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DEPARTMENT OF LABOR

Mine Safety and Health Administration

30 CFR Parts 57, 70, 72, and 75

RIN 1219-AB86

[Docket No. MSHA-2014-0031]

Exposure of Underground Miners to Diesel Exhaust

AGENCY: Mine Safety and Health Administration, Labor.

ACTION: Request for information.

SUMMARY: The Mine Safety and Health Administration (MSHA) is requesting information and data on approaches to control and monitor miners' exposures to diesel exhaust. Epidemiological studies by the National Institute for Occupational Safety and Health (NIOSH) and the National Cancer Institute (NCI) have found that diesel exhaust exposure increases miners' risk of death due to lung cancer. In June 2012, the International Agency for Research on Cancer (IARC) classified diesel exhaust as a human carcinogen. Because of the carcinogenic health risk to miners from exposure to diesel exhaust and to prevent material impairment of miners' health, MSHA is reviewing the Agency's existing standards and policy guidance on controlling miners' exposures to diesel exhaust to evaluate

the effectiveness of the protections now in place to preserve miners' health.

DATES: Comments must be received or postmarked by midnight Eastern Standard Time on [INSERT DATE 90 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: Submit comments and informational materials, identified by RIN 1219–AB86 or Docket No. MSHA-2014-0031, by one of the following methods:

- *Federal E-Rulemaking Portal*: http://www.regulations.gov. Follow the on-line instructions for submitting comments.
- *Electronic Mail*: zzMSHA-comments@dol.gov.
- *Mail:* MSHA, Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, Virginia 22202-5452.
- *Hand Delivery or Courier:* 201 12th Street South, Arlington, Virginia, between 9:00 a.m. and 5:00 p.m. Monday through Friday, except Federal holidays. Sign in at the receptionist's desk in Suite 4E401.
- *Fax:* 202-693-9441.

Instructions: All submissions must include "RIN 1219–AB86" or "Docket No. MSHA-2014-0031." Do not include personal information that you do not want publicly disclosed; MSHA will post all comments without change to http://www.regulations.gov and http://arlweb.msha.gov/currentcomments.asp, including any personal information provided.

Docket: For access to the docket to read comments received, go to http://www.regulations.gov or http://arlweb.msha.gov/currentcomments.asp. To read background documents, go to http://www.regulations.gov. Review the docket in person at MSHA, Office of Standards, Regulations, and Variances, 201 12th Street South, Arlington, Virginia, between 9:00 a.m. and 5:00 p.m. Monday through Friday, except Federal Holidays. Sign in at the receptionist's desk in Suite 4E401.

E-Mail Notification: To subscribe to receive an e-mail notification when MSHA publishes rules in the *Federal Register*, go to http://www.msha.gov.

FOR FURTHER INFORMATION CONTACT: Sheila A. McConnell, Acting Director, Office of Standards, Regulations, and Variances, MSHA, at *mcconnell.sheila.a@dol.gov* (e-mail), 202-693-9440 (voice); or 202-693-9441 (facsimile). These are not toll-free numbers.

SUPPLEMENTARY INFORMATION:

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I. Background

A. Regulatory History

1. DPM in Underground Coal Mines

On October 25, 1996, MSHA published a final rule establishing revised requirements for the approval of diesel engines and related components used in underground coal mines; requirements for coal mine operators’ monitoring of diesel exhaust emissions; and safety standards for the use of diesel-powered equipment in underground coal mines (61 FR 55412). The rule required clean-burning engines on diesel-powered equipment and training for persons maintaining the equipment. The rule also required sufficient ventilating air where diesel-powered equipment is operated.

