistman
240	Leader Head Operator
269	Motorman
262	Rope Rider
240	Roscoe Operator
250	Shuttle Car Operator
216	Trackman

Table C5-2 Coal Job Code Cards, Surface Occupation Codes

Table C5-2: Coal Job Code Cards (MESA, 1973-1977)
Surface Occupation Codes

Job Code	Occupation / Activity
100	*203(b) Miner
370	Auger Operator
371	Auger Helper
372	Barge Attendant
312	Belt Vulcanizer
307	Blaster
368	Bulldozer Operator
340	Boom Operator
362	Brakeman
320	Cage Attendant/Cager
373	Car Dropper
394	Carpenter
355	Chainman
331	Clam Operator
374	Cleaning Plant Operator
313	Cleanup Man
333	Coal Drill Helper
334	Coal Drill Operator

Table C5-2: Coal Job Code Cards (MESA, 1973-1977)
Surface Occupation Codes

Job Code	Occupation / Activity
322	Coal Strip Operator
314	Coal Sampler
367	Coal Shovel Operator
376	Coal Truck Driver
301	Conveyor Operator
378	Crane Operator
365	Dispatcher
378	Dragline Operator
379	Dryer Operator
302	Electrician
303	Electrician Helper
315	Fan Attendant
380	Fine Coal Plant Operator
318	Greaser
398	Groundman
382	Highlift Operator
383	Highwall Drill Helper
384	Highwall Drill Operator

Table C5-2: Coal Job Code Cards (MESA, 1973-1977)
Surface Occupation Codes

Job Code	Occupation / Activity
321	Hoist Engineer/Operator
381	Hoist Operator Helper
316	Laborer Blacksmith
385	Lampman
308	Mason
304	Mechanic
305	Mechanic Helper
369	Motorman
318	Oiler
310	Pan Scraper Operator
386	Refuse Truck Driver
375	Road Grader Operator
356	Rock Driller
317	Rodman
387	Rotary Bucket Excavator Operator
388	Scalper-Screen Operator
360	Shopman Repair Care
307	Shooter
307	Shotfirer
350	Shuttle Car Operator
390	Silo Operator
391	Stripping Shovel Operator
309	Supply Man
392	Tipple Operator
323	Transmit Man
396	Watchman
366	Waterboy
395	Water Truck Operator
393	Weighman

Table C5-2: Coal Job Code Cards (MESA, 1973-1977)
Surface Occupation Codes

Job Code	Occupation / Activity
319	Welder (Shop) Blacksmith
311	Wireman
397	Yard Engine Operator
Supervisory and Staff	
430	Assistant Mine Foreman/Assistant Mine Manager
497	Clerk
414	Dust Sampler
456	Engineers (Electricity, Ventilation, Mining, etc.)
462	Fire Boss Pre-Shift Examiner
464	Inspector
418	Maintenance Foreman
402	Master Electrician
404	Master Mechanic
449	Mine Foreman/Mine Manager
489	Outside Foreman
494	Preparation Plant Foreman
495	Safety Director
481	Superintendent
423	Surveyor
497	Timekeeper
496	Union Representative
MESA – State	
590	Education Specialist
591	Mineral Industry Safety Officer
592	Mine Safety Instructor
593	Safety Representative
594	Training Specialist

MNM Job Code Cards (1997)

Table C5-3 includes MNM Job Codes from a MNM Job Code Card printed in 1997 by the GPO and which referenced a 1981 MSHA form (MSHA Form 4000-50, Sept. 1981).

Table C5-3: MNM Job Code Cards (1997)

Job Code	Occupation / Activity
Development and Production	
607	Jackhammer Operator; Chipping Hammer Operator
807	Powder Gang; Powderman; Power Monkey; Shooter; Shotfirer; Blaster
609	Supply Man; Nipper
710	Ground Control (wood and steel); Timberman
216	Track Man; Track Gang
516	Tamping Machine Operator
833	Drill Helper; Chuck Tender
034	Diamond Drill Operator
134	Jet-Piercing Channeler Operator
234	Jet-Piercing Drill Operator
334	Wagon Drill Operator
434	Churn Drill Operator
534	Jackleg or Stoper Drill Operator
634	Rotary (electric or hydraulic) Drill Operator
734	Rotary (pneumatic) Drill Operator
934	Jumbo Percussion Drill Operator
035	Continuous Miner Helper
036	Continuous Miner Operator
037	Cutting Machine Helper
038	Cutting Machine Operator
045	Hangup Man; Chute Blaster
046	Rock Bolter; Roof Bolter
747	Scaling (hand)
847	Scaling (mechanical)
048	Roof Bolter Mounted
053	Utility Man
057	Stope Miner
058	Drift Miner
059	Raise Miner
759	Raise Borer Operator
663	Shaft Miner; Shaft Sinking
765	Sandfiller (dry operations)
766	Sandfiller (wet operations)
399	Dimension Stone Cutter and Polisher; Rock Sawer
Ore/Mineral Processing	
673	Leaching Operations Worker
079	Crusher Operator; Crusher Worker; Pan-Feeder Operator

Table C5-3: MNM Job Code Cards (1997)

Job Code	Occupation / Activity
179	Ball, Rod, or Pebble Mill Operator
279	Hammer Mill Operator
379	Dryer Operator; Kiln Operator
479	Hydrating Plant Operator
579	Slurry, Mixing or Pumping Operations Worker
679	Flotation Mill Operator; Concentrator Operator
779	Pelletizing Operations Worker
879	Bagging or Packaging Operations Worker
388	Scalper-Screen Operator
488	Dry Screening Plant Operator
588	Sizing and Washing Operations Worker
Load/Haul/Dump	
601	Conveyor Belt Crew
420	Aerial Tram Operator
920	Cager; Cage Attendant; Station Attendant
921	Hoist Operator
622	Dump Operator
825	Bobcat Operator
726	Grizzly Man; Grizzly Tender
028	Scoop-Tram Operator
728	Complete Load/Haul/Dump Cycle
029	Mucking Machine Operator
030	Slusher Operator
930	Skip Tender
331	Clam-Shell Operator
039	Hand Loader (load only)
739	Hand Trammer (load and dump)
043	Gathering Arm Loader Operator
344	Car Shake-Out Operator
750	Shuttle Car Operator (diesel)
850	Ramcar Operator
950	Shuttle Car Operator (electric)
154	Belt Cleaner; Belt Picker
962	Trip Rider; Swamper
367	Shovel Operator
368	Bulldozer Operator
668	Tractor Operator
669	Bin Puller; Truck Loader
969	Motorman

Table C5-3: MNM Job Code Cards (1997)

Job Code	Occupation / Activity
372	Barge Attendant; Boat Operator; Dredge Operator
376	Truck Driver
378	Mobile Crane Operator
678	Dragline Operator
778	Backhoe Operator
878	Overhead Crane Operator
682	Scraper-Loader Operator
782	Front-End Loader Operator
387	Rotary Bucket Excavator Operator
389	Forklift Operator
392	Toplander; Skip Dumper; Tipple Operator
393	Weighman; Scale Man
397	Yard Engine Operator
Maintenance	
602	Electrician
603	Electrician Helper
604	Mechanic
804	Plumber; Pipe Fitter; Millwright
706	Shotcrete Man; Gunite Man
608	Mason
708	Ventilation Crew
612	Belt Vulcanizer
513	Building Repair and Maintenance
613	Cleanup Man
416	Salvage Crew
616	Laborer; Bullgang
716	Cement Man; Concrete Worker
618	Greaser; Oiler
619	Welder (welding, cutting, brazing, hard surfacing, soldering)
032	Brattice Man
041	Jacksetter
342	Bit Grinder; Bit Sharpener
352	Iron Worker; Metal Worker
660	Machinist
261	Battery Station Operator
763	Shaft Repairer
375	Road Grader Operator
385	Lampman
394	Carpenter
894	Painter

Table C5-3: MNM Job Code Cards (1997)

Job Code	Occupation / Activity
Miscellaneous	
413	Janitor
514	Laboratory Technician
614	Sampler; Dust Sampler
623	Surveyor; Transmit Man
649	Administrative, Supervisory, Management Personnel
456	Engineer (electrical, ventilation, mining, etc.); Technical Services
674	Warehouseman; Supply Handler

BILLING CODE 4520–43–C

List of Subjects

30 CFR Part 56

Chemicals, Electric power, Explosives, Fire prevention, Hazardous substances, Incorporation by reference, Metal and nonmetal mining, Mine safety and health, Noise control, Reporting and recordkeeping requirements, Surface mining.

30 CFR Part 57

Chemicals, Electric power, Explosives, Fire prevention, Gases, Hazardous substances, Incorporation by reference, Metal and nonmetal mining, Mine safety and health, Noise control, Radiation protection, Reporting and recordkeeping requirements, Underground mining.

30 CFR Part 60

Coal, Incorporation by reference, Metal and nonmetal mining, Medical surveillance, Mine safety and health, Respirable crystalline silica, Reporting and recordkeeping requirements, Surface mining, Underground mining.

30 CFR Part 70

Coal, Mine safety and health, Reporting and recordkeeping requirements, Respirable dust, Underground coal mines.

30 CFR Part 71

Coal, Mine safety and health, Reporting and recordkeeping requirements, Surface coal mines, Underground coal mines.

30 CFR Part 72

Coal, Health standards, Incorporation by reference, Mine safety and health, Training, Underground mining.

30 CFR Part 75

Coal, Mine safety and health, Reporting and recordkeeping requirements, Underground coal mines, Ventilation.

30 CFR Part 90

Coal, Mine safety and health, Reporting and recordkeeping requirements, Respirable dust.

Christopher J. Williamson,

Assistant Secretary of Labor for Mine Safety and Health.

For the reasons discussed in the preamble, the Mine Safety and Health Administration is amending 30 CFR subchapters K, M, and O as follows:

Subchapter K—Metal and Nonmetal Mine Safety and Health

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.

Subpart D—Air Quality and Physical Agents

■ 2. Amend § 56.5001 by revising the introductory text to read as follows:

§ 56.5001 Exposure limits for airborne contaminants.

The following is required until April 7, 2026. Except as permitted by § 56.5005—

* * * * *

■ 3. Add § 56.5001T to read as follows:

§ 56.5001T Exposure limits for airborne contaminants.

As of April 8, 2026 the following is required, except as permitted by § 56.5005—

(a) *TLVs standard.* Except as provided in paragraph (b) of this section and in part 60 of this chapter, the exposure to airborne contaminants shall not exceed, on the basis of a time weighted average, the threshold limit values adopted by the American Conference of Governmental Industrial Hygienists, as set forth and explained in the 1973 edition of the Conference's publication, entitled *TLV's Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973,* pages 1 through 54. This publication is incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. This incorporation by reference (IBR) material is available for inspection at the Mine Safety and Health Administration (MSHA) and at the National Archives and Records Administration (NARA). Contact MSHA at: MSHA's Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, VA 22202–5450; (202) 693–9440; or at any Mine Safety and Health Enforcement District Office. For information on the availability of this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations* or email *fr.inspection@nara.gov.* The material may be obtained from American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Attn: Customer Service, Cincinnati, OH 45240; *www.acgih.org.*

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

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

Asbestos fiber means a fiber of asbestos that meets the criteria of a fiber.

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 asbestos fiber concentration.* Potential asbestos fiber concentration shall be determined by phase contrast microscopy (PCM) using the OSHA Reference Method in OSHA's asbestos standard found in 29 CFR 1910.1001, Appendix A, or a method at least equivalent to that method in identifying a potential asbestos exposure exceeding the 0.1 f/cc full-shift limit or the 1 f/cc excursion limit. When PCM results indicate a potential exposure exceeding the 0.1 f/cc full-shift limit or the 1 f/cc excursion limit, samples shall be further analyzed using transmission electron microscopy according to NIOSH Method 7402 or a method at least equivalent to that method.

(c) *Required action.* Employees shall be withdrawn from areas where there is present an airborne contaminant given a ''C'' designation by the Conference and the concentration exceeds the threshold limit value listed for that contaminant.

§ 56.5001 [Removed]

■ 4. Effective April 8, 2026, remove § 56.5001.

