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Department of Labor

Mine Safety and Health Administration

30 CFR Part 57
Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners; Proposed Rule

DEPARTMENT OF LABOR

Mine Safety and Health Administration

30 CFR Part 57

RIN 1219–AB29

Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners

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

ACTION: Proposed rule; notice of public hearings; close of comment period; request for data.

SUMMARY: This proposed rule would: Revise the existing diesel particulate matter (DPM) interim concentration limit measured by total carbon (TC) to a comparable permissible exposure limit (PEL) measured by elemental carbon (EC) which renders a more accurate DPM exposure measurement; increase flexibility of compliance by requiring MSHA's longstanding hierarchy of controls for its other exposure-based health standards at metal and nonmetal mines, but prohibit rotation of miners for compliance; allow MSHA to consider economic as well as technological feasibility in determining if operators qualify for an extension of time in which to meet the DPM limits; and simplify requirements for a DPM control plan. The proposed rule would also make conforming changes to existing provisions concerning compliance determinations, environmental monitoring and recordkeeping.

The existing final rule pertaining to ''Diesel Particular Matter Exposure of Underground Metal and Nonmetal Miners,'' was published in the **Federal Register** on January 19, 2001 (66 FR 5706, RIN 1219–AB11) and amended on February 27, 2002 (67 FR 9180). This rulemaking is part of a settlement agreement reached in response to a legal challenge to the January 19, 2001 diesel particular matter (DPM) standard.

Specifically in this proposal, MSHA intends to revise existing § 57.5060(a), limit on concentration of DPM; including designating elemental carbon as an appropriate surrogate for measuring the interim DPM limit; § 57.5060(c), addressing application and approval requirements for an extension of time in which to reduce the concentration of DPM; § 57.5060(d), addressing certain exceptions to the concentration limits; § 57.5060(e), prohibiting use of personal protective equipment to comply with the concentration limits; § 57.5060(f) prohibiting use of administrative controls to comply with the concentration limits, and § 57.5062, addressing the diesel particulate control plan. Also, MSHA intends to make conforming changes in this rulemaking to existing § 57.5061, addressing compliance determinations; § 57.5071, addressing exposure monitoring; and § 57.5075, addressing recordkeeping requirements.

MSHA has incorporated into the record of this rulemaking the existing rulemaking record, including the risk assessment to the January 19, 2001 standard. Commenters are encouraged to submit additional evidence of new scientific data related to the health risk to underground metal and nonmetal miners from exposure to DPM.

MSHA encourages mine operators to submit information in response to these provisions, including their current experiences with controlling miners' exposures to DPM.

In addition, under the terms of the settlement agreement, MSHA agreed to propose to change the existing DPM surrogate from total carbon to elemental carbon for both the interim DPM limit currently in effect and the final DPM limit that is applicable after January 19, 2006. In the Agency's Advance Notice of Proposed Rulemaking published on September 25, 2002 (67 FR 60199), MSHA notified the mining community that this rulemaking would revise both the interim concentration limit of 400 micrograms per cubic meter of air and the final concentration limit of 160 micrograms per cubic meter of air under § 57.5060 (a) and (b) of the existing standard. Some commenters to the ANPRM recommended that MSHA propose separate rulemakings for revising the interim and final DPM limits to give MSHA an opportunity to gather further information to establish a final DPM limit. The Agency agrees, and solicits information that would lead to an appropriate final DPM standard. The Agency will propose a separate rulemaking to amend the existing final concentration limit in the near future. With regard to the final DPM limit of 160 micrograms, MSHA requests comments on an appropriate final DPM limit.

DATES: All comments on the proposed rule, including post-hearing comments, must be received by October 14, 2003. The public hearing dates and locations are listed in the Public Hearings section under **SUPPLEMENTARY INFORMATION.** Individuals or organizations wishing to make oral presentations for the record should submit a request at least 5 days prior to the hearing dates.

ADDRESSES: Comments must be clearly identified as such and may be transmitted electronically to *comments@msha.gov,* by facsimile to (202) 693–9441, or by regular mail or hand delivery to MSHA, Office of Standards, Regulations, and Variances, 1100 Wilson Blvd., Room 2313, Arlington, Virginia 22209–3939. We intend to post comments on our website shortly after they are received.

Information Collection Requirements: Comments concerning information collection requirements must be clearly identified as such and sent to both MSHA and the Office of Management and Budget (OMB) as follows:

(1) Send information collection comments to MSHA at the addresses above.

(2) Send comments to OMB by regular mail addressed to the Office of Information and Regulatory Affairs, Office of Management and Budget, New Executive Office Building, 725 17th Street, NW., Washington, DC 20503, Attn: Desk Officer for MSHA.

FOR FURTHER INFORMATION CONTACT: Marvin W. Nichols, Jr., Director, Office of Standards, Regulations, and Variances, MSHA, 1100 Wilson Blvd., Room 2313, Arlington, Virginia 22209–3939, *Nichols-Marvin@msha.gov,* (202) 693–9440 (telephone), or (202) 693–9441 (facsimile).

You can access this proposed rule and the Preliminary Regulatory Economic Analysis (PREA) at *http://www.msha.gov.* You can obtain these documents in alternative formats, such as large print and electronic files, by contacting MSHA.

SUPPLEMENTARY INFORMATION:

I. Public Hearings

The public hearings will begin at 9 a.m. and will end after the last scheduled speaker testifies. The hearings will be held on the following dates at the locations indicated:

Date	Location	Telephone
September 16, 2003	University Park Marriott, 480 Wakara Way, Salt Lake City, UT 84108.	(801) 581–1000

Date	Location	Telephone
September 18, 2003	Renaissance St. Louis Hotel Airport, 9801 Natural Bridge Road, St. Louis, MO 63134.	(314) 429–1100
September 23, 2003	Hilton Pittsburgh, 600 Commonwealth Place, Pittsburgh, PA 15222.	(412) 391–4600

The hearings will begin with an opening statement from MSHA, followed by an opportunity for members of the public to make oral presentations. You do not have to make a written request to speak. Speakers will speak in the order that they sign in. Any unallotted time will be made available for persons making same-day requests. At the discretion of the presiding official, the time allocated to speakers for their presentation may be limited. Speakers and other attendees may also present information to the MSHA panel for inclusion in the rulemaking record.

The hearings will be conducted in an informal manner. The hearing panel may ask questions of speakers. Although formal rules of evidence or cross examination will not apply, the presiding official may exercise discretion to ensure the orderly progress of the hearing and may exclude irrelevant or unduly repetitious material and questions.

A verbatim transcript of the proceedings will be included in the rulemaking record. Copies of this transcript will be available to the public, and can be viewed at *http://www.msha.gov.*

MSHA will accept post-hearing written comments and other appropriate data for the record from any interested party, including those not presenting oral statements, prior to the close of the comment period on October 7, 2003.

II. Background

On January 19, 2001, MSHA published a final rule addressing diesel particulate matter exposure in underground metal and nonmetal mines (66 FR 5706, amended on February 27, 2002 at 67 FR 9180). The final rule established new health standards for underground metal and nonmetal mines that use equipment powered by diesel engines. The effective date of the rule was listed as March 20, 2001. On January 29, 2001, AngloGold (Jerritt Canyon) Corp. and Kennecott Greens Creek Mining Company filed a petition for review of the final rule in the District of Columbia Circuit Court of Appeals. On February 7, 2001, the Georgia Mining Association, the National Mining Association, the Salt Institute, and the Methane Awareness Resource Group (MARG) Diesel Coalition filed a similar petition in the Eleventh Circuit. On March 14, 2001, Getchell Gold Corporation petitioned for review of the rule in the District of Columbia Circuit. The three petitions were consolidated and are pending in the District of Columbia Circuit. The United Steelworkers of America (USWA) intervened in the litigation.

While these challenges were pending, the AngloGold petitioners filed with MSHA an application for reconsideration and amendment of the final rule and to postpone the effective date of the final rule pending judicial review. The Georgia Mining petitioners similarly filed with MSHA a request for an administrative stay or postponement of the effective date of the rule. On March 15, 2001, MSHA delayed the effective date of the rule until May 21, 2001, in accordance with a January 20, 2001 memorandum from the President's Chief of Staff (66 FR 15032). The delay was necessary to give Department of Labor officials the opportunity for further review and consideration of new regulations. On May 21, 2001 (66 FR 27863), MSHA published a notice in the **Federal Register** delaying the effective date of the final rule until July 5, 2001. The purpose of this delay was to allow the Department of Labor the opportunity to engage in further negotiations to settle the legal challenges to this rule.

First Partial Settlement Agreement

As a result of a partial settlement agreement with the litigants, MSHA published two documents in the **Federal Register** on July 5, 2001 addressing the January 19, 2001 DPM rule. One document (66 FR 35518) delayed the effective date of § 57.5066(b) regarding the tagging provision of the maintenance standard; clarified the effective dates of certain provisions of the final rule; and included correction amendments.

The second document (67 FR 35521) proposed a rule to clarify §§ 57.5066(b)(1) and (b)(2) regarding maintenance and to add a new subparagraph (b)(3) to § 57.5067 regarding the transfer of existing equipment between underground mines. MSHA published these changes as a final rule on February 27, 2002 (67 FR 9180), with an effective date of March 29, 2002.

Under the first partial settlement agreement, MSHA also conducted joint sampling with industry and labor at 31 underground metal and nonmetal mines to determine existing concentration levels of DPM; to assess the performance of the SKC submicron dust sampler with the NIOSH Method 5040; to assess the feasibility of achieving compliance with the standard's concentration limits at the 31 mines; and to assess the impact of interferences on samples collected in the metal and nonmetal underground mining environment before the limits established in the final rule become effective. The final report was issued on January 6, 2003.

Second Partial Settlement Agreement

Settlement negotiations continued on the remaining unresolved issues in the litigation. On July 15, 2002, the parties signed an agreement that is the basis for this proposed rule. On July 18, 2002, MSHA published a notice in the **Federal Register** (67 FR 47296) announcing that the following provisions of the January 19, 2001 rule would become effective on July 20, 2002:

(a) § 57.5060(a), addressing the interim concentration limit of 400 micrograms of total carbon per cubic meter of air;

(b) § 57.5061, compliance determinations; and

(c) § 57.5071, environmental monitoring.

The notice also announced that the following provisions of the rule would continue in effect:

(a) § 57.5065, Fueling practices;

(b) § 57.5066, Maintenance standards;

(c) § 57.5067, Engines;

(d) § 57.5070, Miner training; and

(e) § 57.5075, Diesel particulate records, as they relate to the requirements of the rule that are in effect on July 20, 2002.

The notice also stayed the effectiveness of the following provisions pending completion of rulemaking:

(a) § 57.5060(d), permitting miners to work in areas where the level of diesel particulate matter exceeds the applicable concentration limit with advance approval from the Secretary;

(b) § 57.5060(e), prohibiting the use of personal protective equipment to comply with the concentration limits;

(c) § 57.5060(f) prohibiting the use of administrative controls to comply with the concentration limits; and

(d) § 57.5062, DPM control plan.

Finally, the notice outlined the terms of the DPM settlement agreement and announced MSHA's intent to propose specific changes to the rule, as discussed below.

On September 25, 2002, MSHA published an Advance Notice of Proposed Rulemaking (67 FR 60199) to revise the DPM rule. The comment period closed on November 25, 2002. MSHA received comments from underground metal and nonmetal mine operators, trade associations, organized labor, individual mine operators, public interest groups and individuals. A number of commenters from industry and labor requested that MSHA propose the final DPM limit at a later date to allow MSHA to obtain more data. Commenters suggested that the Agency needs to determine the efficiency of different filtration devices, the relationship between elemental carbon and total carbon, and the feasibility of a DPM exposure limit.

This proposed rule would revise existing § 57.5060(a), addressing the interim concentration limit for DPM and the surrogate for measuring DPM limit; § 57.5060(c), addressing application and approval requirements for an extension of time in which to reduce the concentration of DPM; § 57.5060(d), addressing certain exceptions to the concentration limit; § 57.5060(e), prohibiting use of personal protective equipment to comply with the concentration limits; § 57.5060(f) prohibiting use of administrative controls to comply with the concentration limits, and § 57.5062, addressing the diesel particulate control plan. MSHA is also proposing conforming changes to existing § 57.5061, addressing compliance determinations; § 57.5071, addressing exposure monitoring; and § 57.5075, addressing recordkeeping requirements.

MSHA solicits comments on these provisions, as well as on experiences with controlling miners' exposures to DPM. MSHA also encourages commenters to submit additional evidence or new scientific data related to the health risk of DPM exposure in underground metal and nonmetal mines.

III. The Final PEL

MSHA intends to propose a revision to the final DPM limit in § 57.5060(b) that would reflect an appropriate permissible exposure limit rather than a concentration limit and would change the surrogate from total carbon to elemental carbon. Although the final limit is not a part of this proposed rule, MSHA solicits comments on an appropriate final DPM limit.

IV. Executive Summary of the 31-Mine Study

The following is the executive summary from ''MSHA's Report on Data Collected During a Joint MSHA/Industry Study of DPM Levels in Underground Metal And Nonmetal Mines'' (31-Mine Study) signed by MSHA on January 6, 2003. The Preliminary Regulatory Economic Analysis (PREA) for this proposed rule is not based on the 31-Mine Study.

On January 19, 2001, MSHA published a final standard on exposure of underground metal and nonmetal miners to diesel particulate matter (DPM). The rule was to become effective 60 days later, however, prior to the effective date, the rule was challenged by industry trade associations and mining companies. The United Steelworkers of America (USWA) also intervened in the litigation. In June 2001, agreement was reached on some of the issues in dispute. The parties further agreed to conduct a study involving joint in-mine DPM sampling to determine existing concentration levels of DPM in operating mines and to measure DPM levels in the presence of known or suspected interferences. The goals of the study were to use the sampling results and related information to assess:

—The validity, precision and feasibility of the sampling and analysis method specified by the diesel standard (NIOSH Method 5040);

—The magnitude of interferences that occur when conducting enforcement sampling for total carbon as a surrogate for diesel particulate matter (DPM) in mining environments; and

—The technological and economic feasibility of the underground metal and nonmetal (MNM) mine operators to achieve compliance with the interim and final DPM concentration limits.