On January 19, 2001, MSHA published a final rule (66 FR 5526) limiting diesel particulate matter (DPM) exposure in underground coal mines. This standard is based on laboratory analysis of engine exhaust. It requires that the exhaust of certain pieces of equipment be restricted to the following prescribed levels:

- Permissible equipment must not emit more than 2.5 grams per hour (g/hr) of DPM;
- Non-permissible heavy-duty equipment, as defined by 30 CFR 75.1908(a) and operated in underground areas of underground coal mines, must not emit more than 2.5 g/hr of DPM (30 CFR 72.501(c));
- Non-permissible light-duty equipment, as defined by 30 CFR 75.1908(b), must not emit more than 5.0 g/hr of DPM (30 CFR 72.502(a)).

These standards also require mine operators to use engineering controls to reduce DPM exposures of underground coal miners. Mine operators must provide annual training to all miners exposed to DPM and maintain an inventory of the mine's diesel-powered equipment.

Under 30 CFR 72.502(b), non-permissible, light-duty, diesel-powered equipment must be deemed in compliance with 30 CFR 72.502(a) if it uses an engine that meets or exceeds the applicable Environmental Protection Agency (EPA) particulate matter emissions requirements. In promulgating its DPM rule, which allows more particulate emissions for light-duty equipment than for heavy-duty equipment, MSHA assumed that diesel engine manufacturers would comply with EPA standards and that, when replacing vehicles in the mine's light-duty fleet, mine operators would purchase newer (new or used) vehicles that met EPA emissions standards, thus accelerating the turnover to a newer generation of technology. MSHA expected a significant reduction in the amount of DPM emitted by the underground fleet as these cleaner engines replaced or supplemented older engines in underground coal mines.

MSHA had considered establishing stricter standards for certain types of equipment and covering more light-duty equipment, but concluded that such actions would either be technologically or economically infeasible for the coal mining industry as a whole at that time. MSHA concluded that the introduction of newer and cleaner engines underground that met EPA standards, and the continued development of after-treatment and other control technologies, would allow additional reductions in DPM levels to become feasible for the industry as a whole.

For this reason, MSHA's January 2001 DPM standards incorporated EPA's then-applicable standards for light-duty diesel engine emissions. In 2004, EPA phased in even lower emissions standards for light-duty diesel engines.

All MSHA diesel equipment is classified as "nonroad" under EPA rules. EPA nonroad diesel engine regulations were structured as a 4-tiered progression. Each tier involved a phased-in lowering of emissions standards over several years based on the size (power) of the engine.

EPA published Tier 1 standards on June 17, 1994 (59 FR 31306, 40 CFR part 89) for nonroad compression-ignition engines (which include diesel engines). Under these standards, for engines at and above 130 kilowatts (kW), emissions of particulate matter could not exceed .54 g/kW and carbon monoxide could not exceed 11.4 g/kW. These standards were phased in by engine size for model years 1996 to 2000. In addition, all engines greater than or equal to 37 kW were subject to an oxides of nitrogen (NOx, consisting of NO and NO2) emissions limit of 9.2 g/kW-hr, phased in by engine size over model years 1998 through 2000 (59 FR 31341). However, EPA explicitly excluded engines regulated by MSHA. Id. at 31340.

On October 23, 1998, EPA published Tier 1 DPM standards for nonroad compression-ignition engines less than 37 kW (50 hp), setting a 1.2 g/kW-hr particulate matter limit phased in by engine size over model years 1999 and 2000. The rule also established a Tier 1 NOx limit of 14.6 g/kW-hr for engines 37 kW and above, phased in by engine size over model years 1996 through 2000.

In addition, the rule required more stringent Tier 2 DPM standards for all nonroad diesel engines, ranging from 1.0 g/kW-hr for the smallest engines to .54 g/kW-hr for the largest engines, phased in by engine size over model years 2001 to 2006. Under the rule, Tier 3 DPM standards for engines 37 kW and above were the same as the Tier 2 standards, but for these engines Tier 3 introduced additional limits for other types of emissions (hydrocarbons plus NOx). The rule also introduced Tier 3 standards for engines 37-560 kW for these same other types of emissions, phased in by engine size over model years 2006 through 2008 (40 CFR 89.112). MSHA-regulated engines continued to be exempted from the EPA rule.