§ 56.5001T [Redesignated as § 56.5001]

■ 5. Effective April 8, 2026, redesignate § 56.5001T as § 56.5001.

■ 6. Amend § 56.5005 by revising the introductory text to read as follows:

§ 56.5005 Control of exposure to airborne contaminants.

The following is required until April 7, 2026. Control of employee exposure to harmful airborne contaminants shall be, insofar as feasible, by prevention of contamination, removal by exhaust ventilation, or by dilution with uncontaminated air. However, where accepted, engineering control measures have not been developed or when necessary by the nature of work involved (for example, while establishing controls or occasional entry into hazardous atmospheres to perform maintenance or investigation), employees may work for reasonable periods of time in concentrations of airborne contaminants exceeding permissible levels if they are protected by appropriate respiratory protective equipment. Whenever respiratory protective equipment is used a program for selection, maintenance, training, fitting, supervision, cleaning, and use shall meet the following minimum requirements:

* * * * *

■ 7. Add § 56.5005T to read as follows:

§ 56.5005T Control of exposure to airborne contaminants.

As of April 8, 2026, the following is required. Control of employee exposure to harmful airborne contaminants shall be, insofar as feasible, by prevention of contamination, removal by exhaust ventilation, or by dilution with uncontaminated air. However, where accepted engineering control measures have not been developed or when necessary by the nature of work involved (for example, while establishing controls or occasional entry into hazardous atmospheres to perform maintenance or investigation), employees may work for reasonable periods of time in concentrations of airborne contaminants exceeding permissible levels if they are protected by appropriate respiratory protective equipment. Whenever respiratory protective equipment is used, its selection, fitting, maintenance, cleaning, training, supervision, and use shall meet the following minimum requirements:

(a) Respirators approved by NIOSH under 42 CFR part 84 which are applicable and suitable for the purpose intended shall be furnished and miners shall use the protective equipment in accordance with training and instruction.

(b) A written respiratory protection program consistent with the requirements of ASTM F3387–19, *Standard Practice for Respiratory Protection,* approved August 1, 2019, which is incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. This incorporation by reference (IBR) material is available for inspection at the Mine Safety and Health Administration (MSHA) and at the National Archives and Records Administration (NARA). Contact MSHA at: MSHA's Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, VA 22202–5450; (202) 693–9440; or any Mine Safety and Health Enforcement District Office. For information on the availability of this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations* or email *fr.inspection@nara.gov.* The material may be obtained from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959; *www.astm.org.*

(c) When respiratory protection is used in atmospheres immediately dangerous to life or health (IDLH), the presence of at least one other person with backup equipment and rescue capability shall be required in the event of failure of the respiratory equipment.

§ 56.5005 [Removed]

■ 8. Effective April 8, 2026, remove § 56.5005.

§ 56.5005T [Redesignated as § 56.5005]

■ 9. Effective April 8, 2026, redesignate § 56.5005T as § 56.5005.

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

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

Authority: 30 U.S.C. 811.

Subpart D—Air Quality, Radiation, Physical Agents, and Diesel Particulate Matter

■ 11. Amend § 57.5001 by revising the introductory text to read as follows:

§ 57.5001 Exposure limits for airborne contaminants.

The following is required until April 7, 2026. Except as permitted by § 57.5005—

* * * * *

■ 12. Add § 57.5001T to read as follows:

§ 57.5001T Exposure limits for airborne contaminants.

As of April 8, 2026, except as permitted by § 57.5005—

(a) *TLVs standard.* Except as provided in paragraph (b) of this section and in part 60 of this chapter, the exposure to airborne contaminants shall not exceed, on the basis of a time weighted average, the threshold limit values adopted by the American Conference of Governmental Industrial Hygienists, as set forth and explained in the 1973 edition of the Conference's publication, entitled *TLV's Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973,* pages 1 through 54. This publication is incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C.

552(a) and 1 CFR part 51. This incorporation by reference (IBR) material is available for inspection at the Mine Safety and Health Administration (MSHA) and at the National Archives and Records Administration (NARA). Contact MSHA at: MSHA's Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, VA 22202–5450; (202) 693–9440; or at any Mine Safety and Health Enforcement District Office. For information on the availability of this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations* or email *fr.inspection@nara.gov.* The material may be obtained from American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Attn: Customer Service, Cincinnati, OH 45240; *www.acgih.org.*

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

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

Asbestos fiber means a fiber of asbestos that meets the criteria of a fiber.

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 asbestos fiber concentration.* Potential asbestos fiber concentration shall be determined by phase contrast microscopy (PCM) using the OSHA Reference Method in OSHA's asbestos standard found in 29 CFR 1910.1001, Appendix A, or a method at least equivalent to that method in identifying a potential asbestos exposure exceeding the 0.1 f/cc full-shift limit or the 1 f/cc excursion limit. When PCM results indicate a potential exposure exceeding the 0.1 f/cc full-shift limit or the 1 f/cc excursion limit, samples shall be further analyzed using transmission electron microscopy according to NIOSH Method 7402 or a method at least equivalent to that method.

(c) *Required action.* Employees shall be withdrawn from areas where there is present an airborne contaminant given a ''C'' designation by the Conference and the concentration exceeds the threshold limit value listed for that contaminant.

§ 57.5001 [Removed]

■ 13. April 8, 2026, remove § 57.5001.

§ 57.5001T [Redesignated as § 57.5001]

■ 14. Effective April 8, 2026, redesignate § 57.5001T as § 57.5001.

■ 15. Amend § 57.5005 by revising the introductory text to read as follows:

§ 57.5005 Control of exposure to for airborne contaminants.

The following is required until April 7, 2026. Control of employee exposure to harmful airborne contaminants shall be, insofar as feasible, by prevention of contamination, removal by exhaust ventilation, or by dilution with uncontaminated air. However, where accepted engineering control measures have not been developed or when necessary by the nature of work involved (for example, while establishing controls or occasional entry into hazardous atmospheres to perform maintenance or investigation), employees may work for reasonable periods of time in concentrations of airborne contaminants exceeding permissible levels if they are protected by appropriate respiratory protective equipment. Whenever respiratory protective equipment is used a program for selection, maintenance, training, fitting, supervision, cleaning, and use shall meet the following minimum requirements:

* * * * *

■ 16. Add § 57.5005T to read as follows:

§ 57.5005T Control of exposure to airborne contaminants.

As of April 8, 2026, the following is required. Control of employee exposure to harmful airborne contaminants shall be, insofar as feasible, by prevention of contamination, removal by exhaust ventilation, or by dilution with uncontaminated air. However, where accepted engineering control measures have not been developed or when necessary by the nature of work involved (for example, while establishing controls or occasional entry into hazardous atmospheres to perform maintenance or investigation), employees may work for reasonable periods of time in concentrations of airborne contaminants exceeding permissible levels if they are protected by appropriate respiratory protective equipment. Whenever respiratory protective equipment is used, its selection, fitting, maintenance, cleaning, training, supervision, and use shall meet the following minimum requirements:

(a) Respirators approved by NIOSH under 42 CFR part 84 which are applicable and suitable for the purpose intended shall be furnished and miners shall use the protective equipment in accordance with training and instruction.

(b) A written respiratory protection program consistent with the requirements of ASTM F3387–19, *Standard Practice for Respiratory Protection,* approved August 1, 2019, which is incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. This incorporation by reference (IBR) material is available for inspection at the Mine Safety and Health Administration (MSHA) and at the National Archives and Records Administration (NARA). Contact MSHA at: MSHA's Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, VA 22202–5450; (202) 693–9440; or any Mine Safety and Health Enforcement District Office. For information on the availability of this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations* or email *fr.inspection@nara.gov.* The material may be obtained from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959; *www.astm.org.*

(c) When respiratory protection is used in atmospheres immediately dangerous to life or health (IDLH), the presence of at least one other person with backup equipment and rescue capability shall be required in the event of failure of the respiratory equipment.

§ 57.5005 [Removed]

■ 17. Effective April 8, 2026, remove § 57.5005.

§ 57.5005T [Redesignated as § 57.5005]

■ 18. Effective April 8, 2026, redesignate § 57.5005T as § 57.5005.

Subchapter M—Uniform Mine Health Regulations

■ 19. Add part 60 to subchapter M to read as follows:

PART 60—RESPIRABLE CRYSTALLINE SILICA

Sec.

Authority: 30 U.S.C. 811, 813(h) and 957.

§ 60.1 Scope; compliance dates.

(a) This part sets forth mandatory health standards for each surface and underground metal, nonmetal, and coal mine subject to the Federal Mine Safety and Health Act of 1977, as amended. Requirements regarding medical surveillance for metal and nonmetal mines are also included.

(b) The compliance dates for the provisions of this part are as follows:

(1) For coal mine operators, April 14, 2025.

(2) For metal and nonmetal mine operators, April 8, 2026.

§ 60.2 Definitions.

The following definitions apply in this part:

Action level means an airborne concentration of respirable crystalline silica of 25 micrograms per cubic meter of air (μg/m^3) for a full-shift exposure, calculated as an 8-hour time-weighted average (TWA).

Respirable crystalline silica means quartz, cristobalite, and/or tridymite contained in airborne particles that are determined to be respirable by a sampling device designed to meet the characteristics for respirable-particle-size-selective samplers that conform to the International Organization for Standardization (ISO) 7708:1995: Air Quality—Particle Size Fraction Definitions for Health-Related Sampling.

Specialist means an American Board-Certified Specialist in Pulmonary Disease or an American Board-Certified Specialist in Occupational Medicine.

§ 60.10 Permissible exposure limit (PEL).

The mine operator shall ensure that no miner is exposed to an airborne concentration of respirable crystalline silica in excess of 50 μg/m^3 for a full-shift exposure, calculated as an 8-hour TWA.

§ 60.11 Methods of compliance.

(a) The mine operator shall install, use, and maintain feasible engineering controls, supplemented by administrative controls when necessary, to keep each miner's exposure at or below the PEL, except as specified in § 60.14.

(b) Rotation of miners shall not be considered an acceptable administrative control used for compliance with this part.

§ 60.12 Exposure monitoring.

(a) *Sampling.* (1) Mine operators shall commence sampling by the compliance date in § 60.1 to assess the full shift, 8-hour TWA exposure of respirable crystalline silica for each miner who is or may reasonably be expected to be exposed to respirable crystalline silica.

(2) If the sampling under paragraph (a)(1) of this section is:

(i) Below the action level, the mine operator shall take at least one additional sampling within 3 months.

(ii) At or above the action level but at or below the PEL, the mine operator shall take another sampling within 3 months.

(iii) Above the PEL, the mine operator shall take corrective actions and sample pursuant to § 60.12(b).

(3) Where the most recent sampling indicates that miner exposures are at or above the action level but at or below the PEL, the mine operator shall continue to sample within 3 months of the previous sampling.

(4) The mine operator may discontinue sampling when two consecutive samplings indicate that miner exposures are below the action level. The second of these samplings must be taken after the operator receives the results of the prior sampling but no sooner than 7 days after the prior sampling was conducted.

(b) *Corrective actions sampling.* Where the most recent sampling indicates that miner exposures are above the PEL, the mine operator shall sample after corrective actions are taken pursuant to § 60.13 until the sampling indicates that miner exposures are at or below the PEL. The mine operator shall immediately report all operator samples above the PEL to the MSHA District Manager or to any other MSHA office designated by the District Manager.

(c) *Periodic evaluation.* At least every 6 months after commencing sampling under 60.12(a)(1) or whenever there is a change in: production; processes; installation or maintenance of engineering controls; installation or maintenance of equipment; administrative controls; or geological conditions; mine operators shall evaluate whether the change may reasonably be expected to result in new or increased respirable crystalline silica exposures. Once the evaluation is completed, the mine operator shall:

(1) Make a record of the evaluation, including the evaluated change, the impact on respirable crystalline silica exposure, and the date of the evaluation; and

(2) Post the record on the mine bulletin board and, if applicable, by electronic means, for the next 31 days.

(d) *Post-evaluation sampling.* If the mine operator determines as a result of the periodic evaluation under paragraph (c) of this section that miners may be exposed to respirable crystalline silica at or above the action level, the mine operator shall perform sampling to assess the full shift, 8-hour TWA exposure of respirable crystalline silica for each miner who is or may reasonably be expected to be at or above the action level.

