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DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

National Institute for Occupational
Safety and Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998

February 17, 2006

Mine Safety and Health Administration
Office of Standards, Regulations,
and Variances
1100 Wilson Boulevard
Room 2350
Arlington, VA 22209-3939

Re: RIN 1219-AB29

Dear Sir/Madam:

The National Institute for Occupational Safety and Health (NIOSH) has reviewed the proposed rule *Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Mines* published in the *Federal Register* on September 7, 2005 [70 FR 53280]. Our comments are enclosed.

If you have any questions regarding our submission, please call me at 513/533-8302.

Sincerely yours,

Paul A. Schulte, Ph.D.
Director
Education and Information Division

Enclosure

AB29-COMM-108

National Institute for Occupational Safety and Health

NIOSH Comments to MSHA

Comments of the National Institute for Occupational Safety and Health on the Mine Safety and Health Administration Proposed Rule Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Mines

30 CFR Part 57

Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

2/17/06

The National Institute for Occupational Safety and Health (NIOSH) has reviewed the Mine Safety and Health Administration (MSHA) proposed rule (PR) *Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Mines*, published in the *Federal Register* [70 FR 53280] on September 7, 2005. NIOSH supports MSHA's efforts in this PR to consider both health protection and technological feasibility under the challenging conditions of the mining environment.

Recent Health Studies

In 2001, MSHA identified diesel particulate matter (DPM) exposure to be associated with acute sensory irritations and respiratory symptoms, including allergenic responses; premature death from cardiovascular, cardiopulmonary, or respiratory causes; and lung cancer [66 FR 5706]. Additional evidence was presented in 2005 [70 FR 32868]. Health science literature not noted in these documents has continued to accumulate, adding weight of evidence to MSHA's findings about the adverse health effects of exposure to DPM.

Since 2001, there has been progressive accumulation of evidence that the inflammatory and immunologic effects of diesel exhaust particulate exposure can play a role in the development of allergies and asthma. Progress in this area, particularly laboratory-based research, was reviewed by Riedl and Diaz-Sanchez in 2005. Epidemiological support for an association between diesel exhaust exposure and development of asthma was published in 2004 by Hoppin et al. The study evaluated the odds of wheeze associated with nonpesticide occupational exposures in a cohort of approximately 21,000 farmers in Iowa and North Carolina. Using logistic regression models controlling for age, state, smoking, and history of asthma or atopy to evaluate odds of wheeze in the past year, it was found that driving diesel tractors was associated with elevated odds of wheeze (odds ratio = 1.31; 95% confidence interval = 1.13, 1.52). The odds ratio for driving gasoline tractors was lower at 1.11 (95% confidence interval = 1.02, 1.21). A duration–response relationship was observed for driving diesel tractors but not for driving gasoline tractors. Also in 2004, Pourazar et al. performed laboratory exposures of 15 healthy volunteers to diesel exhaust or air (1 hour exposure, diesel concentration measured as PM10: 300 $\mu g/m^3$). It was found that this diesel exposure caused a significant increase in expression of the cytokine interleukin-(IL)13 in the airways of these volunteers. IL-13 is known to play a key role in the pathogenesis of asthma.

In addition to the studies already cited by MSHA, other studies have shown that exposures of human volunteers to diesel exhaust at levels below 160 $\mu g/m^3$ total carbon cause airways inflammation.

Induction of nasal inflammation by exposure to diesel engine exhaust at levels below the concentration limits proposed by MSHA was documented in a study by

Gluck et al. in 2003. This study compared nasal cytological examinations of 136 customs officers involved solely in clearance of heavy-goods vehicles using diesel engines with examinations of 58 officers working only in offices. Examinations were performed twice a year over a period of 5 years. Measured diesel engine emission concentrations for the exposed group varied between 31 and 60 $\mu g/m^3$. Unlike the office group, the exposed group was found to have chronic inflammatory changes of the nasal mucosa, including goblet cell hyperplasia, increased metaplastic and dysplastic epithelia, and increased leukocytes.

