Consensus Study Report
HIGHLIGHTS
June 2018

Monitoring and Sampling Approaches to Assess Underground Coal Mine Dust Exposures

Decades of efforts to reduce exposure to coal mine dust have dramatically reduced the prevalence of lung diseases associated with coal mining but have not eliminated them. The Mine Safety and Health Administration (MSHA) issued a 2014 rule that lowered the allowable level of respirable coal mine dust in underground mines and required other protective measures, such as the use of personal dust monitors that provide near real-time exposure information. Although industry data are in compliance with the 2014 rule, that is not a guarantee future disease rates will decline. Continued progress will require a shift in the way that coal mine operators approach exposure control, including carrying out voluntary monitoring and sampling that go beyond regulatory compliance.

Photo credit: Mine Safety and Health Administration

Coal production, like all other conventional mining activities, creates dust in the workplace. Occupational exposure to respirable coal mine dust (RCMD) has long been associated with lung diseases common to the coal mining industry, including coal workers' pneumoconiosis (CWP), also known as "black lung disease." In the 1960s, this disease was found in more than 30 percent of coal miners who had worked at least 25 years in underground coal mines.

Regulatory requirements put in place in 1969 to minimize exposure to RCMD, together with improved medical surveillance and other efforts to protect miners' health, have led to several decades of decreased prevalence of CWP (see Figure 1). By 2000, the recognized prevalence of disease in underground coal miners with more than 25 years of work tenure had decreased to about 5 percent. However, since around 2000 there has been an unexpected increase in the proportion of CWP in coal miners with 25 or more years of work tenure, and an increase or plateau of disease prevalence in those with shorter mining tenure (see Figure 1). Moreover, recent reports have described rapidly progressive, severe and fatal forms of disease including progressive massive fibrosis occurring mainly in the central geographic region of Appalachia.

Conducted at the request of Congress and with support from the National Institute for Occupational Safety and Health (NIOSH) and MSHA, this study assesses the effectiveness of monitoring and sampling approaches for informing underground coal mine operators' decision making regarding the control of miner exposure to RCMD.

CURRENT MONITORING AND SAMPLING IN U.S. MINES

Effective exposure control is a key means of addressing the occurrence of CWP in coal miners. Effective monitoring technologies and sampling approaches would

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provide information on, not only the RCMD mass concentrations for meeting regulatory requirements, but also the RCMD particle characteristics (such as composition) of greatest relevance to disease risk in miners. That information would inform a continual assessment of the RCMD standard and, ultimately, approaches for optimal protection of the health of the miners.

As late as 2014, personal exposures to airborne RCMD were monitored using a device that collected a gravimetric sample of particles onto a filter during a miner's work shift. The sample was then sent to a laboratory for analysis, imposing a time lag in initiating appropriate dust controls to reduce elevated exposure concentrations.

MSHA's 2014 dust rule required monitoring of personal dust concentrations using a continuous personal dust monitor (CPDM) beginning in February 2016. The CPDM is required for miners expected to be exposed to the highest RCMD concentrations and miners who have medical findings of CWP but continue to work in a less dusty job in the mine.[1] For the period from August 2016 to May 2017, greater than 99 percent of samples submitted by mine officers were in compliance with the regulatory limit. While the 2014 dust rule put new protections into place, most miners incurred much of their exposures when previous regulations were in effect. Because the latency period of CWP disease onset is typically 10 or more years, sufficient time has not elapsed to assess the effect of the 2014 requirements.