The parties developed a joint MSHA/Industry study protocol to guide sampling and analysis of DPM levels in 31 mines. The parties also developed four subprotocols to guide investigations of the known or suspected interferences, which included mineral dust, drill oil mist, oil mist generated during ammonium nitrate/fuel oil (ANFO) loading operations, and environmental tobacco smoke (ETS). The parties also agreed to study other potential sampling problems, including any manufacturing defects of the DPM sampling cassette.

Major conclusions drawn from the study are as follows:

—The analytical method specified by the diesel standard gives an accurate measure of the TC content of a filter sample and the analytical method is appropriate for making compliance determinations of DPM exposures of underground metal and nonmetal miners.

—SKC satisfactorily addressed concerns over defects in the DPM sampling cassettes and availability of cassettes to both MSHA and mine operators.

—Compliance with both the interim and final concentration limits may be both technologically and economically feasible for metal and nonmetal underground mines in the study. MSHA, however, has limited in-mine documentation on DPM control technology. As a result, MSHA's position on feasibility does not reflect consideration of current complications with respect to implementation of controls, such as retrofitting and regeneration of filters. MSHA acknowledges that these issues may influence the extent to which controls are feasible. The Agency is continuing to consult with the National Institute of Occupational Safety and Health, industry and labor representatives on the availability of practical mine worthy filter technology.

—The submicron impactor was effective in removing the mineral dust, and therefore its potential interference, from DPM samples. Remaining interference from carbonate interference is removed by subtracting the 4th organic peak from the analysis. No reasonable method of sampling was found to eliminate interferences from oil mist or that would effectively measure DPM levels in the presence of ETS with TC as the surrogate. Results and findings of the study are summarized below.

Sampling at 31 Mines

There are a number of methods that can measure DPM concentrations with reasonable accuracy when it is at high concentrations and the purpose is exposure assessment. These methods do not at this time provide the accuracy required to support compliance determinations at the concentration levels required to be achieved under the DPM rule. The NIOSH Method 5040 provides an accurate method of determining the total carbon content of a sample collected in any underground metal or nonmetal mine when the submicron impactor is used. MSHA's January 2001 regulation requires using total carbon (TC) as a surrogate for DPM because a consistent quantitative relationship has been established between total carbon concentrations and the concentration of DPM as a whole. TC concentrations measured during the study ranged from 13 to 2065 μ/m^3, with a mean of 345 μ/m^3. To put these sampling results into context, the interim concentration limit specified in the final rule, effective after July 19, 2002, is 400 micrograms of TC per cubic meter of air (μ/m^3). The final concentration limit is 160 micrograms of TC per cubic meter of air (μ/m^3), effective after January 19, 2006.

TC concentrations at the non-trona mines were four to five times higher than at the trona mines. TC concentrations measured using area samples were found to be 38 to 62 percent of the levels found using occupational or personal samples.

Interferences

The submicron impactor removes 94% of the mineral dust from DPM samples. Remaining carbonate interference, if any, is removed by subtracting the 4th organic peak from the analysis. For typical gold mine samples, the interference from elemental carbon (graphite) would be less than 1.5 μ/m³. The use of the impactor also eliminates the need to acidify samples, including samples from trona mines. For typical non-acidified trona mine samples, the interference from bicarbonate would be less than 0.5 μ/m³. Overload of particulate matter on the impactor substrate to the filter was not observed.

Interference from drill oil mist was found on personal samples collected on the drillers and on area samples collected in the stope where drilling was being performed. Use of a dynamic blank did not eliminate drill oil mist interference. Tests to confirm whether oil mist from ANFO loading operations could be interference were not conclusive. Blasting did not interfere with diesel particulate measurements. MSHA found no reasonable method of sampling to eliminate interferences from oil mist when TC is used as the surrogate.

No reliable marker was identified for confirming the presence of ETS in an atmosphere containing DPM. Use of the impactor does not remove the ETS as an interferent. No reasonable method of sampling was found that would effectively measure DPM levels in the presence of ETS with TC as the surrogate.

Laboratory Analytical Procedures and Sampling Cassettes

Intra- and inter-laboratory analytical imprecision appear to be in line with other airborne contaminants monitored by MSHA and other regulatory agencies. Each of the samples collected in the study was analyzed twice for TC content. To do this, two standard punches were taken from each exposed and each unexposed (*i.e.*, control) filter. One punch was always analyzed using the same instrument in MSHA's laboratory. The second punch from the same filter was either analyzed in MSHA's laboratory using one of two different instruments or sent out to one of three other laboratories, NIOSH, Natlsco or Clayton.

The supplier has satisfactorily addressed concerns over possible manufacturing defects in the specialized SKC DPM sampling cassette. MSHA believes that the performance of this cassette will be adequate for compliance sampling purposes.

Technological Feasibility

Technological feasibility for mine operators to achieve compliance with the interim and final DPM concentration limits was assessed for the 31 mines in the study on a mine-by-mine basis using a computerized Microsoft® 7 Excel spreadsheet program called the Estimator, combined with sampling results from the 31 mines. The Estimator mathematically calculates the effect of any combination of engineering and ventilation controls on existing DPM concentrations in a given production area of a mine. The analyses were based on the highest DPM sample result obtained at each mine and all major DPM emission sources at each mine plus spare equipment.

MSHA, however, has limited in-mine documentation on DPM control technology. Moreover, these sampling results were obtained at a time that few mine operators had implemented controls to reduce DPM concentrations at the subject mines. As a result, MSHA's position on feasibility does not reflect consideration of current complications with respect to implementation of controls, such as retrofitting and regeneration of filters. MSHA acknowledges that these issues may influence the extent to which controls are feasible. The Agency is continuing to consult with the National Institute of Occupational Safety and Health, industry and labor representatives on the availability of practical mine worthy filter technology.

The study found that five mines were already in compliance with the interim concentration limit, and another two mines were already in compliance with the lower, final concentration limit. The Estimator predicted that eleven of the 31 mines could achieve compliance with both limits through installation of DPM filters alone. Ventilation upgrades were specified for only 5 of the 31 mines in this study, and then only to achieve the final concentration limit.

The Estimator predicted that compliance with the interim and final concentration limits would be possible without requiring major ventilation installations (new main fan, repowering main fan, etc.) or requiring environmental cabs as a means of controlling DPM at any of the 31 mines. Industry commenters questioned whether practical mine-worthy filters were available for all engine sizes and whether more expensive controls would be necessary.

Economic Feasibility

Yearly costs for complying with both the interim and final concentration limits were determined for each of the 31 mines in the study. Cost estimates included the purchase cost of DPM controls specified for that mine in the technological feasibility assessment, plus related installation and operating costs. The aggregate yearly cost for all 31 mines to comply with the interim limit was estimated to be $2.1 million. Compliance with the final limit was estimated to cost an additional $1.1 million (in 2002 dollars). The yearly total to comply with both the interim and final concentration limits was estimated to be $3.2 million. The estimated costs in this report are based on the accuracy of the Estimator as reported in Appendix A, and therefore, do not include consideration of current implementation complications that could increase compliance costs.

MSHA concludes that a regulation is economically infeasible if it would threaten an industry's viability or competitive structure. In rulemaking, economic feasibility, as well as technological feasibility, is not defined for individual firms, but for an industry. As a screening device, MSHA has historically questioned economic feasibility if yearly compliance costs equal or exceed one percent of an industry's annual revenues.

MSHA developed a rough estimate of annual mine revenues using each mine's annual employee work hours and the production value per employee hour for the commodity produced. Summing the individual revenue figures resulted in an estimate of total revenues for the 31 mines in the study of $1.8 billion in 2000.

On this basis, MSHA estimates that the 31 mines in the study would incur yearly costs equal to 0.12 percent of their annual revenues to comply with the interim concentration limit and additional yearly costs equal to 0.06 percent of their annual revenues to comply with the final concentration limit. To comply with both the interim and final concentration limits, the 31 mines would incur yearly costs equal to 0.18 percent of their annual revenues. Since estimated yearly compliance costs are less than the screening benchmark of one percent or more of annual revenues, the data in this report supports a finding that the interim and final concentration limits are economically feasible. Industry questions whether all costs for active filter regeneration were considered and whether the proper controls (that is, filters) were used in the cost analysis. In particular, industry questions whether compliance with the interim concentration limit would require some mine operators to make major ventilation upgrades in their mines.

V. Compliance Assistance

A. Baseline Sampling Summary

Under the DPM Settlement Agreement, MSHA agreed to provide compliance assistance to the metal and nonmetal underground mining industry for a one-year period from July 20, 2002 through July 19, 2003. As part of MSHA's compliance assistance activities, the Agency conducted baseline sampling of miners' personal exposures at every underground mine covered by the existing regulation. The results of this sampling were used by MSHA in this preamble to estimate current DPM exposure levels in these mines. These sampling results also assist mine operators in developing compliance strategies based on actual exposure levels. This compliance assistance sampling began in October 2002.

This section summarizes the analytical results of 885 personal DPM samples collected from 171 mines between October 30, 2002 and March 26, 2003 as part of a compliance assistance initiative. Eleven of the 885 samples were invalid samples due to abnormal sample deposits, broken cassettes or filters, contaminated backup pads, or instrument or pump failure. Table V–1 lists the frequencies of invalid samples within each commodity.

The mines that were sampled produce clay, sand, gypsum, copper, gold, platinum, silver, gem stones, dimension marble, granite, lead-zinc, limestone, lime, potash, molybdenum, salt, trona, and other miscellaneous metal ores. These commodities were grouped into four general categories for calculating summary statistics: metal, stone, trona, and other nonmetal (N/M) mines. These categories were selected to be consistent with the categories used for analysis of data for the 31-Mine Study. Most commodities are well represented in this analysis (average of 5.1 samples per mine). Some of these mines, such as the gold mines, have an average of only 2.0 samples per mine. MSHA is conducting additional compliance assistance sampling at these mines, however, the results are not available for inclusion in this analysis. Table V–2 lists the number of samples for each category of commodity.

MSHA used the same sampling strategies for collecting baseline samples as it intends to use for collecting samples for enforcement purposes. These sampling procedures are described in the *Metal and Nonmetal Health Inspection Procedures Handbook (PH90-IV–4),* Chapter A, ''Compliance Sampling Procedures'' and Draft Chapter T, ''Diesel Particulate Matter Sampling.'' Chapter A includes detailed guidelines for selecting and obtaining personal samples for various contaminants. All personal samples were collected for the miner's full-shift regardless of the number of hours worked, and in the miner's breathing zone. For the 874 valid personal samples, 83% were collected for at least eight hours. Total and elemental carbon levels, as well as DPM levels, are reported in units of micrograms per cubic meter for an 8-hour full shift equivalent.

The equation used to calculate a 480-minute (8-hour) full shift equivalent (FSE) exposure of total carbon is Total Carbon Concentration =

$$\frac{[\mathrm{EC} \times 1.3] \text{ or } [\mathrm{OC} + \mathrm{EC}] \left(\mu\mathrm{g/cm}^2\right) \times \mathrm{A}\left(\mathrm{cm}^2\right) \times 1{,}000 \left(\mathrm{L/m}^3\right)}{\text{Flow Rate (Lpm)} \times 480 \text{ (minutes)}}$$

Where:

EC = The corrected elemental carbon concentration measured in the thermal/optical carbon analyzer
OC = The corrected organic carbon concentration measured in the thermal/optical carbon analyzer
A = The surface area of the deposit on the filter media used to collect the sample
Flow Rate = Flow rate of the air pump used to collect the sample measured in Liters per minute
480 minutes = Standardized eight-hour workshift

All levels of carbon or DPM are reported in 8-hour full shift equivalent (FSE) total carbon concentrations measured in μg/m³.

Because personal sampling was conducted and no attempt was made to avoid interference from cigarette smoke or other organic carbon sources, total carbon was also calculated using the formula prescribed in the DPM settlement agreement:

Total Carbon Concentration = EC × 1.3.

MSHA agreed to use the lower of the two values (EC × 1.3 or EC + OC) for enforcement until a final rule is published reflecting EC as the surrogate.

MSHA collected DPM samples with SKC submicron dust samplers that use Dorr-Oliver cyclones and submicron impactors. The samples were analyzed either at MSHA's Pittsburgh Safety and Health Technology Center, Dust Division Laboratory or at the Clayton Laboratory using MSHA Method P–13 (NIOSH Analytical Method 5040, *NIOSH Manual of Analytical Methods (NMAM), Fourth Edition,* September 30, 1999) for determining the total carbon content. Each sample was analyzed for organic, elemental, and carbonaceous carbon and calculated total carbon. Raw analytical results from both laboratories as well as administrative information about the sample are stored electronically in MSHA's Laboratory Information Management System.

If a raw carbon result was greater than or equal to 30 μg/cm² of EC or 40 μg/cm² of TC from the exposed filter loading, then the analysis was repeated using a separate punch of the same filter. The results of these two analyses were then averaged. The companion dynamic blank was also tested for the same analytes. Otherwise, an unexposed filter from the same manufacturer's lot was used to correct for background levels. In the event the initial total carbon result was greater than 100_{EC} μg/cm², a smaller punch of the same exposed filter (in duplicate and corresponding blank) was taken and used in the analysis. Blank-corrected averaged results were used in the analysis when the sample was tested in duplicate.

Generally the lowest reporting limit is 3_{TC} μg/cm². However, for this analysis, MSHA used all results below this limit. Due to variations in the analytical method, three samples have blank corrected elemental carbon results slightly below 0_{EC} μg/m³. This occurred because the corresponding blank filters have TC results slightly more than the exposed filter. Median values are not affected by the distribution of data and MSHA included them where appropriate.

The electronic records of the 885 samples that were available for analysis were reviewed for inconsistencies. Internally inconsistent or extreme values were questioned, researched, and verified. Although no samples were invalidated as a result of the administrative verification, eleven samples (1.2%) were removed from the data set for reasons unrelated to the values obtained. The reasons for invalidating these samples are listed in Table V–1. Accordingly, MSHA has included 874 samples from miners in the analyses. Table V–2 is a list of the number of valid samples by commodity.