(e) *Sampling requirements.* (1) Sampling shall be performed for the duration of a miner's regular full shift and during typical mining activities, including shaft and slope sinking, construction, and removal of overburden.

(2) The full-shift, 8-hour TWA exposure for such miners shall be measured based on:

(i) Personal breathing-zone air samples for metal and nonmetal operations; or

(ii) Occupational environmental samples collected in accordance with § 70.201(c), § 71.201(b), or § 90.201(b) of this chapter for coal operations.

(3) Where several miners perform the same tasks on the same shift and in the same work area, the mine operator may sample a representative fraction (at least two) of these miners to meet the requirements in paragraphs (a) through (e) of this section. In sampling a representative fraction of miners, the mine operator shall select the miners who are expected to have the highest exposure to respirable crystalline silica.

(4) The mine operator shall use respirable-particle-size-selective samplers that conform to ISO 7708:1995(E) to determine compliance with the PEL. ISO 7708:1995(E), *Air quality—Particle size fraction definitions for health-related sampling,* First Edition, 1995–04–01, is incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. This incorporation by reference (IBR) material is available for inspection at the Mine Safety and Health Administration (MSHA) and at the National Archives and Records Administration (NARA). Contact MSHA at: MSHA's Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, VA 22202–5450; (202) 693–9440; or any Mine Safety and Health Enforcement District Office. For information on the availability of this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations* or email *fr.inspection@nara.gov.* The material may be obtained from the International Organization for

Standardization (ISO), CP 56, CH–1211 Geneva 20, Switzerland; phone: + 41 22 749 01 11; fax: + 41 22 733 34 30; website: *www.iso.org.*

(f) *Methods of sample analysis.* (1) The mine operator shall use a laboratory that is accredited to ISO/IEC 17025 ''General requirements for the competence of testing and calibration laboratories'' with respect to respirable crystalline silica analyses, where the accreditation has been issued by a body that is compliant with ISO/IEC 17011 ''Conformity assessment—Requirements for accreditation bodies accrediting conformity assessment bodies.''

(2) The mine operator shall ensure that the laboratory evaluates all samples using respirable crystalline silica analytical methods specified by MSHA, the National Institute for Occupational Safety and Health (NIOSH), or the Occupational Safety and Health Administration (OSHA).

(g) *Sampling records.* For each sample taken pursuant to paragraphs (a) through (e) of this section, the mine operator shall make a record of the sample date, the occupations sampled, and the concentrations of respirable crystalline silica and respirable dust and post the record and the laboratory report on the mine bulletin board and, if applicable, by electronic means, for the next 31 days, upon receipt.

§ 60.13 Corrective actions.

(a) If any sampling indicates that a miner's exposure exceeds the PEL, the mine operator shall:

(1) Make approved respirators available to affected miners before the start of the next work shift in accordance with § 60.14(b) and (c);

(2) Ensure that affected miners wear respirators properly for the full shift or during the period of overexposure until miner exposures are at or below the PEL; and

(3) Immediately take corrective actions to lower the concentration of respirable crystalline silica to at or below the PEL.

(b) Once corrective actions have been taken, the mine operator shall:

(1) Conduct sampling pursuant to § 60.12(b); and

(2) Take additional or new corrective actions until sampling indicates miner exposures are at or below the PEL.

(c) The mine operator shall make a record of corrective actions and the dates of the corrective actions under paragraph (a) of this section.

§ 60.14 Respiratory protection.

(a) *Temporary use of respirators at metal and nonmetal mines.* The metal and nonmetal mine operator shall use respiratory protection as a temporary measure in accordance with paragraph (c) of this section when miners must work in concentrations of respirable crystalline silica above the PEL while:

(1) Engineering control measures are being developed and implemented; or

(2) It is necessary by the nature of work involved (for example, occasional entry into hazardous atmospheres to perform maintenance or investigation).

(b) *Miners unable to wear respirators at all mines.* Upon written determination by a physician or other licensed health care professional (PLHCP) that an affected miner is unable to wear a respirator, the miner shall be temporarily transferred either to work in a separate area of the same mine or to an occupation at the same mine where respiratory protection is not required.

(1) The affected miner shall continue to receive compensation at no less than the regular rate of pay in the occupation held by that miner immediately prior to the transfer.

(2) The affected miner may be transferred back to the miner's initial work area or occupation when temporary use of respirators under paragraph (a) of this section or section 60.13 is no longer required.

(c) *Respiratory protection requirements at all mines.* (1) Affected miners shall be provided with a NIOSH-approved atmosphere-supplying respirator or NIOSH-approved air-purifying respirator equipped with the following:

(i) Particulate protection classified as 100 series under 42 CFR part 84; or

(ii) Particulate protection classified as High Efficiency ''HE'' under 42 CFR part 84.

(2) When approved respirators are used, the mine operator must have a written respiratory protection program that meets the following requirements in accordance with ASTM F3387–19: program administration; written standard operating procedures; medical evaluation; respirator selection; training; fit testing; maintenance, inspection, and storage. ASTM F3387–19, *Standard Practice for Respiratory Protection,* approved August 1, 2019, is incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. This incorporation by reference (IBR) material is available for inspection at the Mine Safety and Health Administration (MSHA) and at the National Archives and Records Administration (NARA). Contact MSHA at: MSHA's Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, VA 22202–5450; (202) 693–9440; or any Mine Safety and Health Enforcement District Office. For information on the availability of this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations* or email *fr.inspection@nara.gov.* The material may be obtained from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959; *www.astm.org.*

§ 60.15 Medical surveillance for metal and nonmetal mines.

(a) *Medical surveillance.* Each operator of a metal and nonmetal mine shall provide to each miner periodic medical examinations performed by a physician or other licensed health care professional (PLHCP) or specialist, as defined in § 60.2, at no cost to the miner.

(1) Medical examinations shall be provided at frequencies specified in this section.

(2) Medical examinations shall include:

(i) A medical and work history, with emphasis on: past and present exposure to respirable crystalline silica, dust, and other agents affecting the respiratory system; any history of respiratory system dysfunction, including diagnoses and symptoms of respiratory disease (*e.g.,* shortness of breath, cough, wheezing); history of tuberculosis; and smoking status and history;

(ii) A physical examination with special emphasis on the respiratory system;

(iii) A chest X-ray (a single posteroanterior radiographic projection or radiograph of the chest at full inspiration recorded on either film (no less than 14 x 17 inches and no more than 16 x 17 inches) or digital radiography systems), classified according to the International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses by a NIOSH-certified B Reader; and

(iv) A pulmonary function test to include forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) and FEV_1/FVC ratio, administered by a spirometry technician with a current certificate from a NIOSH-approved Spirometry Program Sponsor or by a pulmonary function technologist with a current credential from the National Board for Respiratory Care.

(b) *Voluntary medical examinations.* Each mine operator shall provide the opportunity to all miners employed at the mine to have the medical examinations specified in paragraph (a) of this section as follows:

(1) During an initial 12-month period; and

(2) At least every 5 years after the end of the period in paragraph (b)(1). The medical examinations shall be available during a 6-month period that begins no less than 3.5 years and not more than 4.5 years from the end of the last 6-month period.

(c) *Mandatory medical examinations.* For each miner who begins work in the mining industry for the first time, the mine operator shall provide medical examinations specified in paragraph (a) of this section as follows:

(1) An initial medical examination no later than 60 days after beginning employment;

(2) A follow-up medical examination no later than 3 years after the initial examination in paragraph (c)(1) of this section; and

(3) A follow-up medical examination conducted by a specialist no later than 2 years after the examinations in paragraph (c)(2) of this section if the chest X-ray shows evidence of pneumoconiosis or the spirometry examination indicates evidence of decreased lung function.

(d) *Medical examinations results.* (1) The mine operator shall ensure that the results of medical examinations or tests made pursuant to this section shall be provided from the PLHCP or specialist within 30 days of the medical examination to the miner, and at the request of the miner, to the miner's designated physician or another designee identified by the miner.

(2) The mine operator shall ensure that, within 30 days of the medical examination, the PLHCP or specialist provides the results of chest X-ray classifications to the National Institute for Occupational Safety and Health (NIOSH), once NIOSH establishes a reporting system.

(e) *Written medical opinion.* The mine operator shall obtain a written medical opinion from the PLHCP or specialist within 30 days of the medical examination. The written opinion shall contain only the following:

(1) The date of the medical examination;

(2) A statement that the examination has met the requirements of this section; and

(3) Any recommended limitations on the miner's use of respirators.

(f) *Written medical opinion records.* The mine operator shall maintain a record of the written medical opinions received from the PLHCP or specialist under paragraph (e) of this section.

§ 60.16 Recordkeeping requirements.

(a) Table 1 to this paragraph (a) lists the records the mine operator shall retain and their retention period.

(1) Evaluation records made under § 60.12(c) shall be retained for at least 5 years from the date of each evaluation.

(2) Sampling records made under § 60.12(g) shall be retained for at least 5 years from the sample date.

(3) Corrective actions records made under § 60.13(c) shall be retained for at least 5 years from the date of each corrective action. These records must be stored with the records of related sampling under § 60.12(g).

(4) Written determination records received from a PLHCP under § 60.14(b) shall be retained for the duration of the miner's employment plus 6 months.

(5) Written medical opinion records received from a PLHCP or specialist under § 60.15(f) shall be retained for the duration of the miner's employment plus 6 months.

TABLE 1 TO PARAGRAPH (a)—RECORDKEEPING REQUIREMENTS

Record	Section references	Retention period
1. Evaluation records	§ 60.12(c)	At least 5 years from date of each evaluation.
2. Sampling records	§ 60.12(g)	At least 5 years from sample date.
3. Corrective actions records	§ 60.13(c)	At least 5 years from date of each corrective action.
4. Written determination records received from a PLHCP	§ 60.14(b)	Duration of miner's employment plus 6 months.
5. Written medical opinion records received from a PLHCP or specialist.	§ 60.15(f)	Duration of miner's employment plus 6 months.

(b) Upon request from an authorized representative of the Secretary, from an authorized representative of miners, or from miners, mine operators shall promptly provide access to any record listed in this section.

§ 60.17 Severability.

Each section of this part, as well as sections in 30 CFR parts 56, 57, 70, 71, 72, 75, and 90 that address respirable crystalline silica or respiratory protection, is separate and severable from the other sections and provisions. If any provision of this subpart is held to be invalid or unenforceable by its terms, or as applied to any person, entity, or circumstance, or is stayed or enjoined, that provision shall be construed so as to continue to give the maximum effect to the provision permitted by law, unless such holding shall be one of utter invalidity or unenforceability, in which event the provision shall be severable from these sections and shall not affect the remainder thereof.

Subchapter O—Coal Mine Safety and Health

PART 70—MANDATORY HEALTH STANDARDS—UNDERGROUND COAL MINES

■ 20. The authority citation for part 70 continues to read as follows:

Authority: 30 U.S.C. 811, 813(h), 957.

Subpart A—General

§ 70.2 [Amended]

■ 21. Effective April 14, 2025, amend § 70.2 by removing the definition of ''Quartz''.

Subpart B—Dust Standards

§ 70.101 [Removed and Reserved]

■ 22. Effective April 14, 2025, remove and reserve § 70.101.

Subpart C—Sampling Procedures

■ 23. Amend § 70.205 by adding introductory text to read as follows:

§ 70.205 Approved sampling devices; operation; air flowrate.

The following is required until April 14, 2025:

* * * * *

■ 24. Add § 70.205T to read as follows:

§ 70.205T Approved sampling devices; operation; air flowrate.

As of April 14, 2025:

(a) Approved sampling devices shall be operated at the flowrate of 2.0 L/min if using a CMDPSU; at 2.2 L/min if using a CPDM; or at a different flowrate recommended by the manufacturer.

(b) If using a CMDPSU, each approved sampling device shall be examined each shift by a person certified in sampling during:

(1) The second hour after being put into operation to assure it is in the proper location, operating properly, and at the proper flowrate. If the proper flowrate is not maintained, necessary adjustments shall be made by the certified person. This examination is not required if the sampling device is being operated in an anthracite coal mine using the full box, open breast, or slant breast mining method.