On June 29, 2004, the EPA published a final rule introducing even lower Tier 4 emissions standards for new compression-ignition engines of all sizes. (69 FR 38958, 40 CFR 1039). This rule provided for "interim" Tier 4 standards applicable to engines for model years 2014 and earlier and final Tier 4 standards applicable to model years after the 2014 model year. Based on engine size, the final standards set particulate matter limits of .04 to .40 g/kW-hr, NOx limits of .40 to 3.5 g/kW-hr, and carbon monoxide limits of 3.5 to 6.6 g/kW-hr. The final standards also imposed lower hydrocarbon limits. 40 CFR 1039.101. Again, MSHA-regulated engines were explicitly excluded from these standards. 40 CFR 1039.5(c). Tier 4 engines were expected to have 90 percent lower DPM emissions than the same types of engines under Tier 3 standards (69 FR 38958, 40 CFR 1039).

2. DPM in Underground Metal and Nonmetal Mines

In 2001, MSHA published a final rule establishing new health standards for underground metal and nonmetal mines that use equipment powered by diesel engines (30 CFR Part 57). This rule established a concentration limit for DPM and required mine operators to use engineering and work practice controls to reduce DPM to that limit. Operators were required to comply in accordance with a phase-in period, with the final limit to be in effect by January 20, 2006. In the rule, MSHA provided operators with the opportunity to obtain a special extension if engineering and work practice controls that would reduce a miner's personal exposure to the final exposure limit could not be implemented by the deadline due to technological constraints. This extension opportunity did not apply to newer mines.

MSHA published another final rule (70 FR 32868; June 6, 2005) that replaced the concentration limit for DPM exposures of MNM miners from a total carbon (TC) permissible exposure limit (PEL) to a comparable elemental carbon (EC) PEL. This was not intended to be a substantive change to the exposure limits; rather, MSHA believed that EC renders a more accurate measure of DPM exposure than does TC. The first phase of the PEL reduction would have required a PEL of 308 micrograms of EC per cubic meter of air (308_{EC} µg/m^3), effective on May 20, 2006.

After publishing this 2005 rule, however, MSHA found that the engineering applications and related technological implementation issues were more complex and extensive than previously thought. In response, the Agency published a proposed rule (70 FR 53280; September 7, 2005) seeking specific comments and data on an appropriate conversion factor for the final DPM limit from TC to EC and related technological implementation issues.

On May 18, 2006, MSHA published a final rule (71 FR 28924) that reverted back to using TC to measure DPM exposure. This rule phased-in a final DPM PEL of 160 micrograms of TC per cubic meter of air (160_{TC} µg/m^3) over a two-year period. MSHA believed that the industry as a whole was capable of attaining this DPM PEL within the timeframes established using existing DPM control methods and not requiring the development of new technologies.

MSHA stated that the development of high temperature disposable diesel particulate filter (HTDPF) systems would fill a critical gap in available filter technology because they demonstrated high filtration efficiency for EC, and did not increase NO_2 emissions. MSHA also anticipated that production of biodiesel fuel would increase dramatically, making it easier for mine operators to gain access to a reliable supply of this alternative fuel. In addition, MSHA anticipated that EPA-compliant engines along with other engineering and administrative controls would enable the underground MNM mining industry as a whole to resolve lingering implementation challenges relating to the 160_{TC} µg/m^3 DPM final exposure limit.

In the May 18, 2006 final rule, MSHA also: (1) finalized provisions addressing medical evaluation and transfer of miners who are unable to wear respirators for medical reasons; (2) committed the Agency to proposing a rule in the near future to convert the DPM limit from TC to EC; (3) deleted the provision that restricts newer mines from applying for an extension of time in which to meet the final concentration limit; and (4) addressed technological and economic feasibility issues and the costs and benefits of the rule. 30 CFR Part 57. In accordance with the phase-in schedule, the DPM PEL was reduced to 350_{TC} µg/m^3 effective January 20, 2007. The final limit of 160_{TC} µg/m^3 became effective on May 20, 2008.