TABLE V–1.—REASONS FOR EXCLUDING SAMPLES

Reason for excluding from analysis	Metal	Stone	Trona	Other N/M	Total
Abnormal Sample Deposit	0	1	0	0	1
Cassette/Filter Broken	0	2	0	1	3
Contaminated Backup Pad	1	0	0	0	1
Instrument Failure	1	1	0	0	2
Pump Failed	1	3	0	0	4
Total	3	7	0	1	11

TABLE V–2.—NUMBER OF MINES AND VALID SAMPLES, BY COMMODITY

Commodity	Number of mines	Number of valid samples	Average number of valid samples by mine
Metal	36	189	5.3
Stone	109	519	4.8
Trona	3	15	5.0
Other N/M	23	151	6.6
Total	171	874	5.1

Table V–3 lists the number of samples collected by specific commodities at the time the data set was compiled (March 26, 2003) and sorted by the average number of samples per mine. Although MSHA made efforts to sample all underground metal and nonmetal mines covered by this rulemaking within the specified time frame, several mines have few or no samples for DPM in this analysis. Some metal and nonmetal mining operations are seasonal in that they are operated intermittently or operate at less than full production during certain times. These types of variable production schedules limited efforts to collect compliance assistance samples. MSHA continued to collect baseline samples during the compliance assistance period, especially at those mines with a low sampling frequency or where no samples were collected as of March 26, 2003. Future analyses will incorporate all subsequent valid samples.

TABLE V–3.—NUMBER OF VALID SAMPLES PER MINE FOR SPECIFIC MINES

Specific commodity	Number of mines	Number of samples	Average samples per mine
GEMSTONES MINING, N.E.C.	1	2	2.0
GOLD ORE MINING, N.E.C.	17	34	2.0
DIMENSION MARBLE MINING	3	9	3.0
LIMESTONE	2	6	3.0
TALC MINING	1	3	3.0
CRUSHED & BROKEN MARBLE MINING	4	16	4.0
GYPSUM MINING	2	8	4.0
CRUSHED & BROKEN STONE MINING, N.E.C.	5	23	4.6
CRUSHED & BROKEN LIMESTONE MINING, N.E.C.	85	413	4.9
CLAY, CERAMIC & REFRACTORY MINERALS MINING, N.E.C.	1	5	5.0
CONSTRUCTION SAND & GRAVEL MINING, N.E.C.	1	5	5.0
COPPER ORE MINING, N.E.C.	1	5	5.0
CRUSHED & BROKEN SANDSTONE MINING	1	5	5.0
HYDRAULIC CEMENT	1	5	5.0
LIME, N.E.C.	4	20	5.0
TRONA MINING	3	15	5.0
DIMENSION LIMESTONE MINING	4	22	5.5
LEAD-ZINC ORE MINING, N.E.C.	10	70	7.0
SALT MINING	14	98	7.0
MISCELLANEOUS METAL ORE MINING, N.E.C.	1	9	9.0
MOLYBDENUM ORE MINING	2	19	9.5
PLATINUM GROUP ORE MINING	2	20	10.0
POTASH MINING	3	30	10.0
SILVER ORE MINING, N.E.C.	3	32	10.7
AVERAGE OF ALL SAMPLES	171	874	5.1

There are 63 different occupations in underground metal and nonmetal mines represented in this analysis. The most frequently sampled occupations are Blaster, Drill Operator, Front-end Loader Operator, Truck Driver, Scaling (Mechanical), and Mechanic. Table V–4 lists the number of valid samples by occupation and commodity. Only occupations with 14 or more samples are listed. Occupations with fewer samples were aggregated for this table.

TABLE V–4.—VALID SAMPLES, BY OCCUPATION AND MINE CATEGORY

Occupation	Metal	Stone	Trona	Other N/M	Total
Truck Driver	55	121	0	7	183
Front-end Loader Operator	23	115	4	13	155
Blaster, Powder Gang	9	72	0	19	100
Scaling (mechanical)	1	53	0	9	63
Drill Operator, Rotary	0	53	0	5	58
Mechanic	6	10	0	10	26

TABLE V–4.—VALID SAMPLES, BY OCCUPATION AND MINE CATEGORY—Continued

Occupation	Metal	Stone	Trona	Other N/M	Total
Drill Operator, Jumbo Perc.	4	9	0	8	21
Mucking Mach. Operator	15	0	0	3	18
Utility Man	5	3	8	2	18
Scaling (hand)	3	12	0	2	17
Complete Load-Haul-Dump	1	0	0	16	17
Roof Bolter, Rock	3	6	0	5	14
Drill Operator, Rotary Air	1	12	0	1	14
Crusher Oper/Worker	0	12	0	2	14
All Others Combined	63	41	3	49	156
Totals	189	519	15	151	874

TC levels calculated by EC × 1.3 were lower than TC levels calculated by OC + EC in 663 (76%) of the 874 baseline samples. Of the 211 samples where TC = OC + EC was the lower value, 64% of the TC = EC × 1.3 values were within 12% of the TC = OC + EC value. Table V–5 summarizes the results of the baseline samples when determining the TC level using either EC × 1.3 or OC + EC. Approximately 6.3% of results did not concur when measuring TC by the two calculations. Approximately 15.7% of the samples were above the 400_{TC} µg/m³ interim concentration limit when using TC = EC × 1.3 and approximately 19.5% were above the concentration limit when using TC = OC + EC. There is 93.7% concurrence between the two methods of calculating TC and comparing the calculations to the 400_{TC} µg/m³ interim concentration limit.

TABLE V–5.—COMPARISON OF RESULTS WITH 400_{TC} µg/m³ CALCULATING TC BY OC + EC OR EC × 1.3

All Valid Samples—OC + EC > 400 µg/m³	EC × 1.3 > 400 µg/m³		Total
	No	Yes	
No	693 (79.3%)	11 (1.3%)	704 (80.5%)
Yes	44 (5.0%)	126 (14.4%)	170 (19.5%)
Total	737 (84.3%)	137 (15.7%)	874 (100.0%)

Table V–6 lists the 19 occupations found to have at least one sample in which the level of TC was over the interim 400_{TC} µg/m³ concentration limit (TC = EC × 1.3). Table V–6 is sorted by the median TC result. The table also lists the minimum value, median value, and the total number of valid samples for these occupations. TC values varied widely among all miners' occupations.

TABLE V–6.—OCCUPATIONS WITH AT LEAST ONE SAMPLE GREATER THAN OR EQUAL TO 400_{TC} µg/m³

Occupation	Total samples	Minimum	Median	Maximum
Engineer	1	438	438	438
Roof Bolter, Mounted	8	98	335	588
Miner, Stope	11	165	330	622
Clean Up Man	2	66	283	499
Mucking Machine Operator	18	15	278	872
Shuttle Car, Diesel	2	95	257	419
Drill Operator, Rotary Air	14	56	231	1145
Belt Crew	8	26	225	502
Blaster, Powder Gang	101	6	216	960
Drill Operator, Jumbo	21	41	194	708
Complete Load-Haul-Dump	17	42	188	824
Miner, Drift	14	16	185	1459
Scaling (Hand)	17	18	166	2014
Roof Bolter, Rock	14	63	157	829
Truck Driver	184	0	155	1074
Front End Loader	155	0	136	1743
Drill Operator, Rotary	58	3	133	1109
Scaling (Mechanical)	63	0	131	750
Utility Man	18	29	93	638
Supervisor	10	1	87	856
Crusher Operator	14	1	47	427

Table V–7 and Chart V–1 provide the frequencies and percent of overexposures among the four commodities. Chart V–2 provides the frequency of overexposures among the commodities. The metal mines have the highest percent of overexposures followed by stone than other N/M mines. All 15 samples collected in trona mines were less than 200_{TC} µg/m³. For all samples combined, 15.7% were above 400_{TC} µg/m³.

TABLE V–7.—BASELINE SAMPLES BY COMMODITY (TC=EC × 1.3)

Commodity	Number <400 µg/m³ TC	Number >400 µg/m³ TC	Total	Percent >400 µg/m³ TC
Metal	148	41	189	21.7
Stone	435	84	519	16.2
Other N/M	139	12	151	7.9
Trona	15	0	15	0.0
All Mines	737	137	874	15.7

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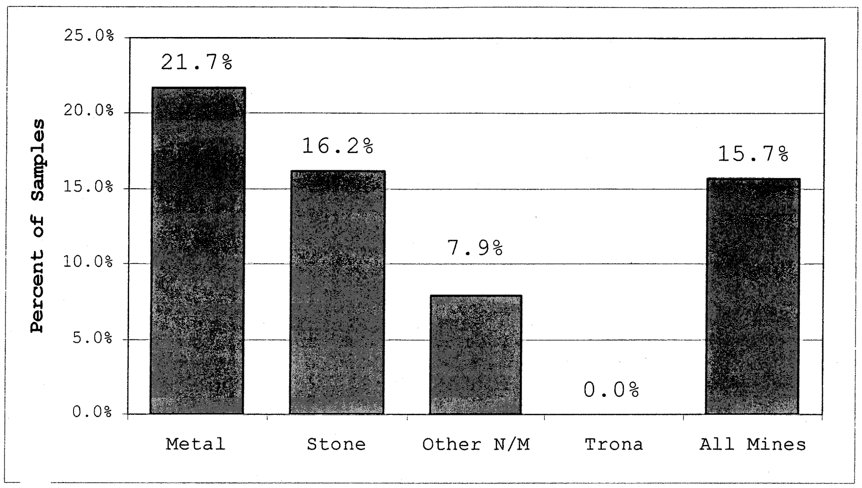

Chart V-1: Percent of Overexposures by Commodity (400_{TC} µg/m³, TC=EC x 1.3)

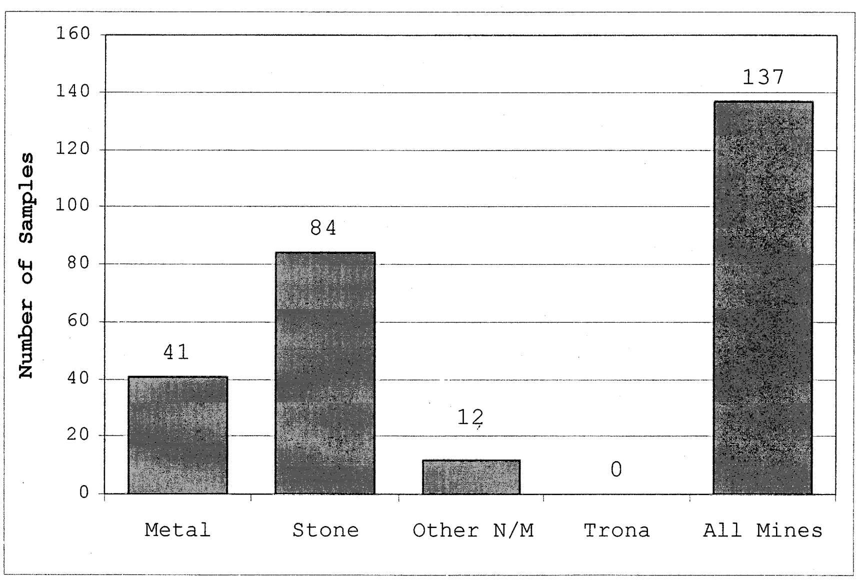

Chart V-2: Frequency of Overexposures by Commodity (400_{TC} µg/m³, TC=EC x 1.3)

Chart V–3 shows the number of mines with a specific number of overexposures. Examination of the frequency of mines with one or more overexposures shows that 51 (29.8%) mines are in this category.

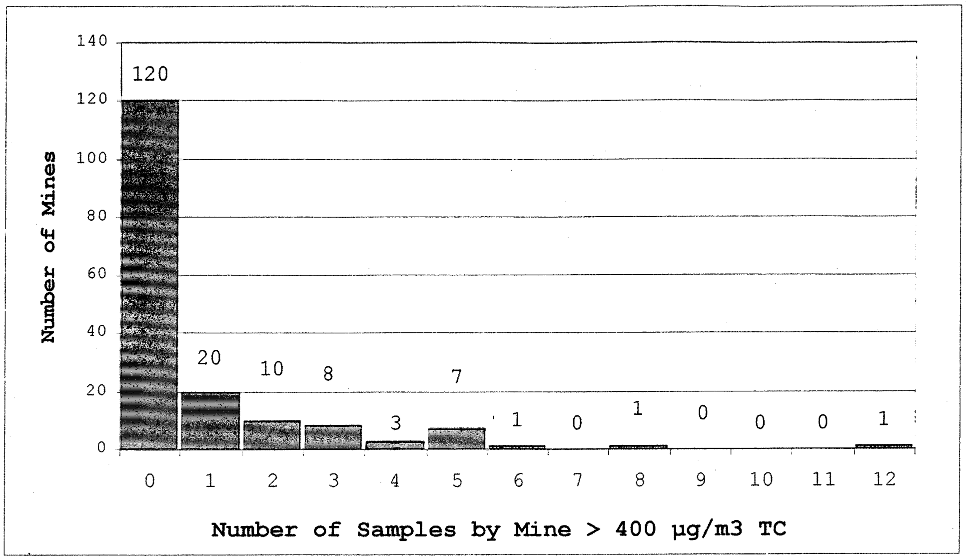

Chart V-3: Number of Mines by the Amount of Overexposures Samples for that Mine (TC=EC x 1.3)

At 14 of the mines, all the samples were above 400_{TC} µg/m³. Between one and five samples were taken at each of these mines. No overexposures were found in 120 (70%) of the mines sampled. (*See* Chart V–4.)

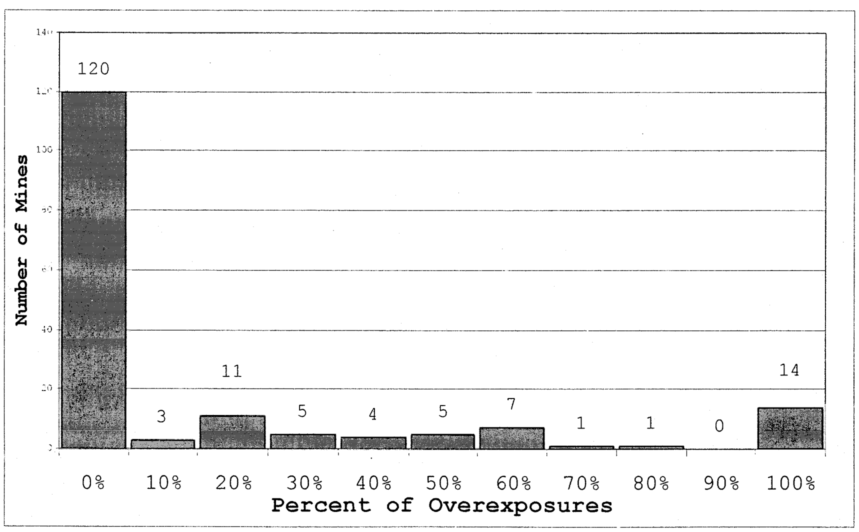

Chart V-4: Number of Mines by Percentage of Overexposures for that Mine

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Tables V–8 and V–9 summarize sample statistics by commodity for total carbon calculated by TC = EC × 1.3 and TC = EC + OC respectively. Overall, the mean TC as calculated by EC × 1.3 is 222 µg/m³. The median level is 153 µg/m³. The mean TC level by OC + EC is 263 µg/m³ and the median level is 209 µg/m³. Individual exposure levels of TC vary widely within all commodities and most mines. The statistics reported in Tables V–8 and V–9 were chosen to be consistent with those reported in the 31-Mine Study and the Exposure Assessment.