In 2004, Stenfors et al. exposed 25 healthy volunteers and 15 mild asthmatics to diesel exhaust or air alone for two hours (diesel concentration measured as PM10: 108 $\mu g/m^3$). At six hours after exposure, subjects underwent bronchoscopy with bronchoalveolar lavage and mucosal biopsies. Diesel exhaust exposure was documented to cause airways inflammation in healthy volunteers. Diesel exhaust exposure did not significantly worsen existing airways inflammation in the asthmatics, but did significantly increase airways expression of the important allergy-associated cytokine, IL-10.

In 2006, Behndig et al. exposed 15 healthy volunteers to diesel exaust or air (2 hours, diesel concentration measured as PM10: 100 $\mu g/m^3$). Eighteen hours after exposure, the volunteers were assessed using bronchoscopy with bronchoalveolar lavage and endobronchial mucosal biopsy. These investigators documented that these exposures to diesel exhaust were sufficient to cause airways inflammation.

Several studies evaluating relationships between diesel exhaust exposure and lung cancer have been published in addition to those already noted by MSHA. In 2003, Jarvholm and Silverman evaluated mortality in Swedish construction workers. Information about occupation and smoking was taken from computerized health records available for the period 1971-1992. Workers in two occupations exposed to diesel exhaust, truck drivers (n = 6364) and drivers of heavy construction vehicles (n = 14,364), were compared to a reference group of carpenters and electricians (n = 119,984). Truck drivers had significantly increased risk for cancer of the lung, but heavy construction vehicle operators did not. In heavy construction operators, a significant trend of decreased risk for lung cancer was associated with increasing use of vehicle cabins. The authors concluded that there was a difference between truck and heavy equipment operators, but no conclusion could be reached without information about diesel exhaust exposure.

In 2004, Garshick et al. published an evaluation of lung cancer mortality in 54,793 railroad workers ages 40-64 with 10-20 years of service in 1959. Based on evaluation of death certificates, subsequent mortality was assessed through 1996. Diesel-exposed workers such as engineers and conductors were compared to a referent group of less-exposed workers such as ticket agents, station agents, signal-maintainers, and clerks. It was found that railroad workers in jobs associated with operating trains had a relative risk of lung cancer mortality of 1.4 (95% confidence limits = 1.30-1.51). This association was not felt to be the result of uncontrolled confounding. No relationship was found between years of exposure and lung cancer risk. This was felt to be due to factors such as a healthy worker survivor effect, lack of information on historical changes in exposure, and the potential contribution of coal combustion products before the transition to diesel locomotives. The authors concluded that "the association between diesel exhaust exposure and lung cancer is real."

In contrast to the Garshick study, Guo et al. published a study in 2004 evaluating lung cancer mortality in all working Finns born between 1906 and 1945 and participating in the national census of December 1970. Based on the reported occupation held for longest time and a national database of exposures for various occupations, a variety of exposures including diesel exhaust was estimated. Information about subsequent diagnosis of lung cancer during the period 1971 to 1995 was obtained from the Finnish Cancer Registry. After controlling for other exposures such as asbestos and quartz dust, only a slight excess of lung cancer was found in men aged 20-59. Only a suggestive association was documented in women. The authors concluded that risk associated with diesel exhaust "was not consistently elevated" and speculated that this was the result of factors such as low exposures or confounding from unmeasured non-occupational exposures.

In summary, new peer-reviewed publications addressing the health effects of exposure to diesel exhaust continue to support MSHA's 2001 risk analysis and its 2005 updated information on health effects [30 Fed. Reg. 5526; CFR 2005].

Technological Feasibility

Although adverse health effects occur at the proposed concentration limits and below, NIOSH recognizes that all factors, including technical and economic feasibility, must be considered by MSHA in developing an exposure standard. NIOSH is aware of the "implementation and operational difficulties" currently facing the metal and nonmetal mining industry presented in MSHA's preamble, Section IV. Technological Feasibility (page 53282). A phase-in period may provide time to resolve such issues. Requiring control technologies before mine operators have had sufficient time to work through selection and implementation problems may create hazards and adverse health effects, such as the elevated levels of NO_2 experienced when some Pt-catalyzed diesel particulate filters (DPFs) have been used in poorly or marginally ventilated areas.

NIOSH also recognizes that the mines covered by this proposed standard have unique designs and operational differences presenting unique challenges in controlling and reducing diesel emissions. For some metal and nonmetal mines, targeted reductions in exposures of underground miners to DPM below the 400 μg/m^3 TC or 308 μg/m^3 elemental carbon (EC) current limit may be achieved only through implementation of complex, integrated strategies and state-of-the-art control technologies.