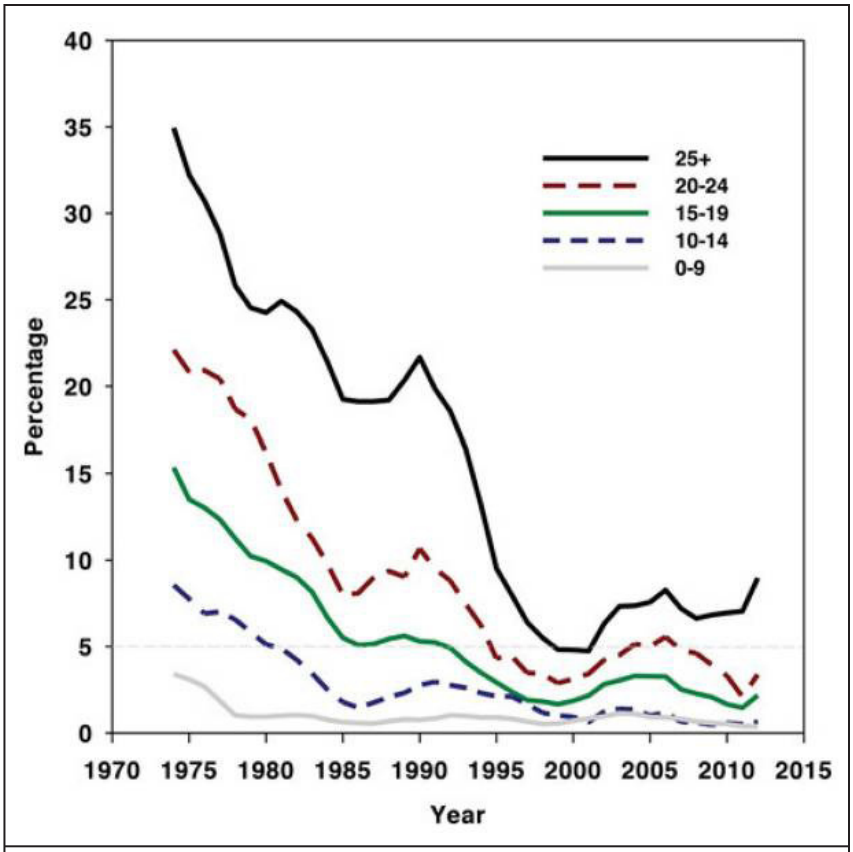

Figure 1. Percentage of examined U.S. underground miners with coal workers' pneumoconiosis (CWP), for 1970 to 2012. Data are presented as 5-year moving averages. Separate plots represent various years of work tenure. SOURCE: Laney and Weissman (2014).

The CPDM is an important technological advancement compared to monitoring methods used previously, as it provides near-real-time readings of airborne RCMD concentrations in the workplace. If a measurement collected over a full shift exceeds allowable limits, mine operators must take corrective actions immediately. In addition, miners wearing CPDMs receive information about their personal exposures and sometimes can modify their activities or locations within a mine in response to elevated readings.

However, only a small fraction of coal miners are required to use a CPDM during any given shift, and it is possible that those coal miners using the CPDMs are not representative of the dust exposure to other miners who are not using the CPDMs. Further, when miners wearing CPDMs react to high monitor readings, for example, by altering their locations while carrying out their job duties, the required RCMD sampling might no longer be representative of the miners with the highest exposures. Whether the airborne RCMD concentration is being maintained at or below the permissible limit for only those miners wearing the CPDM, or all personnel in the work area, is unknown.

OPTIMAL STRATEGIES TO REDUCE RCMD EXPOSURES

Historically, the primary focus of RCMD monitoring and sampling efforts had been based on compliance with federal regulations. Additional monitoring efforts were undertaken by coal mine operators to support improvements in mine ventilation and other dust controls, for instance, to resolve noncompliance conditions. Over three decades, the compliance-driven approach led to a significant reduction in the rate of lung diseases associated with occupational exposure to RCMD among U.S.

Box 1: Sources of Respirable Coal Mine Dust

RCMD has many sources, including particles generated by coal and mineral extraction, rock adjacent to the coal seam being mined, rock dust products used to control explosions in mines, and other particles associated with mining activities (for example, diesel fuel burning and belt abrasion). RCMD also has many components, including silica dust, which is known to pose a serious health risk.

[1] Use of the CPDM is optional for monitoring specific locations in the mine identified by the operator in the mine ventilation plan.

coal mine workers but fell short of the ultimate goal to eliminate such diseases.

The reasons for the recent increase in CWP prevalence are not obvious but could be related to changes in mining practices and conditions. For example, increases in equipment size and horsepower and the mining of increasingly thinner coals seems have resulted in extraction of more rock containing silica and other RCMD components.