The mean TC values (EC × 1.3) are somewhat lower than the interim compliance limit of 400 µg/m³. The mean (median) TC value for metal mines is 296(239) µg/m³. The mean for stone is 214(136), other N/M is 170(129) and for trona mines is 90(91) µg/m³. Table V–8 lists additional statistics for EC values compiled by commodity.

TABLE V–8.—AVERAGE LEVELS OF TOTAL CARBON BY COMMODITY MEASURED IN μg/m³ (EC × 1.3)

[Estimated 8-hour Full Shift Equivalent TC Concentration (μg/m³)]

EC × 1.3	Metal	Stone	Other N/M	Trona	All mines
Number of Samples	189	519	151	15	874
Maximum	2,014	1,743	824	194	2,014
Median	239	136	129	91	153
Mean	296	214	170	90	222
Std. Error	19	10	11	13	8
95% CI Upper	333	233	191	119	236
95% CI Lower	258	195	148	62	207

The mean TC values as calculated by OC + EC are also somewhat lower than the interim compliance limit of 400 μg/m³. The mean (median) TC value for metal mines is 323(285) μg/m³. The mean for stone is 263(200), other N/M is 202(168) and for trona mines is 128(126) μg/m³. Table V–9 lists additional statistics for TC values compiled by commodity.

TABLE V–9.—AVERAGE LEVELS OF TOTAL CARBON BY COMMODITY MEASURED IN μg/m³ (OC + EC)

[Estimated 8-hour Full Shift Equivalent TC Concentration (μg/m³)]

OC + EC	Metal	Stone	Other N/M	Trona	All mines
Number of Samples	189	519	151	15	874
Maximum	1,742	1,559	740	218	1,742
Median	285	200	168	126	209
Mean	323	263	202	128	263
Std. Error	17	11	11	12	8
95% CI Upper	356	284	223	154	278
95% CI Lower	289	243	181	102	248

Tables V–10 and V–11 show total DPM exposures for the baseline and the 31-Mine Study. For baseline sampling DPM was calculated by EC × 1.3 × 1.25. The 1.25 factor represents the assumption that TC comprises 80 percent of DPM. Section VI–B–3 discusses the relationship between elemental and total carbon. The mean (median) value is 369(299) μg/m³ for metal mines, 267(170) for stone mines, 212(162) for other NM, and 113(113) μg/m³ for trona mines. The total DPM exposures for table V–11 were calculated as (OC + EC) × 1.25. The mean values from the baseline samples appear to be lower than the mean values obtained during the 31-Mine Study.

TABLE V–10.—BASELINE DPM CONCENTRATIONS (EC × 1.3 × 1.25, μg/m³), BY MINE CATEGORY

	Metal	Stone	Other N/M	Trona	All mines
Number of Samples	189	519	151	15	874
Maximum	2518	2178	1030	242	2518
Median	299	170	162	113	191
Mean	369	267	212	113	277
Std. Error	24	12	14	17	9
95% UCL	416	291	239	149	296
95% LCL	323	243	185	77	259

TABLE V–11.—BASELINE DPM CONCENTRATIONS ((EC + OC) × 1.25, μg/m³), BY MINE CATEGORY

	Metal	Stone	Other N/M	Trona	All mines
Number of Samples	189	519	151	15	874
Maximum	2177	1949	925	273	2177
Median	357	250	211	158	261
Mean	403	329	252	160	329
Std. Error	21	13	13	15	10
95% CI Upper	445	355	279	193	348
95% CI Lower	361	303	226	127	310

TABLE V–12.—31-MINE STUDY DPM CONCENTRATIONS (µg/m 3), BY MINE CATEGORY

	Metal	Stone	Other N/M	Trona
Number of Samples	116	105	83	54
Maximum	2581	1845	1210	331
Median	491	331	341	82
Mean	610	466	359	94
Std. Error	45	36	27	9
95% CI Upper	699	537	412	113
95% CI Lower	522	394	306	75

Chart V–5 compares the means from Tables V–10, V–11 and V–12. The mines selected in the 31-Mine Study (Table V–12) were not randomly selected and is therefore not considered representative of the underground M/NM mining industry. Additionally the industry has continued to change the diesel-powered fleet to low emission engines that reduce diesel particulate matter exposure. Workers inside equipment cabs were not sampled during the 31-Mine Study due to possible interference from cigarette smoke. Personal samples taken inside cabs were not avoided during baseline compliance assistance sampling.

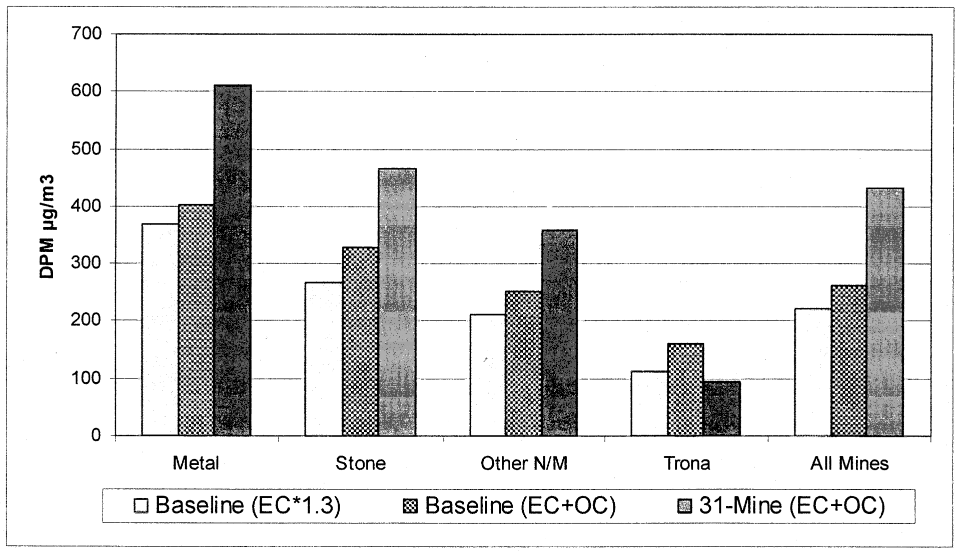

Chart V-5. Comparison of Mean DPM Levels from Baseline Sampling and the 31-Mine Study

B. DPM Control Technology

In addition to conducting baseline DPM sampling at underground metal and nonmetal mines, MSHA participated in a number of compliance assistance activities directed at improving sampling and assisting mine operators with selection and implementation of appropriate DPM control technology. Some of these activities were directed to a segment of, or the entire mining industry. Others were conducted on a mine specific basis. In general, those activities directed toward a large number of mines included outreach programs, workshops, Web site postings and publications. Those activities directed at an individual mine included evaluation of a specific control technology, a review of the technology in use, or that would be available at a specific mine.

Regional DPM Seminars. During September and October 2002, MSHA conducted regional DPM seminars at Ebensburg, PA, Knoxville, TN, Lexington, KY, Des Moines, IA, Kansas City, MO, Albuquerque, NM, Coeur d'Alene, ID, Green River, WY, and Elko, NV. These full-day seminars were offered free of charge in the major underground metal and nonmetal mining regions of the country to facilitate attendance by key mining industry personnel. The seminars covered the health effects of DPM exposure, the history and specific provisions of the regulation, DPM controls, DPM sampling, and the DPM Estimator, which is an interactive computer spreadsheet program used for analyzing a mine's DPM sources and controls.

NIOSH Diesel Emission Workshops. MSHA staff participated in two NIOSH Diesel Emissions and Control Technologies in Underground Metal and Nonmetal Mines in February and March 2003 in Cincinnati, OH and Salt Lake City, UT. These workshops provided technical presentations and a forum for discussing issues relating to control technologies for reducing miners' exposure to particulate matter and gaseous emissions from the exhaust of diesel-powered vehicles in underground mines, and to help mine managers, maintenance personnel, safety and health professionals, and ventilation engineers select and apply diesel particulate filters and other control technologies in their mines. Speakers represented MSHA, NIOSH, and several mining companies, and ample time was provided for questions and in-depth technical discussion of issues raised by attendees.

NSSGA DPM Sampling Workshop: As part of the Kentucky Stone Association Seminar, MSHA staff conducted a diesel particulate sampling workshop in Louisville, Kentucky from December 11 through 13, 2002. The three day seminar was hosted by the National Stone Sand and Gravel Association. On the first day of the seminar, diesel particulate sampling procedures were reviewed. The participants were trained in pump calibration, sample train assembly and note taking. On the second, participants traveled to the Rogers Group Jefferson County Mine and conducted full shift sampling on underground workers. MSHA technical support staff took ventilation measurements and collected area samples to assess mine DPM emissions. On the final day of the seminar, engine emission and ventilation measurements were reviewed with the participants. Additionally, the MSHA DPM outreach material was reviewed and discussed. Approximately 10 industry participants attended the seminar.

Nevada Mining Association Safety Committee. MSHA staff attended a meeting of the Nevada Mining Association Safety Committee in Elko, NV in April 2003 to discuss DPM control technologies. Discussion topics included bio-diesel fuel blends, various fuel additives and fuel pre-treatment devices, to mine ventilation, environmental cabs, clean engines, and diesel particulate filter systems. The mining companies' experiences with and perspectives on these technologies were discussed, along with MSHA's experiences, observations made at various mines, and results of laboratory and field testing.

MSHA South Central Joint Mine Safety and Health Conference. A DPM workshop was presented at this conference in April 2003 in New Orleans, LA. This workshop included a detailed history and explanation of the provisions of the MNM DPM regulation, and a technical presentation on feasible DPM engineering controls.

2003 Joint National Meeting of the Joseph A. Holmes Safety Association, National Association of State Mine Inspection and Training Agencies, Mine Safety Institute of America, and Western TRAM (Training Resources Applied to Mining). A DPM workshop was presented at this joint conference in June 2003 in Reno, NV. This workshop included a detailed history and explanation of the provisions of the MNM DPM regulation, and a technical presentation on DPM sampling, analytical tools for identifying and evaluating DPM sources in mines, and feasible DPM engineering controls.

Web site postings. MSHA created a single source page for DPM final rules for Metal/Nonmetal Mines on its Web site, *www.msha.gov*. Links were established to obtain information on specific topics, including:

—DRAFT Metal and Nonmetal Health Inspection Procedures Handbook, Chapter T—Diesel Particulate Matter Sampling

—DRAFT Diesel Particulate Matter Sampling Field Notes

—Metal and Nonmetal Diesel Particulate Matter (DPM) Standard Error Factor for TC Analysis Written Compliance Strategy

—Metal and Nonmetal Diesel Particulate Matter (DPM) Standard Draft Compliance Guide

—Other Resources

—NIOSH Listserve

—Diesel Emissions and Control Technologies in Underground Metal and Nonmetal Mines

—Metal and Nonmetal Diesel Particulate Filter Selection Guide

—Baseline DPM Sample Results

—PowerPoint Presentations

—From Compliance Assistance Workshops on Diesel Rule

—Summary of Requirements Mine Safety and Health Administration's (MSHA's) Standard on Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners that are in effect as of July 20, 2002.

—SKC Diesel Particulate Matter Cassette with Precision-jeweled Impactor

—Diesel Particulate Matter (DPM) Control Technologies with Percent Removal Efficiency

—Diesel Particulate Matter (DPM) Control Technologies

—Table I: Non-Catalyzed Particulate Filters, Base Metal Particulate Filters, and Paper Filters

—Table II: Catalyzed (Platinum Based) Diesel Particulate Filters

—Work Place Emissions Control Estimator

—Advanced Notice of Proposed Rule Making (ANPRM)

—Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners (ANPRM)—09/25/2002

—Final Rules

—Part II—30 CFR Part 57—Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners—01/19/2001

—Part II—30 CFR Part 57—Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners—Delay of Effective Dates—05/21/2001

—Part II—30 CFR Part 57—Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners—Final Rule and Proposed Rule—07/05/2001

—Part II—30 CFR Part 57—Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners; Final Rule—02/27/2002

—Part II—30 CFR Part 57—Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners; Final Rule—07/18/2002

—Regulatory Economic Analysis

—Final Regulatory Economic Analysis And Regulatory Flexibility Analysis for Final Rule on 30 CFR Parts 57 Final Standards and Regulations—Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners

—News Releases

—MSHA Rules Will Control Miners' Exposure to Diesel Particulate—01/18/2001

—Program Information Bulletins

—PIB01–10 Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners—08/28/2001

—PIB02–04 Potential Health Hazard Caused by Platinum-Based Catalyzed Diesel Particulate Matter Exhaust Filters—05/31/2002—

—PIB02–08 Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners-Summary of Settlement Agreement—08/12/2002

In addition to the Web site postings specifically intended for the metal and nonmetal mining industry, MSHA has created a Diesel Single Source Page for the coal industry. A list of approved engines is accessible from the coal page. Many of the other topics found on that page may also be of interest to the metal and nonmetal mining industry, particularly for those operations at gassy metal/nonmetal mines where permissible equipment is required.

Publications: As part of the settlement agreement, MSHA agreed to issue citations for violations of the interim concentration limit only after MSHA and NIOSH are satisfied with the performance characteristics of the SKC sampler. During the 31-Mine study, MSHA observed that the deposit area of the SKC submicron impactor filter was not as consistent as those obtained for preliminary evaluation. This was attributed to inconsistent crimping of the aluminum foil cone on the filter capsule.