On May 20, 2008 (73 FR 29058), MSHA published a *Federal Register* document announcing that it had decided not to engage in rulemaking to convert the TC limit to a comparable EC limit. This decision was based on MSHA's assessment that the latest available scientific evidence regarding the variability of the TC to EC ratio, at levels below 230 µg TC, was insufficient to suggest an appropriate conversion factor. Because the Agency could not support an appropriate EC limit, MSHA's existing DPM standard presently remains at 160_{TC} µg/m^3.

The existing standards are based on a miner's personal exposure to DPM and specify that, in an underground MNM mine, such exposure must not exceed an average 8-hour equivalent, full-shift airborne concentration of 160 micrograms of total carbon (TC) per cubic meter of air (160_{TC} µg/m^3) when measured as an 8-hour, time-weighted average concentration (TWA_8). 30 CFR 57.5060(b)(3). These standards require mine operators to use engineering and/or workplace controls to reduce miners' exposures to a level as low as feasible and, where controls do not reduce exposure to the PEL or below, to supplement controls with respiratory protection. 30 CFR 57.5060(d). These standards also provide that a physician or other licensed health care professional conduct a medical evaluation of miners to determine the miner's ability to wear respiratory protection. 30 CFR 57.5060(d)(3).

B. Recent Research

The National Cancer Institute (NCI) (Silverman *et al.*) and the National Institute for Occupational Safety and Health (NIOSH) (Attfield *et al.*) completed the Diesel Exhaust in Miners Study in March 2012. This epidemiological study included 12,315 workers from eight nonmetal mining facilities (three potash, three trona, one limestone, and one salt (halite) facility) located in Ohio, Missouri, New Mexico, and Wyoming. The study was conducted to determine whether breathing diesel exhaust could lead to lung cancer and other health outcomes. Two evaluations of this study are published in the *Journal of the National Cancer Institute*, as follows:

> D. Silverman *et al*. (2012). "The Diesel Exhaust in Miners Study: A Nested Case-Control Study of Lung Cancer and Diesel Exhaust." *Journal of the National Cancer Institute*, 104(11):855-68. doi: 10.1093/jnci/djs034

M. Attfield *et al*. (2012). "The Diesel Exhaust in Miners Study: A Cohort Mortality Study with Emphasis on Lung Cancer." *Journal of the National Cancer Institute*, 104(11):869-83. doi: 10.1093/jnci/djs035

Silverman *et al.* concluded that diesel exhaust exposure may cause lung cancer in humans and may represent a potential public health burden. Attfield *et al.* concluded that diesel exhaust increases the risk of death from lung cancer and has important public health implications.

Both the case-control study (Silverman *et al*.) and the mortality study (Attfield *et al*.) showed a strong relationship between the levels of exposure to diesel exhaust and risk of death from lung cancer. In both studies, the relationship between lung cancer risk and diesel exhaust exposure remained after controlling for smoking and other lung cancer risk factors. The death rates were about three to five times greater for workers with the highest exposures to diesel exhaust than for workers who had the lowest exposures.

On June 12, 2012, the International Agency for Research on Cancer (IARC)[1] concluded that there is sufficient evidence of carcinogenicity in humans from diesel exhaust exposure to upgrade its classification of diesel exhaust from "probably carcinogenic" to "carcinogenic to humans".[2]

In November 2015, the Health Effects Institute[3] completed its evaluation of recent epidemiological evidence for assessing the risk of lung cancer from exposure to diesel exhaust. The evaluation concluded that the Diesel Exhaust in Miners Study and the Trucking Industry Particle Study were "well designed and carefully conducted,

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[1] International Agency for Research on Cancer, World Health Organization, Press Release No. 213, "IARC: Diesel Engine Exhaust Carcinogenic," June 12, 2012.