Given current uncertainties about the cause of increase in disease prevalence and severity, the high rates of operator compliance with the 2014 dust rule requirements may not guarantee that RCMD exposures will be controlled adequately or that future disease rates will decline. To continue progress toward reaching this goal, optimal sampling and monitoring strategies are needed. Those strategies would embrace additional voluntary monitoring and sampling that go beyond regulatory compliance to gain information on potentially important factors affecting miners' health as well as the temporal and spatial variation of RCMD within a mine.

NIOSH and other organizations, such as the National Mining Association and the unions representing miners, should conduct a comprehensive investigation to identify key challenges that coal mine operators face in implementing an optimal, beyond-compliance approach to RCMD exposure monitoring and sampling for informing exposure control efforts. The organizations conducting the investigation also should recommend practical solutions for overcoming those challenges.

RECOMMENDTAIONS FOR MAKING PROGRESS

Research and development efforts are needed to better understand the relationships between miners' exposures and disease, including studying effects of changes in mining practices, improving monitoring approaches, and increasing participation in medical surveillance programs. Key recommendations to improve the efficacy of current monitoring technologies and sampling approaches and to aid mine operator's decision making regarding voluntary, beyond-compliance measures for reducing miners' RCMD exposures include the following:

- Conduct studies to evaluate the exposures of miners not wearing CPDMs to ensure that the approach of detecting and mitigating high exposures for designated occupations reliably results in mitigating high exposures of all miners.
- NIOSH and MSHA should carry out a systematic examination of the content and implementation of training and education programs with respect to RCMD exposure. To be most effective, the programs should be relevant to all miners, not just the ones who wear CPDMs, as well as to operators and regulators.
- Develop a real-time crystalline silica monitor. As an interim measure, NIOSH should continue its efforts to develop an end-of-shift silica monitor.
- NIOSH should continue to facilitate the development of a less costly and less ergonomically stressful real-time RCMD monitoring device that would facilitate the use of the personal monitors for engineering studies and other purposes in addition to compliance monitoring.
- Conduct a systematic evaluation of changes in mining technology and activities to determine the extent to which those changes have caused increased extraction of rock and the extent to which past rock extraction had been co-located with disease hot spots.
- Elucidate factors that act as disincentives for participation in the voluntary portions of medical surveillance programs with the goal of improving participation rates in those programs.

NIOSH, MSHA, and other organizations should set priorities for addressing the committee's recommendations and develop a strategy for addressing them. Federal agencies should provide the capability for research to be conducted in an experimental underground coal mine. Federal, academic, and coal mine industry researchers should seek opportunities for conducting collaborative research and development activities.

Box 2. Does Rock Dusting Affect Coal Mine Dust Exposure Monitor Readings?

The application of rock dust products to prevent explosions in mines is a proven practice that has been utilized in some way since the early 1900s. Most of the commercially available rock dust is composed of pulverized limestone or marble. Because rock dust products contain particles in the respirable size range, rock dusting can contribute substantially to the RCMD mass concentration measured by CPDMs. However, rock dusting has not been found to be a large obstacle to demonstrating compliance with the 2014 dust rule. While sustained high exposures to rock dust may trigger respiratory symptoms of irritation and cough and could contribute to a higher risk of chronic obstructive pulmonary disease (COPD), few case reports or studies implicate rock dust exposure in risk for clinically significant coal mine dust lung disease.

COMMITTEE ON THE STUDY OF THE CONTROL OF RESPIRABLE COAL MINE DUST EXPOSURE IN UNDERGROUND MINES

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For More Information . . . This Consensus Study Report Highlights was prepared by the Board on Earth Sciences and Resources, Board on Environmental Studies and Toxicology, and Board on Health Science and Policy based on the Consensus Study Report *Monitoring and Sampling Approaches to Assess Underground Coal Mine Dust Exposures* (2018). The study was sponsored by the National Institute of Occupational Safety and Health. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project. Copies of the Consensus Study Report are available from the National Academies Press, (800) 624-6242; http://www.nap.edu or via the Board on Earth Sciences and Resources web page at http://www.nationalacademies.org/best.

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