NIOSH, in collaboration with MSHA and SKC undertook a project to redesign the filter capsule and improve the consistency of the deposit area. This was accomplished by replacing the cone with a 32-mm inside diameter ring and replacing the 37-mm filter with a 38-mm filter. These modifications provided a consistent 8.04 square centimeter deposit and eliminated leakage around the filter. The results of this project were prepared into a scientific publication ''Sampling Results of the Improved SKC Diesel Particulate Matter Cassette'' by James D. Noll, Robert J. Timko, Linda McWilliams, Peter Hall, and Robert A. Haney. This paper is being peer reviewed for publication in a scientific journal. The following abstract was prepared for the study results:

Diesel particulate matter (DPM) cassettes, manufactured by SKC, Inc., Eighty Four, PA, are designed to collect airborne particulates being emitted by diesel powered machinery. These devices, primarily used in underground metal/non-metal mines, enable officials to determine miner exposure to DPM. The SKC DPM cassette is a size selective sampler that was designed by researchers with the U.S. Bureau of Mines, now a part of the National Institute for Occupational Safety and Health (NIOSH), and SKC engineers to collect DPM. This cassette is preferred to a conventional respirable dust sampler because, if DPM is sampled in the presence of carbonaceous ore dust, the ore dust and DPM will collect on the quartz filter, causing the carbon attributed to DPM to be artificially high. In this study, NIOSH researchers investigated the ability of the SKC DPM cassette to collect DPM while preventing mineral dust from collecting on the filter. This cassette discriminated dusts and efficiently collected DPM in both laboratory and field evaluations. In the presence of carbon-based mineral dust having an average concentration of 8 mg/m^3, no mineral dust was found on SKC DPM cassette filters. NIOSH researchers did discover that DPM deposits on filters that were manufactured prior to August 2002 were non-uniform and inconsistent across the filter surfaces. DPM deposit cross-sectional areas varied from 6 to 9 cm^2. To correct this problem, SKC modified the cassette. The resulting cassette produced areas of DPM deposit between 8.11 and 8.21 cm^2, a difference of less than 2%.

Specific control technology studies. Following the settlement agreement, MSHA was invited by various mining companies to evaluate the effectiveness of several different control technologies for diesel particulate matter. These control technologies included ceramic filters, bio-diesel fuel and a fuel oxygenator. Company participation was essential to the success of each study. Ceramic filters were evaluated in two mines, one where MSHA was the only investigator and one where NIOSH was the primary investigator. In the MSHA study, DPM on a production unit was evaluated with and without ceramic filters installed on the loader and trucks. In the NIOSH study a variety of ceramic filters were tested in an isolated zone.

Bio-diesel fuel was evaluated in two mines. In one mine, a 20 and 50 percent recycled bio-diesel fuel and a 50 percent new bio-diesel were evaluated. In the second mine, a 35 percent recycled bio-diesel fuel and a 35 percent new bio-diesel fuel were evaluated.

The fuel oxygenator system was evaluated in one mine. The mine exhaust was sampled with and without the units installed. For the tests with the oxygenator units, the oxygenator units were installed on all production equipment.

Following is a summary of the five individual mine technology evaluation studies:

Kennecott Greens Creek Mining Company: The Mine Safety and Health Administration and Kennecott Greens Creek Mining Company participated in a collaborative study to verify the efficiency of catalyzed ceramic diesel particulate filters for reducing diesel emissions. The goal of the study was the identification of site-specific, practical mine-worthy filter technology.

This series of tests was designed to determine the reduction in emissions and personal exposure that can be achieved when ceramic filters are installed on a loader and associated haulage trucks operating in a production stope. Relative engine gaseous and diesel particulate matter emissions were also determined for the equipment under specific load condition.

The tests were conducted over a two-week period. Three shifts were sampled with ceramic after-filters installed; and three shifts were sampled without the after-filters installed. Personal samples were collected to assess worker exposures. Area samples were collected to assess engine emissions. Both gaseous and diesel particulate measurements were taken.

Sampling results indicate significant reductions in both personal exposures and engine emissions. These results also indicated that factors such as diesel particulate contamination of intake air, stope ventilation parameters, and isolated atmospheres in vehicle cabs as well as the ceramic diesel particulate filters may have a significant impact on personal exposures. The following findings and conclusions were obtained from the study:

1. The results of the raw exhaust gas measurements conducted during the study indicated that the engines were operating properly.

2. The ceramic filters installed on the machines used in this study did not adversely affect the machine operation. Even with some apparent visual cracking from the rotation of the filter media, the ceramic filters removed more than 90% of the DPM. The filters passively regenerated during machine operation.

3. The Bosch smoke test provides an indication of filter deterioration; however, the colorization method does not quantify the results.

4. Personal DPM exposures were reduced by 60 to 68 percent when after-filters were used.

5. CO levels decreased by up to one-half when the catalyzed filters were being used. There appeared to be an increase in NO_2 when catalyzed filters are being used; however, it was unclear whether this increase was due to data variability, changes in ventilation rate, or the use of the catalyzed filters.

6. The use of cabs reduced DPM concentrations by 75 percent when after-filters were used and by 80 percent when after-filters were not in use.

7. Ventilation airflow was provided to the stopes through fans with rigid and bag tubing. Airflow was the same or greater than the Particulate Index, but typically lower than the gaseous ventilation rate.

8. The use of ceramic after-filters reduced average engine DPM emissions by 96 percent.

9. The reduction in personal exposure was not attributed solely to after-filter performance because other factors such as ventilation, upwind equipment use, and cabs also influence personal exposure.

Carmeuse North America, Inc., Maysville Mine: MSHA entered into a collaborative effort with NIOSH, Industry, and the Kentucky Department of Energy to test DPM emissions and exposures when using various blends of bio-diesel fuels in an underground stone mine. As part of its compliance assistance program, MSHA provides support to mining operations to evaluate diesel particulate control technologies. The study was initiated by the industry partner, with MSHA and NIOSH providing support for study design, data collection, and sample and data analysis. Project funding was provided by Carmeuse and Kentucky Department of Energy, through the Kentucky Clean Fuels Coalition.

The initial study was conducted in two phases, a 20% bio-diesel and a 50% bio-diesel blend of recycled vegetable oil, each mixed with 100% low sulfur No. 2 standard diesel fuel. Baseline conditions were established using low sulfur No. 2 standard diesel fuel. In a third phase of the study, a 50% blend of new soy bio-diesel fuel was tested.

Area samples were collected at shafts to assess equipment emissions. Personal samples were collected to assess worker exposure. These samples were analyzed by NIOSH using the NIOSH 5040 method to determine total carbon and elemental carbon concentrations. Results indicate that significant reductions in emissions and worker exposure were obtained for all bio-diesel mixtures. These reductions were in terms of both elemental and total carbon. Preliminary results for the 20% and 50% recycled vegetable oil indicated 30 and 50 percent reductions in DPM emissions and exposures, respectively. Preliminary results for the tests on the 50% blend of new soy bio-diesel fuel, showed about a 30 percent reduction in DPM emissions and exposures.

Carmeuse North America, Inc., Black River Mine: Following the success of the bio-diesel tests at Maysville Mine, Carmeuse requested assistance in continuing the bio-diesel optimization testing at their Black River Mine. In this test two bio-diesel blends along with a baseline test were made. For each test personal exposures and the mine exhaust were tested for two shifts. The two bio-diesel blends included a 35% recycled vegetable oil and a 35% blend of new soy oil. Preliminary results for both the 35% recycled vegetable oil and the 35% blend of new soy bio-diesel fuel showed about a 30 percent reduction in DPM emissions and exposures.

Rogers Group, Jefferson County Mine: MSHA personnel were invited by the Company to evaluate a fuel oxygenation system. The oxygenator is installed in the fuel line of the diesel equipment. The company was installing the units to increase fuel economy and was interested in determining their effect on DPM. MSHA conducted baseline sampling prior to the installation of the units. Personal samples were collected on production workers and area samples were collected in the mine exhaust airflow. The units were installed on loaders and trucks. The sampling was repeated after the units had accumulated 100 hours of operation. Preliminary results indicated that the use of the fuel oxygenator had no measurable effect on either DPM exposure or emissions.

Review of the Technology in Use Assistance

Martin Marietta Aggregates, North Indianapolis Mine: MSHA personnel provided DPM compliance assistance at this mine during a full-day visit in March 2003. The mine's DPM sampling history was reviewed, along with current operating and equipment maintenance practices, mine ventilation, diesel equipment inventory, and steps taken to date and future plans to reduce DPM exposures. Currently, mechanical ventilation is used at the mine and an upgrade to the ventilation system was in progress. The full range of DPM engineering controls was discussed, an exhaust temperature measurement and data logging system was demonstrated, and easy-to-use computer software for using such data to select appropriate DPM filter systems was presented. A simple approach for measuring the effectiveness of cab air filtering and pressurization systems was demonstrated, MSHA's computer spreadsheet software for evaluating the individual and combined effect of DPM emission sources and controls was presented, the highest DPM-emitting equipment was identified (so that future equipment-specific DPM control efforts could be appropriately focused), and the likely effect of various ventilation system upgrades was discussed.

Martin Marietta Aggregates, Parkville Mine: MSHA personnel provided DPM compliance assistance at this mine during a full-day visit in April 2003. The mine's DPM sampling history was reviewed, along with current operating and equipment maintenance practices, mine ventilation, diesel equipment inventory, and steps taken to date and future plans to reduce DPM exposures. Mechanical ventilation is currently used at the mine and an upgrade to the ventilation system was in progress. The full range of DPM engineering controls was discussed, an exhaust temperature measurement and data logging system was demonstrated, and easy-to-use computer software for using such data to select appropriate DPM filter systems was presented. A simple approach for measuring the effectiveness of cab air filtering and pressurization systems was demonstrated, computer spreadsheet software for evaluating the individual and combined effect of DPM emission sources and controls was presented, the highest DPM-emitting equipment were identified (so that future equipment-specific DPM control efforts could be appropriately focused), and the likely effect of various ventilation system upgrades was discussed.

Martin Marietta Aggregates, Kaskaskia Mine: MSHA personnel provided DPM compliance assistance at this mine during a full-day visit in May 2003. The mine's DPM sampling history was reviewed, along with current operating and equipment maintenance practices, mine ventilation, diesel equipment inventory, and steps taken to date and future plans to reduce DPM exposures. Currently, natural ventilation is used at the mine. The full range of DPM engineering controls was discussed, an exhaust temperature measurement and data logging system was demonstrated, and easy-to-use computer software for using such data to select appropriate DPM filter systems was presented. A simple approach for measuring the effectiveness of cab air filtering and pressurization systems was demonstrated, computer spreadsheet software for evaluating the individual and combined effect of DPM emission sources and controls was presented, the highest DPM-emitting equipment were identified (so that future equipment-specific DPM control efforts could be appropriately focused), and the likely effect of various ventilation system upgrades was discussed.

Martin Marietta Aggregates, Manheim Mine: MSHA personnel provided DPM compliance assistance at this mine during a full-day visit in May 2003. The mine's DPM sampling history was reviewed, along with current operating and equipment maintenance practices, mine ventilation, diesel equipment inventory, and steps taken to date and future plans to reduce DPM exposures. Currently, natural ventilation is used at the mine. The full range of DPM engineering controls was discussed, an exhaust temperature measurement and data logging system was demonstrated, and easy-to-use computer software for using such data to select appropriate DPM filter systems was presented. A simple approach for measuring the effectiveness of cab air filtering and pressurization systems was demonstrated, computer spreadsheet software for evaluating the individual and combined effect of DPM emission sources and controls was presented, the highest DPM-emitting equipment were identified (so that future equipment-specific DPM control efforts could be appropriately focused), and the likely effect of various ventilation system upgrades was discussed.

Rogers Group, Oldham County Mine: MSHA personnel provided DPM compliance assistance at this mine during a full-day visit in November 2002. Extensive DPM sampling was conducted at this mine. Both personal exposure samples and area samples were collected. None of the personal samples exceeded 160 $\mu g/m^3$. Current operating and equipment maintenance practices were reviewed, along with mine ventilation, diesel equipment inventory, and steps taken to date and future plans to reduce DPM exposures. Mechanical ventilation was provided for the mine. The full range of DPM engineering controls was discussed. DPM samples were collected inside and outside equipment cabs. Results from this survey indicate the environmental cabs provided significant reduction in the DPM exposure of the equipment operators.

Rogers Group, Jefferson County Mine: MSHA personnel provided DPM compliance assistance at this mine during a full-day visit in December 2002. Both personal exposure samples and area samples were collected. The highest personal sample, collected on the loader, was 468 $\mu g/m^3$. The loader was operated with the window open. Current operating and equipment maintenance practices were reviewed, along with mine ventilation, diesel equipment inventory, and steps taken to date and future plans to reduce DPM exposures. Mechanical ventilation was provided for the mine. The full range of DPM engineering controls was discussed. The Estimator, MSHA's computer spreadsheet software for evaluating the individual and combined effect of DPM emission sources and controls, was presented, the highest DPM-emitting equipment were identified so that future equipment-specific DPM control efforts could be appropriately focused. Finally, the likely effect of various ventilation system upgrades was discussed.

Nalley and Gibson, Georgetown Mine: MSHA personnel provided DPM compliance assistance at this mine during a full-day visit in May 2003. The mine's DPM sampling history was reviewed, along with current operating and equipment maintenance practices, mine ventilation, diesel equipment inventory, and steps taken to date and future plans to reduce DPM exposures. DPM samples were collected to assess improvements since the baseline sampling. Currently, mechanical ventilation provides airflow to the mine. The full range of DPM engineering controls was discussed, an exhaust temperature measurement and data logging system was demonstrated. An easy-to-use computer software for using such data to select appropriate DPM filter systems was presented. A simple approach for measuring the effectiveness of cab air filtering and pressurization systems was demonstrated. The Estimator, MSHA's computer spreadsheet software for evaluating the individual and combined effect of DPM emission sources and controls, was presented. The highest DPM-emitting equipment were identified so that future equipment-specific DPM control efforts could be appropriately focused, and the likely effect of various ventilation system upgrades was discussed.

Stone Creek Brick Company: MSHA personnel provided DPM compliance assistance at this mine during a full-day visit in May 2003. DPM samples were collected on underground workers. The mine's DPM sampling history was reviewed, along with current operating and equipment maintenance practices, mine ventilation, diesel equipment inventory, and steps taken to date and future plans to reduce DPM exposures. The mine uses mechanical ventilation to provide airflow to the mine. The full range of DPM engineering controls was discussed. None of the equipment were equipped with environmental cabs. The Estimator, MSHA's computer spreadsheet software for evaluating the individual and combined effect of DPM emission sources and controls, was presented. The highest DPM-emitting equipment were identified so that future equipment-specific DPM control efforts could be appropriately focused. Also, the likely effect of various ventilation system upgrades was discussed.