[2] International Agency for Research on Cancer, "Carcinogenicity of Diesel-Engine and Gasoline-Engine Exhausts and Some Nitroarenes," *IARC Monographs*, Volume 105, World Health Organization, 2013.

[3] The Health Effects Institute is an independent, non-profit research institute funded jointly by the U.S. Environmental Protection Agency and industry to provide credible, high quality science on air pollution and health for air quality decisions. HEI sponsors do not participate in the selection, oversight, or review of HEI science, and HEI's reports do not necessarily represent their views.

embodying the attributes of epidemiological studies that are considered important for quantitative risk assessment."[4]

C. Health Hazard Alerts

Following the IARC classification of diesel exhaust as a human carcinogen, MSHA issued two Health Hazard Alerts: one on diesel exhaust and DPM in underground coal and MNM mines, and one on nitrogen dioxide (NO_2) emissions in underground coal mines. The first Health Hazard Alert was issued in partnership with the Occupational Safety and Health Administration (OSHA) on January 10, 2013. It provided information about diesel exhaust and DPM in underground coal and MNM mines, occupations with potential exposure, the health hazards of exposure, engineering and workplace controls, respiratory protection, and the standards in place to protect miners from exposure.

MSHA issued a second Health Hazard Alert on August 6, 2013. The alert reinforced the dangers of platinum-based particulate filters as a source of increased concentrations of nitrogen dioxide (NO_2) in underground coal mines. MSHA had addressed these dangers before. On May 16, 2011, MSHA had published a Program Information Bulletin NO. P11-38,

[4] HEI Press Release, "New Report Examines Latest Studies of Lung Cancer Risk in Workers Exposed to Exhaust from Older Diesel Engines," November 24, 2015.

Re-Issue of P02-04 - Potential Health Hazard Caused by Platinum-Based Catalyzed Diesel Particulate Matter Exhaust Filters, informing mine operators of a potential health hazard caused by then-available platinum-based catalyzed diesel particulate matter (DPM) exhaust filters for diesel-powered equipment. The PIB advised that the use of these filters may result in increased production of nitrogen dioxide (NO_2) gas, as compared to NO_2 emissions produced by engines operating without these filters, causing miners to be exposed to increased concentrations of NO_2.

D. State Actions

West Virginia, Pennsylvania, and Ohio require diesel-powered equipment used in underground coal mines to include an exhaust emissions control and conditioning system that meets the following requirements:

- DPM emissions that do not exceed an average concentration of 0.12 milligrams of DPM per cubic meter of air (mg/m^3) when diluted by 100 percent (West Virginia and Ohio) or by 50 percent (Pennsylvania) of the MSHA Part 7 approved ventilation rate for that diesel engine.
- An oxidation catalyst or other gaseous emissions control device capable of reducing undiluted carbon monoxide (CO) emissions to 100 parts per million (ppm)

or less under all conditions of operation within the normal engine operating temperature range.

- A DPM filter capable of reducing DPM concentrations by at least 75 percent (West Virginia) or by an average of 95 percent (Pennsylvania) or to a level that does not exceed an average concentration of 0.12 milligrams per cubic meter (mg/m^3) of air when diluted by 100 percent of the MSHA Part 7 approved ventilation rate for that diesel engine (Ohio).

In addition, West Virginia, Ohio, and Pennsylvania limit ambient concentrations of exhaust gases to a ceiling of 35 parts per million (ppm) for carbon monoxide (CO) and 3 ppm for nitrogen dioxide (NO_2). West Virginia and Pennsylvania also limit ambient concentrations of nitric oxide (NO) to 25 ppm. If the concentrations of these emissions exceed 75 percent of these limits, these states require mine operators to make changes to the use of diesel equipment, mine ventilation, or other modifications to the mining process.