(2) The last hour of operation to assure that the sampling device is operating properly and at the proper flowrate. If the proper flowrate is not maintained, the respirable dust sample shall be transmitted to MSHA with a notation by the certified person on the back of the dust data card stating that the proper flowrate was not maintained. Other events occurring during the collection of respirable dust samples that may affect the validity of the sample, such as dropping of the sampling head assembly onto the mine floor, shall be noted on the back of the dust data card.

(c) If using a CPDM, the person certified in sampling shall monitor the dust concentrations and the sampling status conditions being reported by the sampling device at mid-shift or more frequently as specified in the approved mine ventilation plan to assure: The sampling device is in the proper location and operating properly; and the work environment of the occupation or DA being sampled remains in compliance with the standard at the end of the shift. This monitoring is not required if the sampling device is being operated in an anthracite coal mine using the full box, open breast, or slant breast mining method.

§ 70.205 [Removed]

■ 25. Effective April 14, 2025, remove § 70.205.

§ 70.205T [Redesignated as § 70.205]

■ 26. Effective April 14, 2025, redesignate § 70.205T as § 70.205.

§§ 70.206 and 70.207 [Removed and Reserved]

■ 27. Effective April 14, 2025, remove and reserve §§ 70.206 and 70.207.

■ 28. Amend § 70.208 by revising the introductory text to read as follows:

§ 70.208 Quarterly sampling; mechanized mining units.

The following is required from February 1, 2016, until April 14, 2025:

* * * * *

■ 29. Add § 70.208T to read as follows:

§ 70.208T Quarterly sampling; mechanized mining units.

As of April 14, 2025:

(a) The operator shall sample each calendar quarter:

(1) The designated occupation (DO) in each MMU on consecutive normal production shifts until 15 valid representative samples are taken. The District Manager may require additional groups of 15 valid representative samples when information indicates the operator has not followed the approved ventilation plan for any MMU.

(2) Each other designated occupation (ODO) specified in paragraphs (b)(1) through (10) of this section in each MMU or specified by the District Manager and identified in the approved mine ventilation plan on consecutive normal production shifts until 15 valid representative samples are taken. Sampling of each ODO type shall begin after fulfilling the sampling requirements of paragraph (a)(1) of this section. When required to sample more than one ODO type, each ODO type must be sampled over separate time periods during the calendar quarter.

(3) The quarterly periods are:

(i) January 1–March 31

(ii) April 1–June 30

(iii) July 1–September 30

(iv) October 1–December 31.

(b) Unless otherwise directed by the District Manager, the approved sampling device shall be worn by the miner assigned to perform the duties of the DO or ODO specified in paragraphs (b)(1) through (10) of this section or by the District Manager for each type of MMU.

(1) *Conventional section using cutting machine.* DO—The cutting machine operator;

(2) *Conventional section blasting off the solid.* DO—The loading machine operator;

(3) *Continuous mining section other than auger-type.* DO—The continuous mining (CM) machine operator or mobile bridge operator when using continuous haulage; ODO—The roof bolting machine operator who works nearest the working face on the return air side of the continuous mining machine; the face haulage operators on MMUs using blowing face ventilation; the face haulage operators on MMUs ventilated by split intake air (‘‘fishtail ventilation’’) as part of a super-section; and face haulage operators where two continuous mining machines are operated on an MMU.

(4) *Continuous mining section using auger-type machine.* DO—The jacksetter who works nearest the working face on the return air side of the continuous mining machine;

(5) *Scoop section using cutting machine.* DO—The cutting machine operator;

(6) *Scoop section, blasting off the solid.* DO—The coal drill operator;

(7) *Longwall section.* DO—The longwall operator working on the tailgate side of the longwall mining machine; ODO—The jacksetter who works nearest the return air side of the longwall working face, and the mechanic;

(8) *Hand loading section with a cutting machine.* DO—The cutting machine operator;

(9) *Hand loading section blasting off the solid.* DO—The hand loader exposed to the greatest dust concentration; and

(10) *Anthracite mine sections.* DO—The hand loader exposed to the greatest dust concentration.

I [Reserved]

(d) If a normal production shift is not achieved, the DO or ODO sample for that shift may be voided by MSHA. However, any sample, regardless of production, that exceeds the standard by at least 0.1 mg/m^3 shall be used in the determination of the equivalent concentration for that occupatioI(e) When a valid representative sample taken in accordance with this section meets or exceeds the ECV in table 1 to this section that corresponds to the particular sampling device used, the operator shall:

(1) Make approved respiratory equipment available to affected miners in accordance with § 72.700 of this chapter;

(2) Immediately take corrective action to lower the concentration of respirable dust to at or below the respirable dust standard; and

(3) Make a record of the corrective actions taken. The record shall be certified by the mine foreman or equivalent mine official, no later than the end of the mine f'reman's or equivalent of'icial's next regularly scheduled working shift. The record shall be made in a secure book that is not susceptible to alteration or electronically in a computer system so as to be secure and not susceptible to alteration. Such records shall be retained at a surface location at the mine for at least 1 year and shall be made available for inspection by authorized representatives of the Secretary and the representative of miners.

(f) Noncompliance with the standard is demonstrated during the sampling period when:

(1) Three or more valid representative samples meet or exceed the ECV in table 1 to this section that corresponds to the particular sampling device used; or

(2) The average for all valid representative samples meets or exceeds the ECV in table 1 to this section that corresponds to the particular sampling device used.

(g)(1) Unless otherwise directed by the District Manager, upon issuance of a citation for a violation of the standard involving a DO in an MMU, paragraph (a)(1) of this section shall not apply to the DO in that MMU until the violation is abated and the citation is terminated in accordance with paragraphs (h) and (i) of this section.

(2) Unless otherwise directed by the District Manager, upon issuance of a citation for a violation of the standard involving a type of ODO in an MMU, paragraph (a)(2) of this section shall not apply to that ODO type in that MMU until the violation is abated and the citation is terminated in accordance with paragraphs (g) and (h) of this section.

(h) Upon issuance of a citation for violation of the standard, the operator shall take the following actions sequentially:

(1) Make approved respiratory equipment available to affected miners in accordance with § 72.700 of this chapter;

(2) Immediately take corrective action to lower the concentration of respirable coal mine dust to at or below the standard; and

(3) Make a record of the corrective actions taken. The record shall be certified by the mine foreman or equivalent mine official, no later than the end of the mine f'reman's or equivalent of'icial's next regularly scheduled working shift. The record shall be made in a secure book that is not susceptible to alteration or electronically in a computer system so as to be secure and not susceptible to alteration. Such records shall be retained at a surface location at the mine for at least 1 year and shall be made available for inspection by authorized representatives of the Secretary and the representative of miners.

(4) Begin sampling, within 8 calendar days after the date the citation is issued, the environment of the affected occupation in the MMU on consecutive normal production shifts until five valid representative samples are taken.

(i) A citation for a violation of the standard shall be terminated by MSHA when:

(1) Each of the five valid representative samples is at or below the standard; and

(2) The operator has submitted to the District Manager revised dust control parameters as part of the mine ventilation plan applicable to the MMU in the citation and the changes have been approved by the District Manager. The revised parameters shall reflect the control measures used by the operator to abate the violation.

TABLE 1 TO § 70.208T—EXCESSIVE CONCENTRATION VALUES (ECV) BASED ON A SINGLE SAMPLE, THREE SAMPLES, OR THE AVERAGE OF FIVE OR FIFTEEN FULL-SHIFT CMDPSU/CPDM CONCENTRATION MEASUREMENTS

Section	Samples	ECV (mg/m³)	
		CMDPSU	CPDM
70.208 (e)	70.1–0(a)—Single sample	1.79	1.70
	70.1–0(b)—Single sample	0.74	0.57
70.208(f)(1)	70.1–0(a)—3 or more samples	1.79	1.70
	70.1–0(b)—3 or more samples	0.74	0.57
70.208(f)(2)	70.1–0(a)—5 sample average	1.63	1.59
	70.1–0(b)—5 sample average	0.61	0.53
70.208(f)(2)	70.1–0(a)—15 sample average	1.58	1.56
	70.1–0(b)—15 sample average	0.57	0.52
70.208(i)(1)	70.1–0(a)—Each of 5 samples	1.79	1.70
	70.1–0(b)—Each of 5 samples	0.74	0.57

§ 70.208 [Removed]

■ 30. Effective April 14, 2025, remove § 70.208.

§ 70.208T [Redesignated as § 70.208]

■ 31. Effective April 14, 2025, redesignate § 70.208T as § 70.208 and redesignate table 1 to § 70.208T as table 1 to § 70.208.

■ 32. Amend § 70.209 by revising the introductory text to read as follows:

§ 70.209 Quarterly sampling; designated areas.

The following is required until April 14, 2025:

* * * * *

■ 33. Add § 70.209T to read as follows:

§ 70.209T Quarterly sampling; designated areas.

As of April 14, 2025:

(a) The operator shall sample quarterly each designated area (DA) on consecutive production shifts until five valid representative samples are taken. The quarterly periods are:

(1) January 1–March 31

(2) April 1–June 30

(3) July 1–September 30

(4) October 1–December 31.

(b) [Reserved].

(c) When a valid representative sample taken in accordance with this section meets or exceeds the ECV in table 1 to this section that corresponds to the particular sampling device used, the operator shall:

(1) Make approved respiratory equipment available to affected miners in accordance with § 72.700 of this chapter;

(2) Immediately take corrective action to lower the concentration of respirable dust to at or below the respirable dust standard; and

(3) Make a record of the corrective actions taken. The record shall be certified by the mine foreman or equivalent mine official, no later than the end of the mine foreman's or equivalent official's next regularly scheduled working shift. The record shall be made in a secure book that is not susceptible to alteration or electronically in a computer system so as to be secure and not susceptible to alteration. Such records shall be retained at a surface location at the mine for at least 1 year and shall be made available for inspection by authorized representatives of the Secretary and the representative of miners.

(d) Noncompliance with the standard is demonstrated during the sampling period when:

(1) Two or more valid representative samples meet or exceed the ECV in table 1 to this section that corresponds to the particular sampling device used; or

(2) The average for all valid representative samples meets or exceeds the ECV in table 1 to this section that corresponds to the particular sampling device used.

(e) Unless otherwise directed by the District Manager, upon issuance of a citation for a violation of the standard, paragraph (a) of this section shall not apply to that DA until the violation is abated and the citation is terminated in accordance with paragraphs (e) and (f) of this section.

(f) Upon issuance of a citation for a violation of the standard, the operator shall take the following actions sequentially:

(1) Make approved respiratory equipment available to affected miners in accordance with § 72.700 of this chapter;

(2) Immediately take corrective action to lower the concentration of respirable coal mine dust to at or below the standard; and

(3) Make a record of the corrective actions taken. The record shall be certified by the mine foreman or equivalent mine official, no later than the end of the mine foreman's or equivalent official's next regularly scheduled working shift. The record shall be made in a secure book that is not susceptible to alteration or electronically in a computer system so as to be secure and not susceptible to alteration. Such records shall be retained at a surface location at the mine for at least 1 year and shall be made available for inspection by authorized representatives of the Secretary and the representative of miners.

(4) Begin sampling, within 8 calendar days after the date the citation is issued, the environment of the affected DA on consecutive normal production shifts until five valid representative samples are taken.

(g) A citation for a violation of the standard shall be terminated by MSHA when:

(1) Each of the five valid representative samples is at or below the standard; and

(2) The operator has submitted to the District Manager revised dust control parameters as part of the mine ventilation plan applicable to the DA in the citation, and the changes have been approved by the District Manager. The revised parameters shall reflect the control measures used by the operator to abate the violation.