Wisconsin Industrial Sand Co., Maiden Rock Mine: MSHA personnel provided DPM compliance assistance at this mine during a full-day visit in May 2003. The mine's DPM sampling history was reviewed, along with current operating and equipment maintenance practices, mine ventilation, diesel equipment inventory, and steps taken to date and future plans to reduce DPM exposures. The full range of DPM engineering controls was discussed. The Estimator, MSHA's computer spreadsheet software for evaluating the individual and combined effect of DPM emission sources and controls, was presented. The highest DPM-emitting equipment were identified so that future equipment-specific DPM control efforts could be appropriately focused.

Gouverneur Talc Company, Inc., No. 4 Mine: MSHA personnel provided DPM compliance assistance at this mine during a full-day visit in May 2003. DPM samples were collected on underground workers. The mine's DPM sampling history was reviewed, along with current operating and equipment maintenance practices, mine ventilation, diesel equipment inventory, and steps taken to date and future plans to reduce DPM exposures. The full range of DPM engineering controls was discussed, an exhaust temperature measurement and data logging system was demonstrated, and easy-to-use computer software for using such data to select appropriate DPM filter systems was presented. A simple approach for measuring the effectiveness of cab air filtering and pressurization systems was demonstrated, a computer spreadsheet software for evaluating the individual and combined effect of DPM emission sources and controls was presented, the highest DPM-emitting equipment was identified (so that future equipment-specific DPM control efforts could be appropriately focused), and the likely effect of various ventilation system upgrades was discussed.

Laboratory Compliance Assistance conducted by MSHA: In addition to the compliance assistance field tests, MSHA's diesel testing laboratory has been working with manufacturers to evaluate various types of DPM control technologies. Certain of these technologies can be applied in either underground metal/nonmetal or coal mines.

Evaluating paper/synthetic media as exhaust filters: MSHA has been evaluating paper/synthetic media as exhaust filters. These filters have shown high DPM removal efficiencies in excess of 90% in the laboratory when tested on MSHA's test engine using the test specified in subpart E of 30 CFR part 7. The laboratory has tested approximately 20 different paper/synthetic media from 10 different filter manufacturers. Even though much of this work is directed to underground coal mine applications for use on permissible equipment, this technology is available for use on permissible equipment that is used in underground gassy metal/nonmetal mines. In addition, some underground coal mine operators have considered adding exhaust heat exchanger systems to nonpermissible equipment in order to use the paper/synthetic filters in place of ceramic filters (a heat exchanger is needed to reduce the exhaust gas temperature to below 302 °F for these types of filters). This could also be an option for metal/nonmetal equipment that would need DPM filter technology, particularly in operations in gassy mines where permissible equipment is required.

Evaluating Ceramic Filter Systems: MSHA has worked with six different ceramic filter system manufacturers to evaluate the effects of their catalytic washcoats on NO_2 production. As discussed elsewhere in this preamble, catalytic washcoats on the ceramic filters may cause increases in NO_2 levels. MSHA used its test engine and followed the test procedures in subpart E of 30 CFR part 7. MSHA has posted on its Web site on the Diesel Single Source Page a list of ceramic filters that have significantly increased NO_2 levels. MSHA has also listed the ceramic filters that are not known to have increased NO_2 levels. MSHA also checked the DPM removal efficiencies for these filters during the laboratory tests and the efficiency results have agreed with the efficiencies posted on the Diesel Single Source Page of 85% for cordierite and 87% for silicon carbide. MSHA also worked with NIOSH during these tests to collect DPM samples for EC analysis using the NIOSH 5040 method. The laboratory results showed that the filters removed EC with efficiencies up to 99%.

Evaluation of Fuel Oxygenator System: MSHA recently completed laboratory tests on a Rentar in-line fuel catalyst. The Rentar unit was installed on a Caterpillar 3306ATAAC which was coupled to a generator. An electrical load bank was used to load the engine under various operating conditions. The engine was baselined for gaseous and DPM emissions without the Rentar; then, the Rentar was installed and operated for 100 hours of break-in. The gaseous and DPM emission measurements were repeated after the 100 hour break-in. The preliminary laboratory results showed some measurable reductions in whole DPM. Samples were also collected for EC analysis using the NIOSH 5040 method. Those results are currently being evaluated by NIOSH.

Evaluation of a Magnet System: MSHA is preparing to perform laboratory tests for Ecomax, a manufacturer of a magnet system installed on the fuel line, oil filter, air intake and radiator. A preliminary MSHA field test of this product was done at a surface aggregate operation. The magnetic device demonstrated a 30% reduction in CO levels. Subsequent laboratory testing will include DPM measurements.

Additional Testing: MSHA is also planning a lab test on a manufacturer's fluidized bed, several types of fuel additives, and a fuel preparative. The test plans and the required test hardware are currently being discussed with the respective manufactures of these products.

VI. Exposure Assessment and Literature Update

A. Introduction

Section VI.B summarizes new exposure data that have become available since publication, on January 19, 2001, of the existing rule limiting DPM levels in underground metal and nonmetal mines. Next, in Section VI.C, we survey the most recent scientific literature (April 2000–March 2003) pertaining to adverse health effects of DPM and fine particulates in general.

B. DPM Exposures in Underground Metal and Nonmetal Mines

In the existing risk assessment (66 FR 5752) we evaluated exposures based on 355 samples collected at 27 underground U.S. M/NM mines prior to the rule's promulgation. Mean DPM concentrations found in the production areas and haulageways at those mines ranged from about 285 μg/m³ to about 2000 μg/m³, with some individual measurements exceeding 3500 μg/m³. The overall mean DPM concentration was 808 μg/m³. All of the samples considered in the existing risk assessment were collected prior to 1999, and some were collected as long ago as 1989.

Two new bodies of DPM exposure data, collected subsequent to promulgation of the 2001 rule, have now been compiled for underground M/NM mines: (1) Data collected in 2001 from 31 mines for purposes of the 31-Mine Study (Ref. 31-Mine Study) and (2) data collected between 10/30/2002 and 3/26/2003 from 171 mines to establish a baseline for future samples (Ref. Baseline Samples, 2003). Both of these datasets have been placed into the public record, and they are summarized in the next two subsections below. Following these summaries, we discuss the relationship between EC and TC, including the ratio of EC to TC (EC:TC). This discussion will be based entirely on samples taken for the 31-Mine Study, since those samples were controlled for potential TC interferences from tobacco smoking and oil mist, whereas the baseline samples were not.

1. Data from Joint Study

As described in greater detail in MSHA's final report on the 31-Mine Study, MSHA collected 464 DPM samples in 2001 at 31 underground M/NM mines. Of these 464 samples, 106 were voided, most of them due to potential interferences resulting in invalid TC content used to evaluate DPM exposures. Table VI–1 shows how the remaining 358 valid DPM samples were distributed across four broad mine categories. All samples at one of the metal mines were voided, leaving 30 mines with valid samples indicating DPM concentrations.

TABLE VI–1.—NUMBER OF DPM SAMPLES, BY MINE CATEGORY

	Number of mines with valid samples	Number of valid samples	Average Number of valid samples per mine
Metal	11	116	10.5
Stone	9	105	11.7
Trona	3	54	18.0
Other	7	83	11.9
Total	30	358	12.5

Table VI–2 summarizes the valid DPM concentrations observed in each mine category, assuming that submicrometer TC, as measured by the SKC sampler, comprises 80 percent of all DPM. The mean concentration across all 358 valid samples was 432 μg/m³ (Std. error = 21.0 μg/m³). The mean concentration was greatest at metal mines, followed by stone and "other N/M." At the three trona mines sampled, both the mean and median DPM concentration were substantially lower than what was observed for the other categories. This was due to the increased ventilation used at these mines to control methane emissions.

TABLE VI–2.—DPM CONCENTRATIONS (μG/M³), BY MINE CATEGORY. DPM IS ESTIMATED BY TC/0.8

	Metal	Stone	Trona	Other N/M
Number of samples	116	105	54	83
Minimum	46.	16.	20.	27.
Maximum	2581.	1845.	331.	1210.
Median	491.	331.	82.	341.

TABLE VI–2.—DPM CONCENTRATIONS (µG/M³), BY MINE CATEGORY. DPM IS ESTIMATED BY TC/0.8—Continued

	Metal	Stone	Trona	Other N/M
Mean	610.	465.	94.	359.
Std. Error	44.7	36.0	9.4	26.6
95% UCL	699.	537.	113.	412.
95% LCL	522.0	394.	75.	306.

After adjusting for differences in sample types and in occupations sampled, DPM concentrations at the non-trona mines were estimated to be about four to five times the concentrations found at the trona mines. Although there were significant differences between individual mines, the adjusted differences between the general categories of metal, stone, and other N/M mines were not statistically significant.[1] For the 304 valid samples taken at mines other than trona, the mean DPM concentration was 492 µg/m³ (Std. error = 23.0).

Again assuming that submicrometer TC as measured by the SKC sampler comprises 80 percent of DPM, the mean DPM concentration observed was 1019 µg/m³ at the single mine exhibiting greatest DPM levels. Four of the nine valid samples at this mine exceeded 1487 µg/m³. In contrast, DPM concentrations never exceeded 500 µg/m³ at 8 of the 30 mines with valid samples (2 of the 11 metal mines, 1 of the 3 stone, all 3 trona, and 2 of the 7 other N/M). (Note that 500 µg/m³ is the whole particulate equivalent of the 400 µg/m³ interim standard.) Some individual measurements exceeded 200DPM µg/m³ at all but one of the mines sampled.

2. Baseline Data

An analysis of MSHA's baseline sampling appears in Section V, Compliance Assistance, and is used as the basis for this dicussion.

Table VI–1 summarizes, by general commodity, the EC levels measured during this sampling. The overall mean eight-hour full shift equivalent EC concentration of samples in this study was 170 µg/m³, and the overall median was 117 µg/m³. Table VI–2 provides a similar summary for estimated DPM levels, using TC/0.8 and $TC \approx 1.3 \times EC$.[2] Under these assumptions, the estimated mean DPM level was 277 µg/m³, and the median was 191 µg/m³. Since the baseline data and the 31-Mine study both showed significantly lower levels at trona mines than at other underground M/NM mines, Tables VI–7 and VI–8 present overall results both including and excluding the three underground trona mines sampled.

TABLE VI–1.—BASELINE EC CONCENTRATIONS

	8-hour full shift equivalent EC concentration—(µg/m³)					
	Metal	Stone	Other N/M	Trona	Total	Total excluding Trona
Number of samples	189	519	151	15	874	859
Maximum	1549	1340	634	149	1549	1549
Median	184	104	99	70	117	120
Mean	227	164	130	69	170	172
Std. Error	14.6	7.5	8.5	10.3	5.8	5.9
95% UCL	256	179	147	92	182	184
95% LCL	198	150	115	47	159	161

TABLE VI–2.—BASELINE DPM CONCENTRATIONS

	Estimated 8-hour full shift equivalent DPM concentration—(µg/m³)					
	Metal	Stone	Other N/M	Trona	Total	Total excluding Trona
Number of samples	189	519	151	15	874	859
Maximum	2518.	2178.	1030.	242.	2518.	2518.
Median	299.	170.	162.	113.	191.	195.
Mean	369.	267.	212.	113.	277.	280.
Std. Error	23.8	12.2	13.8	16.7	9.4	9.5
95% UCL	416.	291.	239.	149.	295.	299.
95% LCL	323.	243.	185.	77.	259.	261.

Baseline EC sample results varied widely between mines within commodities and also within most mines. Table VI–3 summarizes baseline EC results for the 19 occupations found to have at least one sample where the

[1] These conclusions derive from an analysis of variance, based on TC measurements, as described in the report of the 31–Mine Study. They depend on an assumption that the ratio of DPM to TC is uncorrelated with mine category, sample type (*i.e.*, personal or area), and occupation.

[2] The relationship $DPM \approx TC/0.8$ is the same as that assumed in the existing risk assessment. The relationship $TC \approx 1.3 \times EC$ was formulated under the settlement agreement, based on TC:EC ratios observed in the joint 31–Mine Study, as described in the next subsection of this exposure assessment.

EC level exceeded the proposed 308 µg/m³ 8-hour full shift equivalent interim EC limit. As indicated by the table, EC levels varied widely within each occupation.

TABLE VI–3.—BASELINE EC CONCENTRATIONS FOR OCCUPATIONS WITH AT LEAST ONE VALUE EXCEEDING PROPOSED INTERIM EC LIMIT

Occupation	8-hour full shift equivalent EC concentration (µg/m³)			
	Number of valid samples	Minimum	Median	Maximum
Scaling (hand)	17	14	128	1,549
Front-end Loader	155	0	104	1,340
Miscoded	3	395	450	1,123
Drill Operator	93	2	122	880
Truck Driver	183	0	118	826
Blaster, Power Gang	100	5	165	738
Miner, Drift	13	12	134	712
Mucking Machine	18	12	213	671
Supervisor	10	1	67	658
Roof Bolter	22	48	167	638
Complete Loader	17	32	145	634
Scaling (mechanical)	63	0	101	577
Utility Man	18	22	71	491
Miner, Stope	11	127	254	479
Belt Crew	8	20	173	386
Cleanup Man	2	51	217	384
Engineer	1	337	337	337
Crusher operator	14	1	36	328
Shuttle car operator	3	14	73	323

Figure VI–1 depicts, by mine category, the percentage of baseline samples that exceed the proposed interim limit of 308 µg/m³. Underground metal mines exhibited the highest proportion of samples exceeding this limit, followed by stone and then other nonmetal mines. All 15 samples collected in the three trona mines met the proposed limit. Across all commodities, 15.7 percent of the 874 valid baseline samples exceeded the interim EC limit.