All three states require mine operators to keep written records of emissions tests, pre-operational examinations, and maintenance and repairs for all diesel equipment operated underground. These states also require specific information to be recorded that MSHA does not require, e.g., the results of testing the engine at full throttle against the brakes with loaded hydraulics (engine speed tests), operating hour meter hours, total intake restriction, total exhaust back pressure, cooled exhaust gas temperature, coolant temperature, engine oil pressure, and engine oil temperature.

II. Information Request

MSHA requests information and data on the effectiveness of the existing standards in controlling miners' exposures to diesel exhaust, including DPM. MSHA specifically requests input from industry, labor, and other interested parties on approaches that may enhance control of DPM and diesel exhaust exposures to improve protections for miners in underground coal and MNM mines. When responding—

- Address your comments to the topic and question number. For example, the response to questions regarding underground coal mines, Question 1, would be identified as "A.1".
- Explain the rationale supporting your views and, where possible, include specific examples.
- Provide sufficient detail in your responses to enable proper Agency review and consideration.

- Identify the information on which you rely and include applicable experiences, data, models, calculations, studies and articles, standard professional practices, availability of technology, and costs.

MSHA invites comment in response to the specific questions posed below and encourages commenters to include any related cost and benefit data, and any specific issues related to the impact on small mines.

A. Non-Permissible, Light-Duty, Diesel-Powered Equipment in Underground Coal Mines

It has been 14 years since MSHA promulgated its DPM rule for underground coal mines. At that time, MSHA had estimated a service life of 10 years for non-permissible, light-duty, diesel-powered equipment. Based on this estimate, MSHA expects that all the non-permissible, light-duty, diesel-powered equipment in use at that time has now been replaced with equipment having newer and cleaner diesel engines. MSHA's latest diesel inventory for underground coal mines indicates that this newer light-duty equipment makes up about 66 percent of the total existing diesel-powered fleet. MSHA believes that this newer equipment has resulted in a decrease in the overall levels of diesel emissions in underground coal mines. Diesel engine manufacturers have integrated a variety of advanced technologies into new engine designs to reduce engine emissions to meet EPA requirements.

To assist MSHA in determining whether it is feasible to lower the emissions limits for non-permissible, light-duty, diesel-powered equipment to 2.5 g/hr of DPM or less, please respond to the following questions. For each response, please provide data, the specific type of equipment, manufacturer, engine type, filter type, level of DPM, and comments that support your response.

1. Is there evidence that non-permissible, light-duty, diesel-powered equipment currently being operated in underground mines emits 2.5 g/hr of DPM or less? If so, please provide this evidence.

2. What administrative, engineering, and technological challenges would the coal mining industry face in meeting a 2.5 g/hr DPM emissions level for non-permissible, light-duty, diesel-powered equipment?

3. What costs would the coal mining industry incur to lower emissions of DPM to 2.5 g/hr or less on non-permissible, light-duty diesel-powered equipment? What are the advantages, disadvantages of requiring that light-duty diesel-powered equipment emit no more than 2.5 g/hr of DPM?

4. What percentage of non-permissible, light-duty, diesel-powered equipment operating underground does not meet the current EPA emissions standards?

5. What modifications could be applied to non-permissible, light-duty, diesel-powered equipment to meet current EPA emissions standards? What percentage of this equipment could not be modified to meet current EPA emissions standards? If these are specific types of equipment, please list the manufacturers and model numbers.

6. What are the advantages, disadvantages, and costs associated with requiring all non-permissible, light-duty, diesel-powered equipment operating in underground coal mines to meet current EPA emissions standards? Please be specific and include the rationale for your response.

7. West Virginia, Pennsylvania, and Ohio limit diesel equipment in the outby areas of underground coal mines based on the air quantity approved on the highest ventilation plate. What are the advantages, disadvantages, and costs of MSHA adopting such an approach?