TABLE 1 TO § 70.209T—EXCESSIVE CONCENTRATION VALUES (ECV) BASED ON A SINGLE SAMPLE, TWO SAMPLES, OR THE AVERAGE OF FIVE OR FIFTEEN FULL-SHIFT CMDPSU/CPDM CONCENTRATION MEASUREMENTS

Section	Samples	ECV (mg/m³)	
		CMDPSU	CPDM
70.209 (c)	70.100(a)—Single sample	1.79	1.70
	70.100(b)—Single sample	0.74	0.57
70.209(d)(1)	70.100(a)—2 or more samples	1.79	1.70
	70.100(b)—2 or more samples	0.74	0.57
70.209(d)(2)	70.100(a)—5 sample average	1.63	1.59
	70.100(b)—5 sample average	0.61	0.53
70.209(d)(2)	70.100(a)—15 sample average	1.58	1.56
	70.100(b)—15 sample average	0.57	0.52
70.209(g)(1)	70.100(a)—Each of 5 samples	1.79	1.70
	70.100(b)—Each of 5 samples	0.74	0.57

§ 70.209 [Removed]

■ 34. Effective April 14, 2025, remove § 70.209.

§ 70.209T [Redesignated as § 70.209]

■ 35. Effective April 14, 2025, redesignate § 70.209T as § 70.209 and redesignate table 1 to § 70.209T as table 1 to § 70.209.

Tables 70–1 and 70–2 to Subpart C of Part 70 [Removed]

■ 36. Effective April 14, 2025, remove tables 70–1 and 70–2 to subpart C of part 70.

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

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

Authority: 30 U.S.C. 811, 813(h), 957.

Subpart A—General

§ 71.2 [Amended]

■ 38. Effective April 14, 2025, amend § 71.2 by removing the definition of "Quartz".

Subpart B—Dust Standards

§ 71.101 [Removed and Reserved]

■ 39. Effective April 14, 2025, remove and reserve § 71.101.

Subpart C—Sampling Procedures

■ 40. Amend § 71.205 by adding introductory text to read as follows:

§ 71.205 Approved sampling devices; operation; air flowrate.

The following is required until April 14, 2025:

* * * * *

■ 41. Add § 71.205T to read as follows:

§ 71.205T Approved sampling devices; operation; air flowrate.

As of April 14, 2025:

(a) Approved sampling devices shall be operated at the flowrate of 2.0 L/min, if using a CMDPSU; at 2.2 L/min, if using a CPDM; or at a different flowrate recommended by the manufacturer.

(b) If using a CMDPSU, each sampling device shall be examined each shift by a person certified in sampling during:

(1) The second hour after being put into operation to assure it is in the proper location, operating properly, and at the proper flowrate. If the proper flowrate is not maintained, necessary adjustments shall be made by the certified person.

(2) The last hour of operation to assure that it is operating properly and at the proper flowrate. If the proper flowrate is not maintained, the respirable dust sample shall be transmitted to MSHA with a notation by the certified person on the back of the dust data card stating that the proper flowrate was not maintained. Other events occurring during the collection of respirable dust samples that may affect the validity of the sample, such as

dropping of the sampling head assembly onto the mine floor, shall be noted on the back of the dust data card.

(c) If using a CPDM, the person certified in sampling shall monitor the dust concentrations and the sampling status conditions being reported by the sampling device at mid-shift or more frequently as specified in the approved respirable dust control plan, if applicable, to assure: The sampling device is in the proper location and operating properly; and the work environment of the occupation being sampled remains in compliance with the standard at the end of the shift.

§ 71.205 [Removed]

■ 42. Effective April 14, 2025, remove § 71.205.

§ 71.205T [Redesignated as § 71.205]

■ 43. Effective April 14, 2025, redesignate § 71.205T as § 71.205.

■ 44. Amend § 71.206 by adding introductory text to read as follows:

§ 71.206 Quarterly sampling; designated work positions.

The following is required until April 14, 2025:

* * * * *

■ 45. Add § 71.206T to read as follows:

§ 71.206T Quarterly sampling; designated work positions.

As of April 14, 2025:

(a) Each operator shall take one valid representative sample from the DWP during each quarterly period. The quarterly periods are:

(1) January 1–March 31

(2) April 1–June 30

(3) July 1–September 30

(4) October 1–December 31.

(b) [Reserved].

(c) Designated work position samples shall be collected at locations to measure respirable dust generation sources in the active workings. The specific work positions at each mine where DWP samples shall be collected include:

(1) Each highwall drill operator (MSHA occupation code 384);

(2) Bulldozer operators (MSHA occupation code 368); and

(3) Other work positions designated by the District Manager for sampling in accordance with § 71.206(m).

(d) Operators with multiple work positions specified in paragraphs (b)(2) and (3) of this section shall sample the DWP exposed to the greatest respirable dust concentration in each work position performing the same activity or task at the same location at the mine and exposed to the same dust generation source. Each operator shall provide the District Manager with a list identifying the specific work positions where DWP samples will be collected for:

(1) Active mines—by October 1, 2014.

(2) New mines—Within 30 calendar days of mine opening.

(3) DWPs with a change in operational status that increases or reduces the number of active DWPs—within 7 calendar days of the change in status.

(e) Each DWP sample shall be taken on a normal work shift. If a normal work shift is not achieved, the respirable dust sample shall be transmitted to MSHA with a notation by the person certified in sampling on the back of the dust data card stating that the sample was not taken on a normal work shift. When a normal work shift is not achieved, the sample for that shift may be voided by MSHA. However, any sample, regardless of whether a normal work shift was achieved, that exceeds the standard by at least 0.1 mg/m³ shall be used in the determination of the equivalent concentration for that occupation.

(f) Unless otherwise directed by the District Manager, DWP samples shall be taken by placing the sampling device as follows:

(1) *Equipment operator:* On the equipment operator or on the equipment within 36 inches of the operator's normal working position.

(2) *Non-equipment operators:* On the miner assigned to the DWP or at a location that represents the maximum concentration of dust to which the miner is exposed.

(g) Upon notification from MSHA that any valid representative sample taken from a DWP to meet the requirements of paragraph (a) of this section exceeds the standard, the operator shall, within 15 calendar days of notification, sample that DWP each normal work shift until five valid representative samples are taken. The operator shall begin sampling on the first normal work shift following receipt of notification.

(h) When a valid representative sample taken in accordance with this section meets or exceeds the excessive concentration value (ECV) in table 1 to this section that corresponds to the particular sampling device used, the mine operator shall:

(1) Make approved respiratory equipment available to affected miners in accordance with § 72.700 of this chapter;

(2) Immediately take corrective action to lower the concentration of respirable coal mine dust to at or below the standard; and

(3) Make a record of the corrective actions taken. The record shall be certified by the mine foreman or equivalent mine official, no later than the end of the mine foreman's or equivalent official's next regularly scheduled working shift. The record shall be made in a secure book that is not susceptible to alteration or electronically in a computer system so as to be secure and not susceptible to alteration. Such records shall be retained at a surface location at the mine for at least 1 year and shall be made available for inspection by authorized representatives of the Secretary and the representative of miners.

(i) Noncompliance with the standard is demonstrated during the sampling period when:

(1) Two or more valid representative samples meet or exceed the ECV in table 1 to this section that corresponds to the particular sampling device used; or

(2) The average for all valid representative samples meets or exceeds the ECV in table 1 to this section that corresponds to the particular sampling device used.

(j) Unless otherwise directed by the District Manager, upon issuance of a citation for a violation of the standard, paragraph (a) of this section shall not apply to that DWP until the violation is abated and the citation is terminated in accordance with paragraphs (j) and (k) of this section.

(k) Upon issuance of a citation for violation of the standard, the operator shall take the following actions sequentially:

(1) Make approved respiratory equipment available to affected miners in accordance with § 72.700 of this chapter;

(2) Immediately take corrective action to lower the concentration of respirable coal mine dust to at or below the standard; and

(3) Make a record of the corrective actions taken. The record shall be certified by the mine foreman or equivalent mine official, no later than the end of the mine foreman's or equivalent official's next regularly scheduled working shift. The record shall be made in a secure book that is not susceptible to alteration or electronically in a computer system so as to be secure and not susceptible to alteration. Such records shall be retained at a surface location at the mine for at least 1 year and shall be made available for inspection by authorized representatives of the Secretary and the representative of miners.

(4) Begin sampling, within 8 calendar days after the date the citation is issued, the environment of the affected DWP on consecutive normal work shifts until five valid representative samples are taken.

(l) A citation for violation of the standard shall be terminated by MSHA when the equivalent concentration of each of the five valid representative samples is at or below the standard.

(m) The District Manager may designate for sampling under this section additional work positions at a surface coal mine and at a surface work area of an underground coal mine where a concentration of respirable dust exceeding 50 percent of the standard has been measured by one or more MSHA valid representative samples.

(n) The District Manager may withdraw from sampling any DWP designated for sampling under paragraph (m) of this section upon finding that the operator is able to maintain continuing compliance with the standard. This finding shall be based on the results of MSHA and operator valid representative samples taken during at least a 12-month period.

TABLE 1 TO § 71.206T—EXCESSIVE CONCENTRATION VALUES (ECV) BASED ON A SINGLE SAMPLE, TWO SAMPLES, OR THE AVERAGE OF FIVE FULL-SHIFT CMDPSU/CPDM CONCENTRATION MEASUREMENTS

Section	Samples	ECV (mg/m³)	
		CMDPSU	CPDM
71.206(h)	Single sample	1.79	1.70
71.206(i)(1)	2 or more samples	1.79	1.70
71.206(i)(2)	5 sample average	1.63	1.59
71.206(l)	Each of 5 samples	1.79	1.70

§ 71.206 [Removed]

■ 46. Effective April 14, 2025, remove § 71.206.

§ 71.206T [Redesignated as § 71.206]

■ 47. Effective April 14, 2025, redesignate § 71.206T as § 71.206 and redesignate table 1 to § 71.206T as table 1 to § 71.206.

Subpart D—Respirable Dust Control Plans

■ 48. Amend § 71.300 by adding introductory text to read as follows:

§ 71.300 Respirable dust control plan; filing requirements.

The following is required until April 14, 2025:

* * * * *

■ 49. Add § 71.300T to read as follows:

§ 71.300T Respirable dust control plan; filing requirements.

As of April 14, 2025:

(a) Within 15 calendar days after the termination date of a citation for violation of the standard, the operator shall submit to the District Manager for approval a written respirable dust control plan applicable to the DWP identified in the citation. The respirable dust control plan and revisions thereof shall be suitable to the conditions and the mining system of the coal mine and shall be adequate to continuously maintain respirable dust to at or below the standard at the DWP identified in the citation.

(1) The mine operator shall notify the representative of miners at least 5 days prior to submission of a respirable dust control plan and any revision to a dust control plan. If requested, the mine operator shall provide a copy to the representative of miners at the time of notification;

(2) A copy of the proposed respirable dust control plan, and a copy of any proposed revision, submitted for approval shall be made available for inspection by the representative of miners; and

(3) A copy of the proposed respirable dust control plan, and a copy of any proposed revision, submitted for approval shall be posted on the mine bulletin board at the time of submittal. The proposed plan or proposed revision shall remain posted until it is approved, withdrawn, or denied.

(4) Following receipt of the proposed plan or proposed revision, the representative of miners may submit timely comments to the District Manager, in writing, for consideration during the review process. Upon request, a copy of these comments shall be provided to the operator by the District Manager.

(b) Each respirable dust control plan shall include at least the following:

(1) The mine identification number and DWP number assigned by MSHA, the operator's name, mine name, mine address, and mine telephone number and the name, address, and telephone number of the principal officer in charge of health and safety at the mine;

(2) The specific DWP at the mine to which the plan applies;

(3) A detailed description of the specific respirable dust control measures used to abate the violation of the respirable dust standard; and

(4) A detailed description of how each of the respirable dust control measures described in response to paragraph (b)(3) of this section will continue to be used by the operator, including at least the specific time, place and manner the control measures will be used.

§ 71.300 [Removed]

■ 50. Effective April 14, 2025, remove § 71.300.

§ 71.300T [Redesignated as § 71.300]

■ 51. Effective April 14, 2025, redesignate § 71.300T as § 71.300.

■ 52. Amend § 71.301 by adding introductory text to read as follows:

§ 71.301 Respirable dust control plan; approval by District Manager and posting.

The following is required until April 14, 2025:

* * * * *

■ 53. Add § 71.301T to read as follows:

§ 71.301T Respirable dust control plan; approval by District Manager and posting.