The first steps to control diesel emission are fundamental changes to improve mine ventilation and diesel engine maintenance practices, along with the introduction of cleaner engines or the use of alternative fuels, such as biodiesel, when practical. When these are insufficient to achieve compliance, more advanced diesel emission control technologies, such as DPF systems, may be necessary to achieve compliance.

Controlling diesel emissions is made more complicated by important technical implementation and operation issues of control technologies such as particular DPF systems which are unique to underground mining environments and operations. Research [McGinn 2004; Stachulak et al. 2005; Bugarski et al. 2005] has indicated that, while control technologies such as DPF systems and reformulated fuels can be effectively used to control DPM, other off-the-shelf solutions for control of diesel emissions may be technically and economically infeasible for underground mining applications, until certain technical and operational issues are solved. Fuel burners used in conjunction with DPFs, NO_X scrubbers, and other promising technologies have not been fully explored.

The comments of Dr. John Howard, Director, NIOSH, in his June 25, 2003, letter to the Assistant Secretary, MSHA regarding the use of filters and the interim standard are equally applicable here: "With regard to the availability of filters and the interim standard, the experience to date has shown that while diesel particulate filter (DPF) systems for retrofitting most existing diesel-powered equipment in underground metal and nonmetal mines are commercially available, the successful application of these systems is predicated on solving technical and operational issues associated with the circumstances unique to each mine. Operators will need to make informed decisions regarding filter selection, retrofitting, engine and equipment deployment, operation, and maintenance, and specifically work through issues such as in-use efficiencies, secondary emissions, engine backpressure, DPF regeneration, DPF reliability and durability."

Gaining extensive experience with implementation and operation of DPF systems on production vehicles would greatly assist in resolving some of these issues. The DPM rule is technology forcing, and overcoming technological and operational issues will require active participation and coordination of the mining industry, suppliers, and government for the development and optimization of currently available and emerging control technologies. Options for controlling exposure to DPM currently exist, but a substantial, multi-faceted effort on the part of interested parties is needed to make implementation and use of these technologies feasible. To ensure success of the phase-in period concept, individual mines or a consortium of mines or other partnerships should have compliance plans detailing the mine's integrated approach to reducing DPM levels in terms of maintenance, ventilation, fuels, control technologies, retrofitting, and monitoring.

Respiratory Protection Issues

In the preamble, MSHA emphasized that engineering controls are preferential to the use of respiratory protection. Every effort must be made to institute effective engineering controls, employing respiratory protections only in limited, and preferably, short-term circumstances. The potential problems of respiratory protection are well known--failure of protection can occur if respirators are not worn or are worn but do not fit or function properly. Using a respirator may place a physiological burden on employees that varies with the type of respirator worn, the job and workplace conditions in which the respirator is used, and the medical status of the employee.

In other industries where respirators are used, NIOSH supports the requirements specified in the Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard [29 CFR 1910.134], with the exception of (a) the use of irritant smoke for qualitative respirator fit testing, and (b) unsupervised medical evaluations conducted by healthcare professionals who are not licensed for independent practice to perform or supervise medical evaluations. The requirements for respiratory protection programs in general industry found in the OSHA Respiratory Protection Standard would serve as a guide for the use of respirators under this proposed MSHA rule. Additionally, minimum respirator requirements for specific contaminants can be found in 29 CFR 1910 Subpart Z - Toxic and Hazardous Substance Standards and the NIOSH Respirator Selection Logic [NIOSH 2005].

Following are a few concerns regarding respirator use:

- Negative-pressure air-purifying respirators require periodic replacement of filter elements; these should be P- or R-series filters in order to avoid filter degradation by DPM. However, P- and R-series filters will not provide protection from the vapor components associated with diesel exhaust.

- Respirators with tight-fitting facepieces cannot be worn by employees who have facial hair that comes between the sealing surface of the facepiece and the face or interferes with valve function; or any facial condition that interferes with the face-to-facepiece seal or valve function such as scars, dentures or lack of teeth, deep skin creases, prominent cheekbones, or severe acne. With half-facepiece respirators, care must be taken to ensure that wearing of corrective glasses, goggles, or other personal protective equipment does not interfere with the seal of the facepiece to the face of the user.