B. Maintenance of Diesel-Powered Equipment in Underground Coal Mines and Recordkeeping Requirements

Performing routine preventive maintenance of diesel engines helps ensure that the engines are maintained in approved condition. Under 30 CFR 75.1914(f), all diesel-powered equipment must be examined and tested weekly in accordance with approved checklists and manufacturers' maintenance manuals. Under 30 CFR 75.1914(g), diesel-powered equipment approved under 30 CFR part 36 and non-permissible, heavy-duty, diesel-powered equipment in underground coal mines are tested and evaluated on a weekly basis in accordance with mine operator-developed standard operating procedures. These procedures must provide for carbon monoxide sampling; carbon monoxide concentration must not exceed 2500 parts per million.

8. What would be the advantages, disadvantages, safety and health benefits, and costs of testing non-permissible, light-duty, underground diesel-powered equipment on a weekly basis for carbon monoxide as required for permissible diesel-powered equipment and non-permissible, heavy-duty, diesel-powered equipment?

9. Reducing the emissions of nitric oxide (NO) and nitrogen dioxide (NO_2) is one way that engine manufacturers can control particulate production indirectly. What are the advantages, disadvantages, and costs of expanding exhaust emissions tests to include NO and NO_2 to determine the effectiveness of emissions controls in underground coal mines? Please provide data and comments that support your response.

10. Should MSHA require that diagnostics system tests include engine speed (testing the engine at full throttle against the brakes with loaded hydraulics), operating hour meter, total intake restriction, total exhaust back pressure, cooled exhaust gas temperature, coolant temperature, engine oil pressure, and engine oil temperature, as required by some states? Why or why not?

11. What would be the advantages, disadvantages, and costs associated with requiring additional records to document the testing and maintenance of diesel-powered equipment in underground coal mines, such as the testing described above? Please be specific and include the rationale for your response.

12. If your mine is in West Virginia, Pennsylvania, or Ohio, what is your experience with the resources expended to keep testing records? How have these records been used, e.g., have you analyzed the records for trends? Have you made any changes in the use of the diesel-powered equipment, emissions controls, or mine ventilation based on the records of emissions testing? If so, please provide examples.

13. Please provide information related to additional training requirements for persons who operate and maintain diesel equipment. Please be specific on the types of

training required, time associated with training, and additional safety and health benefits provided.

C. Exhaust After-Treatment and Engine Technologies

Options for reducing diesel exhaust emissions that are available include integration of advanced technologies into new engine designs and exhaust after-treatment systems. Reduction of diesel exhaust emissions prior to their release into the mine environment is an effective strategy used to prevent or reduce exposure of underground miners to diesel exhaust. The underground coal and MNM mining industries use exhaust after-treatment technology to control and reduce DPM and gaseous emissions from the existing fleet of diesel-powered equipment. While existing DPM standards provide for flexibility of controls to reach the required limit (i.e., controls that reduce engine emissions), MSHA expected that most operators would use hot gas (ceramic) filters to comply.

MSHA is requesting information on the types and effectiveness of exhaust after-treatment technologies used in underground mines. Please describe some best practices for selecting and using after-treatment devices.

14. What exhaust after-treatment technologies are currently used on diesel-powered equipment? What are the costs associated with acquiring and maintaining these

after-treatment technologies and by how much did they reduce DPM emissions? How durable and reliable are after-treatment technologies and how often should these technologies be replaced? Please be specific and include examples and the rationale for your response.

15. What are the advantages, disadvantages, and relative costs of using DPM filters capable of reducing DPM concentrations by at least 75 percent or by an average of 95 percent or to a level that does not exceed an average concentration of 0.12 milligrams per cubic meter (mg/m^3) of air when diluted by 100 percent of the MSHA Part 7 approved ventilation rate for that diesel engine? How often do the filters need to be replaced?

16. What sensors (e.g. ammonia, nitrogen oxide (NO), nitrogen dioxide (NO_2)) are built into the after-treatment devices used on the diesel-powered equipment?