As of April 8, 2026:

(a) The District Manager will approve respirable dust control plans on a mine-by-mine basis. When approving respirable dust control plans, the District Manager shall consider whether:

(1) The respirable dust control measures would be likely to maintain concentrations of respirable coal mine dust at or below the standard; and

(2) The operator's compliance with all provisions of the respirable dust control plan could be objectively ascertained by MSHA.

(b) MSHA may take respirable dust samples to determine whether the respirable dust control measures in the operator's plan effectively maintain concentrations of respirable coal mine dust at or below the applicable standard.

(c) The operator shall comply with all provisions of each respirable dust control plan upon notice from MSHA that the respirable dust control plan is approved.

(d) The approved respirable dust control plan and any revisions shall be:

(1) Provided upon request to the representative of miners by the operator following notification of approval;

(2) Made available for inspection by the representative of miners; and

(3) Posted on the mine bulletin board within 1 working day following notification of approval, and shall remain posted for the period that the plan is in effect.

(e) The operator may review respirable dust control plans and submit proposed revisions to such plans to the District Manager for approval.

§ 71.301 [Removed]

■ 54. Effective April 14, 2025, remove § 71.301.

§ 71.301T [Redesignated as § 71.301]

■ 55. Effective April 14, 2025, redesignate § 71.301T as § 71.301.

PART 72—HEALTH STANDARDS FOR COAL MINES

■ 56. The authority citation for part 72 continues to read as follows:

Authority: 30 U.S.C. 811, 813(h), 957.

Subpart E—Miscellaneous

■ 57. Revise § 72.710 to read as follows:

§ 72.710 Selection, fit, use, and maintenance of approved respirators.

The following is required until April 14, 2025. In order to ensure the maximum amount of respiratory protection, approved respirators shall be selected, fitted, used, and maintained in accordance with the provisions of the American National Standards Institute's (ANSI) *Practices for Respiratory Protection* ANSI Z88.2–1969, which is incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. This incorporation by reference (IBR) material is available for inspection at the Mine Safety and Health Administration (MSHA) and at the National Archives and Records Administration (NARA). Contact MSHA at: MSHA's Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, VA 22202–5450; (202) 693–9440; or any Mine Safety and Health Enforcement District Office. For information on the availability of this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations* or email *fr.inspection@nara.gov.*

■ 58. Add § 72.710T to read as follows:

§ 72.710T Selection, fit, use, and maintenance of approved respirators.

As of April 14, 2025: Approved respirators shall be selected, fitted, used, and maintained in accordance with the provisions of a written respiratory protection program consistent with the requirements of ASTM F3387–19. ASTM F3387–19, *Standard Practice for Respiratory Protection,* approved August 1, 2019, is incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. This incorporation by reference (IBR) material is available for inspection at the Mine Safety and Health Administration (MSHA) and at the National Archives and Records Administration (NARA). Contact MSHA at: MSHA's Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, VA 22202–5450; (202) 693–9440; or any Mine Safety and Health Enforcement District Office. For information on the availability of this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations* or email *fr.inspection@nara.gov.* The material may be obtained from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959; *www.astm.org.*

§ 72.710 [Removed]

■ 59. Effective April 14, 2025, remove § 72.710.

§ 72.710T [Redesignated as § 72.710]

■ 60. Effective April 14, 2025, redesignate § 72.710T as § 72.710.

■ 61. Revise § 72.800 to read as follows:

§ 72.800 Single, full-shift measurement of respirable coal mine dust.

The Secretary will use a single, full-shift measurement of respirable coal mine dust to determine the average concentration on a shift since that measurement accurately represents atmospheric conditions to which a miner is exposed during such shift. Until April 14, 2025, noncompliance with the respirable dust standard, in accordance with this subchapter, is demonstrated when a single, full-shift measurement taken by MSHA meets or exceeds the applicable ECV in table 1 to § 70.208, table 1 to § 70.209, table 1 to § 71.206, or table 1 to § 90.207 of this chapter that corresponds to the particular sampling device used. Upon issuance of a citation for a violation of the standard, and for MSHA to terminate the citation, the mine operator shall take the specified actions in this subchapter.

■ 62. Add § 72.800T to read as follows:

§ 72.800T Single, full-shift measurement of respirable coal mine dust.

The Secretary will use a single, full-shift measurement of respirable coal mine dust to determine the average concentration on a shift since that measurement accurately represents atmospheric conditions to which a miner is exposed during such shift. As of April 14, 2025, noncompliance with the respirable dust standard, in accordance with this subchapter, is demonstrated when a single, full-shift measurement taken by MSHA meets or exceeds the applicable ECV in table 1 to § 70.208, table 1 to § 70.209, table 1 to § 71.206, or table 1 to § 90.207 of this chapter that corresponds to the particular sampling device used. Upon issuance of a citation for a violation of the standard, and for MSHA to terminate the citation, the mine operator shall take the specified actions in this subchapter.

§ 72.800 [Removed]

■ 63. Effective April 14, 2025, remove § 72.800.

§ 72.800T [Redesignated as § 72.800]

■ 64. Effective April 14, 2025, redesignate § 72.800T as § 72.800.

PART 75—MANDATORY SAFETY STANDARDS—UNDERGROUND COAL MINES

■ 65. The authority citation for part 75 continues to read as follows:

Authority: 30 U.S.C. 811, 813(h), 957.

Subpart D—Ventilation

■ 66. Amend § 75.350 by adding introductory text to read as follows:

§ 75.350 Belt air course ventilation.

The following is required until April 14, 2025:

* * * * *

■ 67. Add § 75.350T to read as follows:

§ 75.350T Belt air course ventilation.

As of April 14, 2025:

(a) The belt air course must not be used as a return air course; and except as provided in paragraph (b) of this section, the belt air course must not be used to provide air to working sections or to areas where mechanized mining equipment is being installed or removed.

(1) The belt air course must be separated with permanent ventilation controls from return air courses and from other intake air courses except as provided in paragraph (c) of this section.

(2) Effective December 31, 2009, the air velocity in the belt entry must be at least 50 feet per minute. When requested by the mine operator, the district manager may approve lower velocities in the ventilation plan based on specific mine conditions. Air velocities must be compatible with all fire detection systems and fire suppression systems used in the belt entry.

(b) The use of air from a belt air course to ventilate a working section, or an area where mechanized mining equipment is being installed or removed, shall be permitted only when evaluated and approved by the district manager in the mine ventilation plan. The mine operator must provide justification in the plan that the use of air from a belt entry would afford at least the same measure of protection as where belt haulage entries are not used to ventilate working places. In addition, the following requirements must be met:

(1) The belt entry must be equipped with an AMS that is installed, operated, examined, and maintained as specified in § 75.351.

(2) All miners must be trained annually in the basic operating principles of the AMS, including the actions required in the event of activation of any AMS alert or alarm signal. This training must be conducted prior to working underground in a mine that uses belt air to ventilate working sections or areas where mechanized mining equipment is installed or removed. It must be conducted as part of a miner's 30 CFR part 48 new miner training (§ 48.5), experienced miner training (§ 48.6), or annual refresher training (§ 48.8).

(3)(i) The average concentration of respirable dust in the belt air course, when used as a section intake air course, shall be maintained at or below 0.5 milligrams per cubic meter of air (mg/m^3).

(ii) A permanent designated area (DA) for dust measurements must be established at a point no greater than 50 feet upwind from the section loading point in the belt entry when the belt air flows over the loading point or no greater than 50 feet upwind from the point where belt air is mixed with air from another intake air course near the loading point. The DA must be specified and approved in the ventilation plan.

(4) The primary escapeway must be monitored for carbon monoxide or smoke as specified in § 75.351(f).

(5) The area of the mine with a belt air course must be developed with three or more entries.

(6) In areas of the mine developed after the effective date of this rule, unless approved by the district manager, no more than 50% of the total intake air, delivered to the working section or to areas where mechanized mining equipment is being installed or removed, can be supplied from the belt air course. The locations for measuring these air quantities must be approved in the mine ventilation plan.

(7) The air velocity in the belt entry must be at least 100 feet per minute. When requested by the mine operator, the district manager may approve lower velocities in the ventilation plan based on specific mine conditions.

(8) The air velocity in the belt entry must not exceed 1,000 feet per minute. When requested by the mine operator, the district manager may approve higher velocities in the ventilation plan based on specific mine conditions.

(c) Notwithstanding the provisions of § 75.380(g), additional intake air may be added to the belt air course through a point-feed regulator. The location and use of point feeds must be approved in the mine ventilation plan.

(d) If the air through the point-feed regulator enters a belt air course which is used to ventilate a working section or an area where mechanized mining equipment is being installed or removed, the following conditions must be met:

(1) The air current that will pass through the point-feed regulator must be monitored for carbon monoxide or smoke at a point within 50 feet upwind of the point-feed regulator. A second point must be monitored 1,000 feet upwind of the point-feed regulator unless the mine operator requests that a lesser distance be approved by the district manager in the mine ventilation plan based on mine specific conditions;

(2) The air in the belt air course must be monitored for carbon monoxide or smoke upwind of the point-feed regulator. This sensor must be in the belt air course within 50 feet of the mixing point where air flowing through the point-feed regulator mixes with the belt air;

(3) The point-feed regulator must be provided with a means to close the regulator from the intake air course without requiring a person to enter the crosscut where the point-feed regulator is located. The point-feed regulator must also be provided with a means to close the regulator from a location in the belt air course immediately upwind of the crosscut containing the point-feed regulator;

(4) A minimum air velocity of 300 feet per minute must be maintained through the point-feed regulator;

(5) The location(s) and use of a point-feed regulator(s) must be approved in the mine ventilation plan and shown on the mine ventilation map; and

(6) An AMS must be installed, operated, examined, and maintained as specified in § 75.351.

§ 75.350 [Removed]

■ 68. Effective April 14, 2025, remove § 75.350.

§ 75.350T [Redesignated as § 75.350]

■ 69. Effective April 14, 2025, redesignate § 75.350T as § 75.350.

PART 90—MANDATORY HEALTH STANDARDS—COAL MINERS WHO HAVE EVIDENCE OF THE DEVELOPMENT OF PNEUMOCONIOSIS

■ 70. The authority citation for part 90 continues to read as follows:

Authority: 30 U.S.C. 811, 813(h), 957.

Subpart A—General

■ 71. Revise § 90.2 to read as follows:

§ 90.2 Definitions.

Until April 14, 2025, the following definitions apply in this part:

Act. The Federal Mine Safety and Health Act of 1977, Public Law 91–173, as amended by Public Law 95–164 and Public Law 109–236.

Active workings. Any place in a coal mine where miners are normally required to work or travel.

Approved sampling device. A sampling device approved by the Secretary and Secretary for Health and Human Services (HHS) under part 74 of this subchapter.

Certified person. An individual certified by the Secretary in accordance with § 90.202 to take respirable dust samples required by this part or certified in accordance with § 90.203 to perform the maintenance and calibration of respirable dust sampling equipment as required by this part.

Coal mine dust personal sampler unit (CMDPSU). A personal sampling device approved under part 74, subpart B, of this subchapter.

Concentration. A measure of the amount of a substance contained per unit volume of air.

Continuous personal dust monitor (CPDM). A personal sampling device approved under part 74, subpart C, of this subchapter.

District Manager. The manager of the Coal Mine Safety and Health District in which the mine is located.

Equivalent concentration. The concentration of respirable coal mine dust, including quartz, expressed in milligrams per cubic meter of air (mg/

m^3) as measured with an approved sampling device, determined by dividing the weight of dust in milligrams collected on the filter of an approved sampling device by the volume of air in cubic meters passing through the filter (sampling time in minutes (t) times the sampling airflow rate in cubic meters per minute), and then converting that concentration to an equivalent concentration as measured by the Mining Research Establishment (MRE) instrument. When the approved sampling device is:

(1) The CMDPSU, the equivalent concentration is determined by multiplying the concentration of respirable coal mine dust by the constant factor prescribed by the Secretary.

(2) The CPDM, the device shall be programmed to automatically report end-of-shift concentration measurements as equivalent concentrations.