- Respirator facepieces can muffle the wearer's voice and impede communication, especially in noisy environments. The facepiece could adversely affect the wearer's range of vision and head mobility. Decreased vision and communication could adversely affect safety and lead to injuries.

- Powered air purifying respirators (PAPRs) have some of the same limitations as negative pressure respirators; they can impede communication, hearing, and vision, and they require replacement of the purifying elements at certain intervals. As with the negative pressure P- and R-series filters, the high efficiency filter elements used with PAPRs will not provide protection from the vapor components associated with diesel exhaust. In addition, the battery must be recharged on a daily basis so that the blower will deliver enough respirable air to the respiratory inlet covering. Batteries have a limited useful life and cannot be recharged indefinitely. The blower's high speed motor can wear out and require replacement; if the blower fails in a loose-fitting PAPR, the wearer will be without respiratory protection. Other disadvantages include the weight and bulk of the PAPR with its blower and battery, which can hinder movement; complex design; and the need for a higher level of maintenance than a negative pressure respirator.

Medical Evaluation for Respirator Use

If the physician or other licensed healthcare professional (PLHCP) evaluating a miner finds that the miner has a medical condition placing the miner at risk from using a negative pressure respirator, use of a PAPR is a potential alternative to transfer of duties. Under normal use, PAPRs do not impose the resistance to breathing that is associated with negative pressure respirators. MSHA may wish to consider specifying that if a medical evaluation determines that a miner cannot use a negative pressure respirator, but can use a PAPR, and if use of a PAPR provides adequate protection and is safe and appropriate in that mining environment, the mine operator should provide a PAPR to the miner. If a subsequent medical evaluation finds the employee medically able to use a negative pressure respirator, then the employer would no longer be required to provide a PAPR. Transfer should be reserved for those who cannot use either a negative pressure respirator or a PAPR. The timeframe for transfer should be as rapid as possible if a miner is experiencing acute health effects from exposure. NIOSH suggests that MSHA receive exposure data from mines where respirators must be used. NIOSH recommends that mine operators be required to maintain records of miners' medical evaluations, respirator use, and transfers required under this rule. These records should be kept confidential and in a secure location. MSHA may wish to refer to the requirements specified in 29 CFR 1910.1020, Access to Employee Exposure and Medical Records. Consistent with the practices recommended in 29 CFR 1910.134, NIOSH recommends that the PLHCP performing medical evaluations to assess a miner's ability to wear a respirator, provide written medical opinions to both the employer and the miner.

Use of Elemental Carbon (EC) as the Surrogate for DPM

NIOSH continues to recommend that EC is a better surrogate than TC for determining a miner's exposure to DPM in underground metal/nonmetal mines [NIOSH 1998; 2000; 2002]. EC in area and personal samples can be measured accurately below 100 µg EC/m^3 in underground metal/nonmetal mines while TC measurements are subject to interference especially at the lower concentrations. NIOSH recognizes that some control technologies, primarily DPFs, may affect the consistency of the DPM/EC relationship; however, DPM from vehicles with DPFs would have to dominate the overall DPM ambient concentrations for the DPFs to impact the DPM/EC relationship.

A size selective sampler [Cantrell and Rubow 1991; McCartney and Cantrell 1992; Cash et al. 2003; Noll et al. 2005] has been shown to effectively segregate coarse mineral dust from submicron DPM. However, the size-selective sampler does not efficiently remove cigarette smoke and organic carbon aerosols from oil mist because these aerosols generally belong to the same size category as diesel aerosols. Therefore, cigarette smoke and oil mist cannot always be avoided when taking personal samples. NIOSH is unaware of a method for correcting these interferences. When TC concentrations in mines approach the final DPM concentration limit, the contribution from these interferences will increase.

Using EC directly as the surrogate provides the following additional advantages:

- Simplifies sampling and analysis because DPM is the only source of submicron EC, in underground metal/nonmetal mines.
- Enables the collection of personal samples, which are more representative of miners' exposures than area samples.
- Analysis does not require correction for OC sampling artifacts [Eatough et al. 1995; Kirchstetter et al. 2001; Turpin et al. 1994].

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