17. Are integrated engine and exhaust after-treatment systems used to control DPM and gaseous emissions in the mining industry? If so, please describe the costs associated with acquiring and maintaining integrated systems, and the reduction in DPM emissions produced.

18. What are the advantages, disadvantages, and relative costs of requiring that all light-duty diesel-

powered equipment be equipped with high-efficiency DPM filters?

As discussed above, on June 29, 2004, EPA adopted Tier 4 diesel engine standards. These standards are performance-based and technology-neutral in the sense that manufacturers are responsible for determining which emissions control technologies will be needed to meet the requirements. Engine manufacturers will produce new engines with advanced emissions control technologies to comply with Tier 4 emissions standards. Exhaust emissions from these engines are expected to decrease by more than 90 percent.

19. In the mining industry, are operators replacing the engines on existing equipment with Tier 4i (interim) or Tier 4 engines? If so, please specify the type of equipment (make and model) and engine size and tier. Please indicate how much it costs to replace the engine (parts and labor).

20. What types of diesel equipment purchased new for use in the mining industry is powered by Tier 4i or Tier 4 engines? What types of diesel-powered equipment, purchased used for use in the mining industry, are powered by Tier 3, Tier 4i or Tier 4 engines?

21. Are Tier 4i or Tier 4 engines used in underground mines equipped with diesel particulate filter (DPF) systems (e.g., advanced diesel engines with integrated after-treatment systems)? Please provide specific examples.

22. How long have Tier 4i or Tier 4 engines been in use in the mining industry and what additional cost is associated with maintaining equipment equipped with these engines?

23. What percentage of underground coal mines' total diesel equipment inventory is equipped with Tier 4i or Tier 4 engines?

D. *Monitoring MNM Miners' Exposures to DPM*

Under the existing standards, MSHA uses total carbon (TC) measurements as a surrogate for DPM when determining MNM miners' DPM exposures.

24. MSHA requests information on alternative surrogates, other than TC, to estimate a miner's DPM exposure. What is the surrogate's limit of detection and what are potential interferences in a mine environment?

25. What are the advantages, disadvantages, and relative costs for using the alternative surrogate to determine a MNM miner's exposure to DPM? Please be specific and include the rationale for your response.

26. MSHA requests information on advances in sampling and analytical technology and other methods for measuring a MNM miner's DPM exposure that may allow for a reduced exposure limit.

E. MNM Miners' Personal Exposure Limit (PEL)

MSHA analyzed its sampling data from 2006 (when the final PEL was published) to 2015, and found that the average exposures of MNM miners decreased by 57 percent from 253_{TC} to 109_{TC} $\mu g/m^3$ in MNM mines. Further analysis of the data revealed that approximately 63 percent of the mines sampled had average exposures below 100_{TC} $\mu g/m^3$ in 2015 and 75 percent of the mines sampled have average exposures below 122_{TC} $\mu g/m^3$. Overall, 50 percent of the mines sampled have average exposures between 48_{TC} and 122_{TC} $\mu g/m^{3.}$ For operators who have had success in reducing exposures below the existing standard, please describe the best practices that you have used to reduce controls. MSHA intends to share this information with the underground metal and nonmetal mining community.

27. What existing controls were most effective in reducing exposures since 2006? Are these controls available and applicable to all MNM mines?

28. Based on MSHA's data, MNM miners' average exposures are well below the existing standard of

160_{TC} µg/m^3. What are the technological challenges and relative costs of reducing the DPM exposure limit?

F. Other Information

Please provide any other data or information that may be useful to MSHA in evaluating miners’ exposures to harmful diesel exhaust emissions, including the effectiveness of existing control mechanisms for reducing harmful diesel emissions and limiting miners’ exposures to harmful diesel exhaust emissions.

Authority: 30 U.S.C. 811, 813(h).

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