Mechanized mining unit (MMU). A unit of mining equipment including hand loading equipment used for the production of material; or a specialized unit which uses mining equipment other than specified in § 70.206(b) or in § 70.208(b) of this subchapter. Each MMU will be assigned a four-digit identification number by MSHA, which is retained by the MMU regardless of where the unit relocates within the mine. However, when:

(1) Two sets of mining equipment are used in a series of working places within the same working section and only one production crew is employed at any given time on either set of mining equipment, the two sets of equipment shall be identified as a single MMU.

(2) Two or more sets of mining equipment are simultaneously engaged in cutting, mining, or loading coal or rock from working places within the same working section, each set of mining equipment shall be identified as a separate MMU.

MRE instrument. The gravimetric dust sampler with a four channel horizontal elutriator developed by the Mining Research Establishment of the National Coal Board, London, England.

MSHA. The Mine Safety and Health Administration of the U.S. Department of Labor.

Normal work duties. Duties which the part 90 miner performs on a routine day-to-day basis in his or her job classification at a mine.

Part 90 miner. A miner employed at a coal mine who has exercised the option under the old section 203(b) program (30 CFR part 90, effective as of July 1, 1972), or under § 90.3 of this part to work in an area of a mine where the average concentration of respirable dust in the mine atmosphere during each shift to which that miner is exposed is continuously maintained at or below the applicable standard, and who has not waived these rights.

Quartz. Crystalline silicon dioxide (SiO2) not chemically combined with other substances and having a distinctive physical structure.

Representative sample. A respirable dust sample, expressed as an equivalent concentration, that reflects typical dust concentration levels in the working environment of the part 90 miner when performing normal work duties.

Respirable dust. Dust collected with a sampling device approved by the Secretary and the Secretary of HHS in accordance with part 74 (Coal Mine Dust Sampling Devices) of this subchapter.

Secretary. The Secretary of Labor or a delegate.

Secretary of Health and Human Services. The Secretary of Health and Human Services (HHS) or the Secretary of Health, Education, and Welfare.

Transfer. Any change in the work assignment of a part 90 miner by the operator and includes:

(1) Any change in occupation code of a part 90 miner;

(2) any movement of a part 90 miner to or from an MMU; or

(3) any assignment of a part 90 miner to the same occupation in a different location at a mine.

Valid respirable dust sample. A respirable dust sample collected and submitted as required by this part, including any sample for which the data were electronically transmitted to MSHA, and not voided by MSHA.

■ 72. Add § 90.2T to read as follows:

§ 90.2T Definitions.

As April 14, 2025, the following definitions apply in this part:

Act. The Federal Mine Safety and Health Act of 1977, Public Law 91–173, as amended by Public Law 95–164 and Public Law 109–236.

Active workings. Any place in a coal mine where miners are normally required to work or travel.

Approved sampling device. A sampling device approved by the Secretary and Secretary for Health and Human Services (HHS) under part 74 of this subchapter.

Certified person. An individual certified by the Secretary in accordance with § 90.202 to take respirable dust samples required by this part or certified in accordance with § 90.203 to perform the maintenance and calibration of respirable dust sampling equipment as required by this part.

Coal mine dust personal sampler unit (CMDPSU). A personal sampling device approved under part 74, subpart B, of this subchapter.

Concentration. A measure of the amount of a substance contained per unit volume of air.

Continuous personal dust monitor (CPDM). A personal sampling device approved under part 74, subpart C, of this subchapter.

District Manager. The manager of the Coal Mine Safety and Health District in which the mine is located.

Equivalent concentration. The concentration of respirable coal mine dust, including quartz, expressed in milligrams per cubic meter of air (mg/m^3) as measured with an approved sampling device, determined by dividing the weight of dust in milligrams collected on the filter of an approved sampling device by the volume of air in cubic meters passing through the filter (sampling time in minutes (t) times the sampling airflow rate in cubic meters per minute), and then converting that concentration to an equivalent concentration as measured by the Mining Research Establishment (MRE) instrument. When the approved sampling device is:

(1) The CMDPSU, the equivalent concentration is determined by multiplying the concentration of respirable coal mine dust by the constant factor prescribed by the Secretary.

(2) The CPDM, the device shall be programmed to automatically report end-of-shift concentration measurements as equivalent concentrations.

Mechanized mining unit (MMU). A unit of mining equipment including hand loading equipment used for the production of material; or a specialized unit which uses mining equipment other than specified in § 70.206(b) or in § 70.208(b) of this subchapter. Each MMU will be assigned a four-digit identification number by MSHA, which is retained by the MMU regardless of where the unit relocates within the mine. However, when:

(1) Two sets of mining equipment are used in a series of working places within the same working section and only one production crew is employed at any given time on either set of mining equipment, the two sets of equipment shall be identified as a single MMU.

(2) Two or more sets of mining equipment are simultaneously engaged in cutting, mining, or loading coal or rock from working places within the same working section, each set of mining equipment shall be identified as a separate MMU.

MRE instrument. The gravimetric dust sampler with a four channel horizontal elutriator developed by the Mining Research Establishment of the National Coal Board, London, England.

MSHA. The Mine Safety and Health Administration of the U.S. Department of Labor.

Normal work duties. Duties which the part 90 miner performs on a routine day-to-day basis in his or her job classification at a mine.

Part 90 miner. A miner employed at a coal mine who has exercised the option under the old section 203(b) program (30 CFR part 90, effective as of July 1, 1972), or under § 90.3 to work in an area of a mine where the average concentration of respirable dust in the mine atmosphere during each shift to which that miner is exposed is continuously maintained at or below the standard, and who has not waived these rights.

Representative sample. A respirable dust sample, expressed as an equivalent concentration, that reflects typical dust concentration levels in the working environment of the part 90 miner when performing normal work duties.

Respirable dust. Dust collected with a sampling device approved by the Secretary and the Secretary of HHS in accordance with part 74 (Coal Mine Dust Sampling Devices) of this subchapter.

Secretary. The Secretary of Labor or a delegate.

Secretary of Health and Human Services. The Secretary of Health and Human Services (HHS) or the Secretary of Health, Education, and Welfare.

Transfer. Any change in the work assignment of a part 90 miner by the operator and includes:

(1) Any change in occupation code of a part 90 miner;

(2) any movement of a part 90 miner to or from an MMU; or

(3) any assignment of a part 90 miner to the same occupation in a different location at a mine.

Valid respirable dust sample. A respirable dust sample collected and submitted as required by this part, including any sample for which the data were electronically transmitted to MSHA, and not voided by MSHA.

§ 90.2 [Removed]

■ 73. Effective April 14, 2025, remove § 90.2.

§ 90.2T [Redesignated as § 90.2]

■ 74. Effective April 14, 2025, redesignate § 90.2T as § 90.2.

■ 75. Amend § 90.3 by adding the introductory text to read as follows:

§ 90.3 Part 90 option; notice of eligibility; exercise of option.

The following is required until April 14, 2025:

* * * * *

■ 76. Add § 90.3T to read as follows:

§ 90.3T Part 90 option; notice of eligibility; exercise of option.

Effective April 14, 2025:

(a) Any miner employed at a coal mine who, in the judgment of the Secretary of HHS, has evidence of the development of pneumoconiosis based on a chest X-ray, read and classified in the manner prescribed by the Secretary of HHS, or based on other medical examinations shall be afforded the option to work in an area of a mine where the average concentration of respirable dust in the mine atmosphere during each shift to which that miner is exposed is continuously maintained at or below the standard. Each of these miners shall be notified in writing of eligibility to exercise the option.

(b) Any miner who is a section 203(b) miner on January 31, 1981, shall be a part 90 miner on February 1, 1981, entitled to full rights under this part to retention of pay rate, future actual wage increases, and future work assignment, shift and respirable dust protection.

(c) Any part 90 miner who is transferred to a position at the same or another coal mine shall remain a part 90 miner entitled to full rights under this part at the new work assignment.

(d) The option to work in a low dust area of the mine may be exercised for the first time by any miner employed at a coal mine who was eligible for the option under the old section 203(b) program (*www.msha.gov/REGSTECHAMEND.htm*), or is eligible for the option under this part by sending a written request to the Chief, Division of Health, Mine Safety and Health Enforcement, MSHA, 201 12th Street South, Arlington, VA 22202–5452.

(e) The option to work in a low dust area of the mine may be re-exercised by any miner employed at a coal mine who exercised the option under the old section 203(b) program (*www.msha.gov/REGSTECHAMEND.htm*) or exercised the option under this part by sending a written request to the Chief, Division of Health, Mine Safety and Health Enforcement, MSHA, 201 12th Street South, Arlington, VA 22202–5452. The request should include the name and address of the mine and operator where the miner is employed.

(f) No operator shall require from a miner a copy of the medical information received from the Secretary or Secretary of HHS.

§ 90.3 [Removed]

■ 77. Effective April 14, 2025, remove § 90.3.

§ 90.3T [Redesignated as § 90.3]

■ 78. Effective April 14, 2025, redesignate § 90.3T as § 90.3.

Subpart B—Dust Standards, Rights of Part 90 Miners

■ 79. Amend § 90.100 by adding introductory text to read as follows:

§ 90.100 Respirable dust standard.

The following is required until April 14, 2025. After the 20th calendar day following receipt of notification from MSHA that a part 90 miner is employed at the mine, the operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which the part 90 miner in the active workings of the mine is exposed, as measured with an approved sampling device and expressed in terms of an equivalent concentration, at or below:

* * * * *

■ 80. Add § 90.100T to read as follows:

§ 90.100T Respirable dust standard.

The following is required as of April 14, 2025. After the 20th calendar day following receipt of notification from MSHA that a part 90 miner is employed at the mine, the operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which the part 90 miner in the active workings of the mine is exposed, as measured with an approved sampling device and expressed in terms of an equivalent concentration, at or below 0.5 mg/m^3.

§ 90.100 [Removed]

■ 81. Effective April 14, 2025, remove § 90.100.

§ 90.100T [Redesignated as § 90.100]

■ 82. Effective April 14, 2025, redesignate § 90.100T as § 90.100.

§ 90.101 [Removed and Reserved]

■ 83. Effective April 14, 2025, remove and reserve § 90.101.

■ 84. Amend § 90.102 by adding introductory text to read as follows:

§ 90.102 Transfer; notice.

The following is required until April 14, 2025:

* * * * *

■ 85. Add § 90.102T to read as follows:

§ 90.102T Transfer; notice.

As of April 14, 2025:

(a) Whenever a part 90 miner is transferred in order to meet the standard, the operator shall transfer the miner to an existing position at the same coal mine on the same shift or shift rotation on which the miner was employed immediately before the transfer. The operator may transfer a part 90 miner to a different coal mine, a newly created position or a position on a different shift or shift rotation if the miner agrees in writing to the transfer. The requirements of this paragraph do not apply when the respirable dust concentration in a part 90 miner's work position complies with the standard but circumstances, such as reductions in workforce or changes in operational status, require a change in the miner's job or shift assignment.

(b) On or before the 20th calendar day following receipt of notification from MSHA that a part 90 miner is employed at the mine, the operator shall give the District Manager written notice of the occupation and, if applicable, the MMU unit to which the part 90 miner shall be assigned on the 21st calendar day following receipt of the notification from MSHA.

(c) After the 20th calendar day following receipt of notification from MSHA that a part 90 miner is employed at the mine, the operator shall give the District Manager written notice before any transfer of a part 90 miner. This notice shall include the scheduled date of the transfer.

§ 90.102 [Removed]

■ 86. Effective April 14, 2025, remove § 90.102.

§ 90.102T [Redesignated as § 90.102]

■ 87. Effective April 14, 2025, redesignate § 90.102T as § 90.102.

■ 88. Revise § 90.104 to read as follows:

§ 90.104 Waiver of rights; re-exercise of option.

The following is required until April 14, 2025:

(a) A part 90 miner may waive his or her rights and be removed from MSHA's active list of miners who have rights under part 90 by:

(1) Giving written notification to the Chief, Division of Health, Mine Safety and Health Enforcement, MSHA, that the miner waives all rights under this part;

(2) Applying for and accepting a position in an area of a mine which the miner knows has an average respirable dust concentration exceeding the applicable standard; or

(3) Refusing to accept another position offered by the operator at the same coal mine that meets the requirements of §§ 90.100, 90.101 and 90.102(a) after dust sampling shows that the present position exceeds the applicable standard.