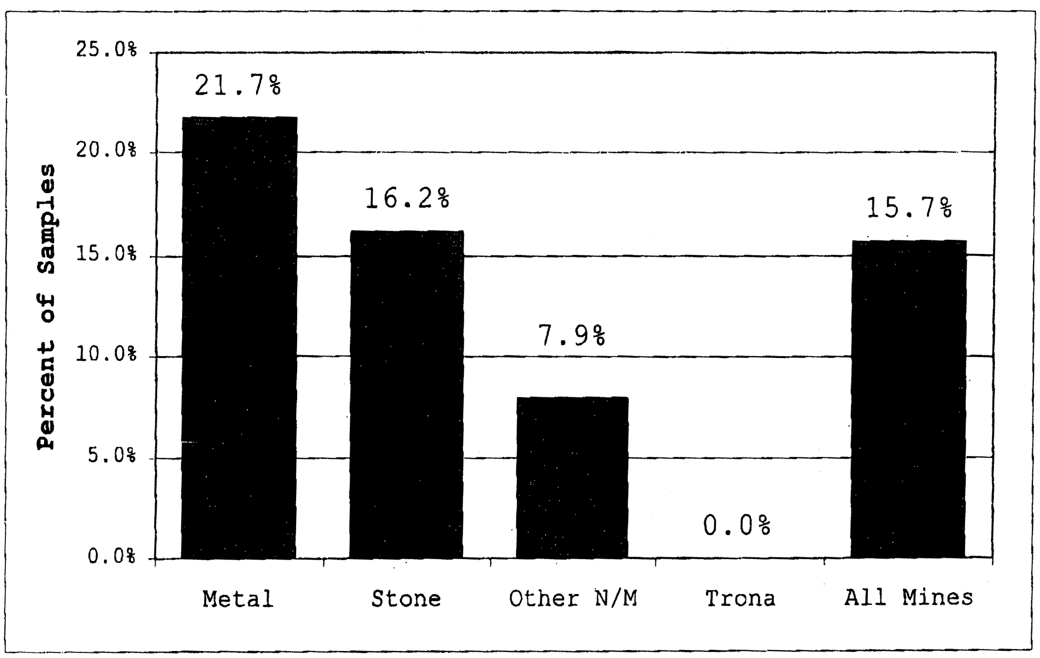

Figure VI-1 Distribution of samples exceeding proposed interim EC limit.

Figure VI–2 shows how samples exceeding the proposed interim EC limit were distributed over individual mines. One to five baseline samples were taken at each mine. In 120 of the 171 mines sampled (70 percent), none of the baseline EC measurements exceeded 308 μg/m³. The remaining 51 mines (30 percent) had at least one sample for which EC exceeded 308 μg/m³. All samples taken at 14 of the mines exceeded the proposed interim limit.

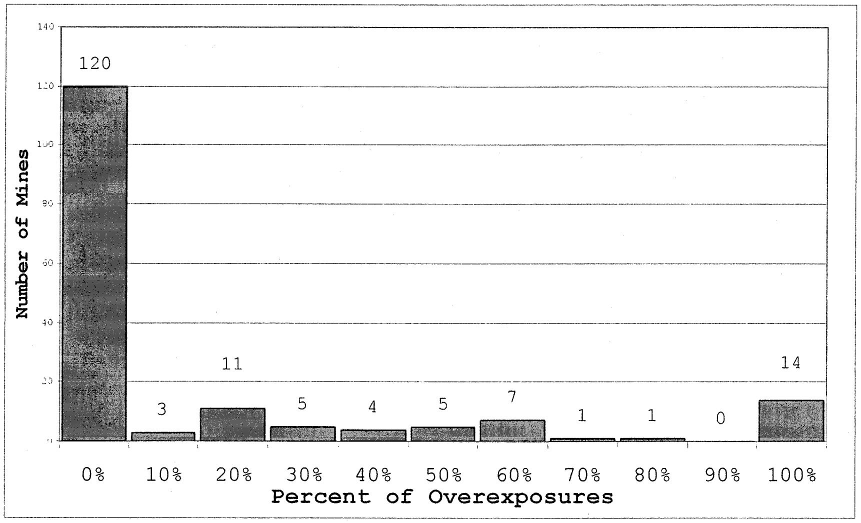

Figure VI-2. Distribution of samples exceeding proposed interim EC limit.

3. Relationship Between Elemental and Total Carbon

Unlike the 31-Mine Study, no special precautions were taken during MSHA's baseline sampling to avoid tobacco smoke or other substances that could potentially interfere with using TC (*i.e.*, EC + OC) as a surrogate measure of DPM. Therefore, the baseline data should not be used to evaluate the OC content of DPM or the ratio of EC to TC within DPM. In the 31-Mine Study, great care was taken to void all samples that may have been exposed to tobacco smoke or other extraneous sources of organic carbon. Accordingly, the analysis of the EC:TC ratio we present here relies entirely on data from the 31-Mine Study. It is important to note that most of the samples in this study were taken in the absence of exhaust filters to control DPM emissions. Since exhaust filters may have different effects on EC and OC emissions, the results described here apply only to mine areas where exhaust filters are not employed.

Figure VI–3 plots the EC:TC ratios observed in the 31-Mine Study against the corresponding TC concentrations. The various symbols shown in the plot identify samples taken at the same mine. The EC:TC ratio ranged from 23 percent to 100 percent, with a mean of 75.7 percent and a median of 78.2 percent. Note that the reciprocal of 0.78, which is 1.3, equals the median of the TC:EC ratio observed in these samples.[3] The 1.3 TC:EC ratio was the value accepted, under terms of the settlement agreement, for the purpose of temporarily converting EC measurements to TC measurements.

[3] The median of reciprocal values is always equal to the reciprocal of the median. This relationship does not hold for the mean.

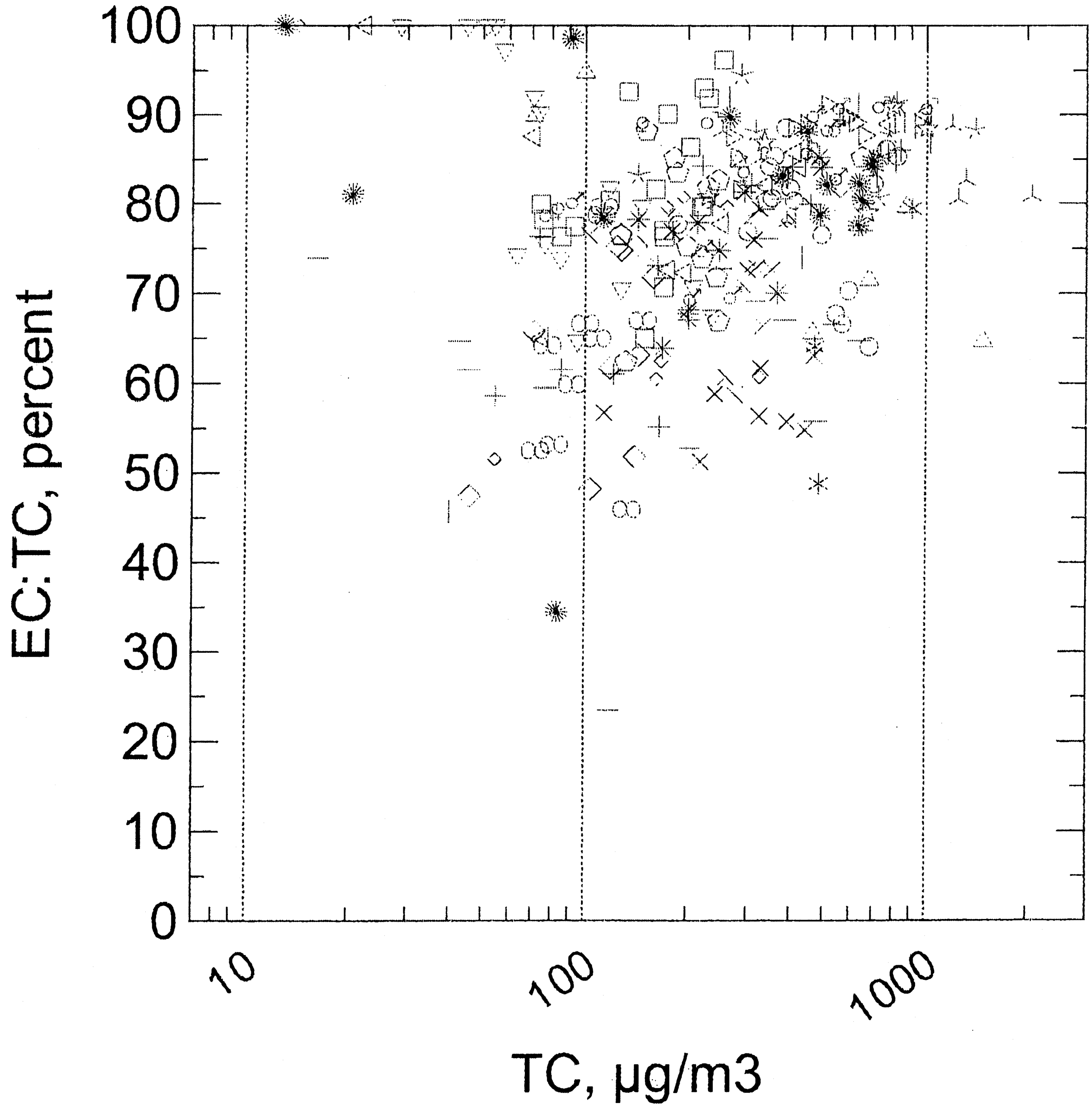

Figure VI-3. EC:TC ratios found in 358 valid samples from 31-Mine Study. Symbols identify samples from same mine.

The existing rule defines an interim TC limit of 400 µg/m³. Under the current proposal, this interim limit would be replaced with an interim EC limit of 308 µg/m³. Table VI–4 indicates the impact of this proposed change, based on the EC and TC data obtained from the 31-Mine Study. Both the 400 µg/m³ TC limit and the 308 µg/m³ EC limit were exceeded by about 31 to 32 percent of the samples. The difference (one sample out of 358) is not statistically significant in the aggregate. Seven samples, however, exceeded the TC limit but not the EC limit, and six samples exceeded the EC limit but not the TC limit.

TABLE VI–4.—COMPLIANCE WITH 400 μG/M³ TC LIMIT AND/OR PROPOSED 308 μG/M³ EC LIMIT.

[Numbers in parentheses are percentages.]

EC > 308 μg/m³	TC > 400 μg/m³		Total
	No	Yes	
no	239 (66.8)	7 (2.0)	246 (68.7)
yes	6 (1.7)	106 (29.6)	112 (31.3)
Total	245 (68.4)	113 (31.6)	358 (100.0)

C. Health Effects Literature Update

We have identified additional scientific literature pertaining to health effects of fine particulates in general and DPM in particular published subsequent to the January 19, 2001 final rule.

TABLE VI–5 STUDIES OF HUMAN RESPIRATORY AND IMMUNOLOGICAL EFFECTS, 2000–2002

Authors, year	Description	Key results
Frew *et al.*, 2001	25 healthy subjects and 15 subjects with mild asthma were exposed to diesel exhaust (108 μg/m³) or filtered air for 2 hr, with intermittent exercise. Lung function was assessed using a computerized whole body plethysmograph. Airway responses were sampled by bronchial wash (BW), bronchoalveolar lavage (BAL), and mucosal biopsies 6 hr. after ceasing exposures.	Both the asthmatic and healthy subjects developed increased airway resistance after exposure to diesel emissions, but airway inflammatory responses were different for the 2 groups. The healthy subjects showed statistically significant BW neutrophilia and BAL lymphocytosis 6 hr after exposure. The neutrophilic response of the healthy subjects was less intense than that seen in a previous study using a DPM concentration of 300 μg/m³.
Fusco *et al.*, 2001	Analysis of daily hospital admissions for acute respiratory infections, COPD, asthma, and total respiratory conditions in Rome, Italy.	Respiratory admissions among adults were significantly correlated with CO and NO_2 levels, but not with suspended particles. The authors noted that since CO and NO_2 are good indicators of combustion products in vehicular exhaust, the detected effects may be due to unmeasured fine and ultrafine particles.
Holgate *et al.,* 2002	25 healthy and 15 asthmatic subjects were exposed for 2 hours to 100 μg/m³ of DPM and to filtered air on separate days. Another 30 healthy subjects were exposed for 2 hours to DPM concentrations ranging from 25 to 311 μg/m³ and compared to 12 different healthy subjects exposed to filtered air. Exposure effects were assessed using lung function tests and biochemical tests of bronchial tissue samples.	Healthy and asthmatic subjects exhibited evidence of bronchioconstriction immediately after exposure. Biochemical tests of inflammation yielded mixed results but showed small inflammatory changes in healthy subjects after DPM inhalation.
Oliver *et al.*, 2001	Pulmonary function tests and questionnaire data were obtained for 359 ‘‘heavy and highway’’ (HH) construction workers. Intensity of DPM exposure was estimated according to job classification. Duration of exposure was estimated based on length of union membership.	After adjusting for smoking and some other potential confounders, HH workers showed elevated risk of asthma. One subgroup (tunnel workers) also showed elevated risk of both undiagnosed asthma and chronic bronchitis, compared to other HH workers. Respiratory symptoms appeared to decline with exposure duration as measured by length of union membership. The authors interpreted this as suggesting that HH workers tend to leave their trade when they experience adverse respiratory symptoms.
Salvi *et al.*, 2000	15 healthy nonsmoking volunteers were exposed to 300 μg/m³ DPM and clean air for one hour at least three weeks apart. Biochemical analyses were performed on bronchial tissue and bronchial wash cells obtained six hours after each exposure.	Diesel exhaust exposure enhanced gene transcription of IL–8 in the bronchial tissue and airway cells and increased IL–8 and GRO–α protein expression in the bronchial epithelium. This was accompanied by a trend toward increased IL–5 mRNA gene transcripts in the bronchial tissue. Study showed effects on chemokine and cytokine production in the lower airways of health adults. These substances attract and activate leukocytes. They are associated with the pathophysiology of asthma and allergic rhinitis.

TABLE VI–5 STUDIES OF HUMAN RESPIRATORY AND IMMUNOLOGICAL EFFECTS, 2000–2002—Continued

Authors, year	Description	Key results
Svartengren *et al.,* 2000	Twenty nonsmoking subjects with mild allergic asthma were exposed for 30 minutes to high and low levels of engine exhaust air pollution on two separate occasions at least four weeks apart. Respiratory symptoms and pulmonary function were measured immediately before, during and after both exposure periods. Four hours after each exposure, the test subjects were challenged with a low dose of inhaled allergen. Lung function and asthmatic reactions were monitored for several hours after exposure.	Subjects with $PM_{2.5}$ exposure_100 µg/m³ exhibited slightly increased asthmatic responses. Associations with adverse outcome variables were weaker for particulates than for NO_2.