(b) If rights under part 90 are waived, the miner gives up all rights under part 90 until the miner re-exercises the option in accordance with § 90.3(e) (Part 90 option; notice of eligibility; exercise of option).

(c) If rights under part 90 are waived, the miner may re-exercise the option under this part in accordance with § 90.3(e) (Part 90 option; notice of eligibility; exercise of option) at any time.

■ 89. Add § 90.104T to read as follows:

§ 90.104T Waiver of rights; re-exercise of option.

As of April 14, 2025:

(a) A part 90 miner may waive his or her rights and be removed from MSHA's active list of miners who have rights under part 90 by:

(1) Giving written notification to the Chief, Division of Health, Mine Safety and Health Enforcement, MSHA, that the miner waives all rights under this part;

(2) Applying for and accepting a position in an area of a mine which the miner knows has an average respirable dust concentration exceeding the standard; or

(3) Refusing to accept another position offered by the operator at the same coal mine that meets the requirements of §§ 90.100, 90.101 and 90.102(a) after dust sampling shows that the present position exceeds the applicable standard.

(b) If rights under part 90 are waived, the miner gives up all rights under part 90 until the miner re-exercises the option in accordance with § 90.3(e) (Part 90 option; notice of eligibility; exercise of option).

(c) If rights under part 90 are waived, the miner may re-exercise the option under this part in accordance with § 90.3(e) (Part 90 option; notice of eligibility; exercise of option) at any time.

§ 90.104 [Removed]

■ 90. Effective April 14, 2025, remove § 90.104.

§ 90.104T [Redesignated as § 90.104]

■ 91. Effective April 14, 2025, redesignate § 90.104T as § 90.104.

Subpart C—Sampling Procedures

■ 92. Amend § 90.205 by adding introductory text to read as follows:

§ 90.205 Approved sampling devices; operation; air flowrate.

The following is required until April 14, 2025:

* * * * *

■ 93. Add § 90.205T to read as follows:

§ 90.205T Approved sampling devices; operation; air flowrate.

As of April 14, 2025:

(a) Approved sampling devices shall be operated at the flowrate of 2.0 L/min if using a CMDPSU; at 2.2 L/min if using a CPDM; or at a different flowrate recommended by the manufacturer.

(b) If using a CMDPSU, each approved sampling device shall be examined each shift, by a person certified in sampling during:

(1) The second hour after being put into operation to assure it is in the proper location, operating properly, and at the proper flowrate. If the proper flowrate is not maintained, necessary adjustments shall be made by the certified person. This examination is not required if the sampling device is being operated in an anthracite coal mine using the full box, open breast, or slant breast mining method.

(2) The last hour of operation to assure that the sampling device is operating properly and at the proper flowrate. If the proper flowrate is not maintained, the respirable dust sample shall be transmitted to MSHA with a notation by the certified person on the back of the dust data card stating that the proper flowrate was not maintained. Other events occurring during the collection of respirable dust samples that may affect the validity of the sample, such as dropping of the sampling head assembly onto the mine floor, shall be noted on the back of the dust data card.

(c) If using a CPDM, the person certified in sampling shall monitor the dust concentrations and the sampling status conditions being reported by the sampling device at mid-shift or more frequently as specified in the approved respirable dust control plan, if applicable, to assure: The sampling device is in the proper location and operating properly; and the work environment of the Part 90 miner being sampled remains in compliance with the standard at the end of the shift. This monitoring is not required if the sampling device is being operated in an anthracite coal mine using the full box, open breast, or slant breast mining method.

§ 90.205 [Removed]

■ 94. Effective April 14, 2025, remove § 90.205.

§ 90.205T [Redesignated as § 90.205]

■ 95. Effective April 14, 2025, redesignate § 90.205T as § 90.205.

■ 96. Amend § 90.206 by adding introductory text to read as follows:

§ 90.206 Exercise of option or transfer sampling.

The following is required until April 14, 2025:

* * * * *

■ 97. Add § 90.206T to read as follows:

§ 90.206T Exercise of option or transfer sampling.

(a) The operator shall take five valid representative dust samples for each part 90 miner within 15 calendar days after:

(1) The 20-day period specified for each part 90 miner in § 90.100; and

(2) Implementing any transfer after the 20th calendar day following receipt of notification from MSHA that a part 90 miner is employed at the mine.

(b) Noncompliance with the standard shall be determined in accordance with § 90.207(d).

(c) Upon issuance of a citation for a violation of the standard, the operator shall comply with § 90.207(f).

§ 90.206 [Removed]

■ 98. Effective April 14, 2025, remove § 90.206.

§ 90.206T [Redesignated as § 90.206]

■ 99. Effective April 14, 2025, redesignate § 90.206T as § 90.206.

■ 100. Amend § 90.207 by adding introductory text to read as follows:

§ 90.207 Quarterly sampling.

The following is required until April 14, 2025:

* * * * *

■ 101. Add § 90.207T to read as follows:

§ 90.207T Quarterly sampling.

As of April 14, 2025:

(a) Each operator shall take five valid representative samples every calendar quarter from the environment of each part 90 miner while performing normal work duties. Part 90 miner samples shall be collected on consecutive work days. The quarterly periods are:

(1) January 1–March 31

(2) April 1–June 30

(3) July 1–September 30

(4) October 1–December 31.

(b) [Reserved]

(c) When a valid representative sample taken in accordance with this section meets or exceeds the ECV in table 1 to this section corresponding to the particular sampling device used, the mine operator shall:

(1) Make approved respiratory equipment available to affected miners in accordance with § 72.700 of this chapter;

(2) Immediately take corrective action to lower the concentration of respirable coal mine dust to below the standard; and

(3) Make a record of the corrective actions taken. The record shall be certified by the mine foreman or equivalent mine official, no later than the end of the mine foreman's or equivalent official's next regularly scheduled working shift. The record shall be made in a secure book that is not susceptible to alteration or electronically in a computer system so as to be secure and not susceptible to alteration. Such records shall be retained at a surface location at the mine for at least 1 year and shall be made available for inspection by authorized representatives of the Secretary and the part 90 miner.

(d) Noncompliance with the standard is demonstrated during the sampling period when:

(1) Two or more valid representative samples meet or exceed the ECV in table 1 to this section that corresponds to the particular sampling device used; or

(2) The average for all valid representative samples meets or exceeds the ECV in table 1 to this section that corresponds to the particular sampling device used.

(e) Unless otherwise directed by the District Manager, upon issuance of a citation for a violation of the standard, paragraph (a) of this section shall not apply to that Part 90 miner until the violation is abated and the citation is terminated in accordance with paragraphs (e) and (f) of this section.

(f) Upon issuance of a citation for a violation of the standard, the operator shall take the following actions sequentially:

(1) Make approved respiratory equipment available to the affected part 90 miner in accordance with § 72.700 of this subchapter.

(2) Immediately take corrective action to lower the concentration of respirable dust to below the standard. If the corrective action involves:

(i) Reducing the respirable dust levels in the work position of the part 90 miner identified in the citation, the operator shall implement the proposed corrective actions and begin sampling the affected miner within 8 calendar days after the date the citation is issued, until five valid representative samples are taken.

(ii) Transferring the Part 90 miner to another work position at the mine to meet the standard, the operator shall comply with § 90.102 and then sample the affected miner in accordance with § 90.206(a).

(3) Make a record of the corrective actions taken. The record shall be certified by the mine foreman or equivalent mine official, no later than the end of the mine foreman's or equivalent official's next regularly scheduled working shift. The record shall be made in a secure book that is not susceptible to alteration or electronically in a computer system so as to be secure and not susceptible to alteration. Such records shall be retained at a surface location at the mine for at least 1 year and shall be made available for inspection by authorized representatives of the Secretary and the part 90 miner.

(g) A citation for a violation of the standard shall be terminated by MSHA when the equivalent concentration of each of the five valid representative samples is below the standard.

TABLE 1 TO § 90.207T—EXCESSIVE CONCENTRATION VALUES (ECV) BASED ON A SINGLE SAMPLE, TWO SAMPLES, OR THE AVERAGE OF FIVE FULL-SHIFT CMDPSU/CPDM CONCENTRATION MEASUREMENTS

Section	Samples	ECV (mg/m³)	
		CMDPSU	CPDM
90.207(c)	Single sample	0.74	0.57
90.207(d)(1)	2 or more samples	0.74	0.57
90.207(d)(2)	5 sample average	0.61	0.53
90.207(g)	Each of 5 samples	0.74	0.57

§ 90.207 [Removed]

■ 102. Effective April 14, 2025, remove § 90.207.

§ 90.207T [Redesignated as § 90.207]

■ 103. Effective April 14, 2025], redesignate § 90.207T as § 90.207.

Subpart D—Respirable Dust Control Plans

■ 104. Amend § 90.300 by adding introductory text to read as follows:

§ 90.300 Respirable dust control plan; filing requirements.

The following is required until April 14, 2025:

* * * * *

■ 105. Add § 90.300T to read as follows:

§ 90.300T Respirable dust control plan; filing requirements.

As of April 14, 2025:

(a) If an operator abates a violation of the standard by reducing the respirable dust level in the position of the Part 90 miner, the operator shall submit to the District Manager for approval a written respirable dust control plan for the Part 90 miner in the position identified in the citation within 15 calendar days after the citation is terminated. The respirable dust control plan and revisions thereof shall be suitable to the conditions and the mining system of the coal mine and shall be adequate to continuously maintain respirable dust below the standard for that Part 90 miner.

(b) Each respirable dust control plan shall include at least the following:

(1) The mine identification number assigned by MSHA, the operator's name, mine name, mine address, and mine telephone number and the name, address and telephone number of the principal officer in charge of health and safety at the mine;

(2) The name and MSHA Individual Identification Number of the part 90 miner and the position at the mine to which the plan applies;

(3) A detailed description of how each of the respirable dust control measures used to continuously maintain concentrations of respirable coal mine dust below the standard; and

(4) A detailed description of how each of the respirable dust control measures described in response to paragraph (b)(3) of this section will continue to be used by the operator, including at least the specific time, place, and manner the control measures will be used.

§ 90.300 [Removed]

■ 106. Effective April 14, 2025, remove § 90.300.

§ 90.300T [Redesignated as § 90.300]

■ 107. Effective April 14, 2025, redesignate § 90.300T as § 90.300.

■ 108. Amend § 90.301 by adding introductory text to read as follows:

§ 90.301 Respirable dust control plan; approval by District Manager; copy to part 90 miner.

The following is required until April 14, 2025:

* * * * *

■ 109. Add § 90.301T to read as follows:

§ 90.301T Respirable dust control plan; approval by District Manager; copy to part 90 miner.

As of April 14, 2025:

(a) The District Manager will approve respirable dust control plans on a mine-by-mine basis. When approving respirable dust control plans, the District Manager shall consider whether:

(1) The respirable dust control measures would be likely to maintain concentrations of respirable coal mine dust below the standard; and

(2) The operator's compliance with all provisions of the respirable dust control plan could be objectively ascertained by MSHA.

(b) MSHA may take respirable dust samples to determine whether the respirable dust control measures in the operator's plan effectively maintain concentrations of respirable coal mine dust below the standard.

(c) The operator shall comply with all provisions of each respirable dust control plan upon notice from MSHA that the respirable dust control plan is approved.

(d) The operator shall provide a copy of the current respirable dust control plan required under this part to the part 90 miner. The operator shall not post the original or a copy of the plan on the mine bulletin board.

(e) The operator may review respirable dust control plans and submit proposed revisions to such plans to the District Manager for approval.

§ 90.301 [Removed]

■ 110. Effective April 14, 2025, remove § 90.301.

§ 90.301T [Redesignated as § 90.301]

■ 111. Effective April 14, 2025, redesignate § 90.301T as § 90.301.

[FR Doc. 2024–06920 Filed 4–16–24; 8:45 am]

BILLING CODE 4520–43–P