TABLE VI–6.—REVIEW ARTICLES ON RESPIRATORY AND IMMUNOLOGICAL EFFECTS, 1999–2002

Authors, Year	Description	Key results
Gavett and Koren, 2001	Summarizes results of EPA studies done to determine whether PM can enhance allergic sensitization or exacerbate existing asthma or asthma-like responses in humans and animal models.	Studies indicate that PM enhances allergic sensitization in animal models of allergy and exacerbate inflammation and airway hyper-responsiveness in asthmatics and animal models of asthma.
Pandya *et al.* 2002	Reviews human and animal research relevant to question of whether DPM is associated with asthma.	Evidence indicates that DPM is associated with the inflammatory and immune responses involved in asthma, but DPM appears to have a far greater impact as an adjuvant with allergens than alone. DPM appears to augment IgE, trigger eosinophil degranulation, and stimulate release of numerous cytokines and chemokines. DPM may also promote the cytotoxic effects of free radicals in the airways.
Patton and Lopez, 2002	Review of evidence and mechanisms for the role of air pollutants in allergic airway diseases.	Evidence suggests that air pollutants (including DPM) ''affect allergic response by different mechanisms. Pollutants may increase total IgE levels and potentiate the initial sensitization to allergens and the IgE response to a subsequent allergen exposure. Pollutants also may act by increasing allergic airway inflammation and by directly stimulating airway inflammation. In addition, it is well known that pollutants can be direct irritants of the airways, increasing symptoms in patients with allergic syndromes.''
Peden, 2002	Review of ''studies that exemplify the impact of ozone, particulates, and toxic components of particulates on asthma.''.	DPM ''may play a significant role not only in asthma exacerbation but also in T_H2 inflammation via the actions of polyaromatic hydrocarbons on B lymphocytes.'' ''* * * PM in which the active agents are biologically active metal ions and organic residues * * * may have significant effects on asthma, especially modulating immune function, as demonstrated by the role of polyaromatic hydrocarbons from diesel exhaust in IgE production.''
Sydbom *et al.* 2001	Review of scientific literature on health effects of diesel exhaust, especially the DPM components.	The epidemiological support for particle effects on asthma and respiratory health is very evident; and respiratory, immunological, and systemic effects of DPM have been documented in a wide variety of experimental studies. Acute effects of DPM exposure include irritation of the nose and eyes, lung function changes, and airway inflammation. Exposure studies in healthy humans have documented a number of profound inflammatory changes in the airways, notably, before changes in pulmonary function can be detected. Such effects may be even more detrimental in subjects with compromised pulmonary function. Ultrafine particles are currently suspected of being the most aggressive particulate component of diesel exhaust.

TABLE VI–7.—STUDIES RELATING TO CARDIOVASCULAR AND CARDIOPULMONARY EFFECTS, 2000–2002

Authors, Year	Description	Key Results
Lippmann *et al.,* 2000	Day-to-day fluctuations in particulate air pollution in the Detroit area were compared with corresponding fluctuations in daily deaths and hospital admissions for 1985–1990 and 1992–1994.	After adjustment for the presence of other pollutants, significant associations were found between particulate levels and an increased risk of death due to circulatory causes. However, relative risks were about the same for $PM_{2.5}$ and larger particles.
Magari *et al.*, 2001	Longitudinal study of a male occupational cohort examined the relationship between $PM_{2.5}$ exposure and cardiac autonomic function.	After adjusting for potential confounding factors such as age, time of day, and urinary nicotine level, $PM_{2.5}$ exposure was significantly associated with disturbances in cardiac autonomic function.
Pope *et al.*, 2002	Prospective cohort mortality study, based on data collected for Cancer Prevention II study, which began in 1982. Questionnaires were used to obtain individual risk factor data (age, sex, race, weight, height, smoking history, education, marital status, diet, alcohol confounders, and occupational exposures). For about 500,000 adults, these were combined with air pollution data for metropolitan areas throughout the United States and with vital status and cause of death data through 1998.	After adjustment for other risk factors potential using a variety of statistical consumption, and methods, fine particulate ($PM_{2.5}$) exposures were significantly associated with cardiopulmonary mortality (and also with lung cancer). Each 10-$\mu g/m^3$ increase in mean level of ambient fine particulate air pollution was associated with an increase of approximately 6 percent in the risk of cardiopulmonary mortality.
Samet *et al.*, 2000a, 2000b	Time series analyses were conducted on data from the 20 and 90 largest U.S. cities to investigate relationships between PM_{10} and other pollutants and daily mortality.	Results of both the 20-city and 90-city mortality analyses are consistent with an average increase in cardiovascular and cardiopulmonary deaths of more than 0.5% for every 10 $\mu g/m^3$ increase in PM_{10} measured the day before death.
Wichmann *et al.*, 2000	Time series analyses were conducted on data from Erfurt, Germany to investigate relationships between the number and mass concentrations of ultrafine and fine particles and daily mortality.	Higher levels of both fine and ultrafine particle concentrations were significantly associated with increased mortality rate.

TABLE VII.–8.—STUDIES AND REVIEW OF ARTICLE ON CANCER EFFECTS, 2000–2002

Authors, year	Description	Key results
Boffetta *et al*, 2001	Cohort studied was entire Swedish working population (other than farmers). Job title and industry were classified according to probability and intensity of diesel exhaust exposure for years 1960 and 1970, and according to authors' confidence in assessment. Cohort members followed up for mortality for 19-year period from 1971 through 1989. Cause of death, specific cancer type, when applicable, obtained through national registries.	Relative risks (RR) of lung cancer among men were 0.95, 1.1, and 1.3 for job categories with low, medium, and high exposure to diesel exhaust compared to workers in jobs classified as having no occupational exposure. Elevated risks for medium and high exposure groups were statistically significant, and no similar pattern was observed for other cancer types.
Gustavsson *et al*, 2000	Case-control study involving all 1,042 male cases of lung cancer and 2,364 randomly selected controls (matched by age and inclusion year) in Stockholm County, Sweden from 1985 through 1990. Occupational exposure, smoking habits, and other risk factors assessed based on written questionnaires mailed to subjects or next of kin. Relative Risk (RR) estimates adjusted for age, selection year, tobacco smoking, residential radon, occupational exposures to asbestos and combustion products, and environmental exposure to NO^2.	Adjusted RR for the highest quartile of estimated lifetime exposure was 1.63, compared to the group with no exposure.
Pope *et al.*, 2002	Prospective cohort lung cancer mortality study using data collected for the American Cancer Society Cancer Prevention II Study (began 1982). Questionnaires used to obtain individual risk factor data including age, sex, race, weight, height, smoking history, education, marital status, diet, alcohol consumption, and occupational exposures. This risk factor data combined with air pollution data for metropolitan areas throughout United States and vital status and cause of death data through 1998 for about 500,000 adults.	After adjusting for other risk factors and potential cofounders, chronic $PM_{2.5}$ exposures found to be significantly associated with elevated lung cancer mortality. Each 10 g/m^3 increase in mean level of ambient fine particulate air pollution associated with statistically significant increase of approximately 8 percent in risk of lung cancer mortality.

TABLE VII.–8.—STUDIES AND REVIEW OF ARTICLE ON CANCER EFFECTS, 2000–2002—Continued

Authors, year	Description	Key results
Boffetta and Silverman, 2001	Meta-analysis performed on 44 independent results from 29 distinct studies of bladder cancer in occupational groups having varying exposure to diesel exhaust (studies included only if at least 5 years between first exposure and bladder cancer development). Separate quantitative meta-analyses performed for heavy equipment operators, truck drivers, bus drivers, and studies with semi-quantitative exposure assessments based on a job exposure matrix (JEM).	Overall Relative Risk (RR) was 1.37 for heavy equipment operators, 1.17 for truck drivers, 1.33 for bus drivers, and 1.13 for JEM. Quantitiatives meta-analysis also performed on 8 independent studies showing results for ''high'' diesel exposure. Combined results were RR=1.23 for ''any exposure,'' and RR=1.44 for ''high exposure.''
Zeegers *et al.*, 2001	Prospective case-cohort study involving 98 bladder cancer cases among men occupationally exposed to diesel exhaust. A cohort of 58,279 men who were 55–69 years old in 1986 was followed up through 1992. Exposure assessed by job history given on self- administered questionnaire, combined with expert assessment of exposure probability. ''Cumulative probability of exposure'' determined by multiplying job duration by exposure probability. Four categories of relative cumulative exposure probability defined: none, lowest third, middle third, highest third. Relative risks adjusted for age, cigarette smoking, and exposure to other occupational risk factors.	Relative risk for category with highest cumulative probability of exposure was 1.17.
Ojajarvi *et al*, 2000	Meta-analysis of 161 independent results (populations) from 92 studies on relationship between worksite exposures and pancreatic cancer.	Based on 20 populations, no elevated risk associated with diesel exposure. Combined relative risk was 1.0. This result consistent with existing risk assessment which identified lung and bladder cancer as the only forms of cancer for which there was evidence of an association with DPM exposure.
Szadkowska-stanczyk and Ruszkowska, 2000.	Literature review of studies relating to carcinogenic effects of diesel emissions. (Article in Polish; MSHA had access only to English translation of Abstract.).	Authors conclude long-term exposure (>20 years) associated with 30% to 40% increase in lung cancer risk in workers in transport industry.

TABLE VI–8.—STUDIES ON TOXICOLOGICAL EFFECTS OF DPM EXPOSURE, 2000–2002

Authors, Year	Description	Key results	Agent(s) of toxicity
Al-Humadi *et al.,* 2002	IT instillation in rats of 5 mg/kg saline, DPM, or carbon black.	Exposure to DPM or carbon black augments OVA sensitization; particle composition (of DPM) may not be critical for adjuvant effect.	DPM and carbon black particles.
Bünger *et al.,* 2000	In Vitro: assessment of content of polynuclear aromatic compounds and mutagenicity of DPM generated from four fuels, Ames assay used.	Production of black carbon and polynuclear aromatic engine compounds that are mutagenic; correlation with sulfur content of fuel and engine speed.	DE generated from diesel engine DPM collected on filters and soluble organic extracts prepared.
Carero *et al.,* 2001	In Vitro: assessment of DPM, carbon black, and urban particulate matter genotoxicity, human alveolar epithelial cells used.	DNA damage produced, but no cytotoxicity produced.	DPM, urban particulate matter (UPM), and carbon black (CB). DPM, UPM purchased from NIST, CB purchased from Cabot.
Castranova *et al.,* 2001	In Vitro: assessment of DPM on alveolar macrophage functions and role of adsorbed chemicals; rat alveolar macrophages used. In Vivo: assessment of DPM on alveolar macrophage functions and role of adsorbed chemicals, use of IT instillation in rats.	DPM depresses antimicrobial potential of macrophages, thereby increasing susceptibility of lung to infections, this inhibitory effect due to adsorbed chemicals rather than carbon core of DPM.	No information on generation of DPM (details may be found in previous publications from this lab).

TABLE VI–8.—STUDIES ON TOXICOLOGICAL EFFECTS OF DPM EXPOSURE, 2000–2002—Continued

Authors, Year	Description	Key results	Agent(s) of toxicity
Fujimaki *et al.,* 2001	In Vitro: assessment of cytokine production, spleen cells used. In Vivo: assessment of cytokine production profile following IP sensitization to OA and subsequent exposure to 1.0 mg/mg^3 DE for 12 hr/day, 7 days/week over 4 weeks, mouse inhalation model used.	Adverse effects of DE on cytokine and antibody production by creating an imbalance of helper T-cell functions.	DE generated from diesel engine DPM, CO_2, SO_2 $NO/NO_2/NO_X$ measured.
Gilmour *et al.,* 2001	In Vivo: assessment of infectivity and allergenicity following exposure to woodsmoke, oil furnace emissions, or residual oil fly ash, mouse inhalation model used, IT instillation used in rats.	Exposure to woodsmoke increased susceptibility to and severity of streptococcal infection, exposure to residual oil fly ash increased pulmonary hypersensitivity reactions.	Woodsmoke, oil furnace emissions, and residual oil fly ash (ROFA) used
Hsiao *et al.*, 2000	In Vitro: assessment of cytotoxic effects (cell proliferation, DNA damage) of PM2.5 (fine PM) and PM2.5–10 (coarse PM), rat embryo fibroblast cells used.	Seasonal variations in PM, in their solubility, and in their ability to produce cytotoxicity. Long-term exposure to non-killing doses of PM may lead to accumulation of DNA lesions.	PM collected Hong Kong area and solvent- extractable organic compounds used.
Kuljukka-Rabb *et al.*, 2001	In Vitro: assessment of of adduct formation following exposure to DPM, DPM extracts, benzo[a]pyrene, or 5-methylchrysene, mammary carcinoma cells used.	Temporal and dose-dependent DNA adduct formation by PAHs. Carcinogenic PAHs from diesel extracts lead to stable DNA adduct formation.	Some DPM purchased from NIST, some DPM collected on filters from diesel vehicle, and solvent-extractable organic compounds used.
Moyer *et al.*, 2002	In Vivo: 2-phase retrospective study, review of NTP data from 90-day and 2-yr exposures to particulates, use of mouse inhalation model.	Induction and/or exacerbation of arteritis following chronic exposure (beyond 90-day) to particulates.	Indium phosphide, cobalt sulfate heptahydrate, vanadium pentoxide, gallium arsenide, nickel oxide, nickel subsulfide, nickel sulfate hexahydrate, talc, molybdenum trioxide used.
Saito *et al.*, 2002	In Vivo: assessment of cytokine expression following exposure to DE (100 µg/m3 or 3 mg/m3 DPM) for 7-hrs/day × 5 days/wk × 4 wks, mouse inhalation model used..	DE alters immunological responses in the lung and may increase susceptibility to pathogens, low-dose DE may induce allergic/asthmatic reactions.	DE generated from diesel engine DPM, CO, SO2, and NO2 measured.
Sato *et al.*, 2000	In Vivo: assessment of mutant frequency and mutation spectra in lung following 4–wk exposure to 1 or 6 mg/m^3 DE, transgenic rat inhalation model used.	DE produced lesions in DNA and was mutagenic in rat lung.	DE generated from light-duty diesel engine Concentration of suspended particulate matter (SPM) measured, 11 PAHs and nitrated PAHs identified and quantitated in SPM.
Van Zijverden *et al.,* 2000	In Vivo: assessment of immunomodulating capacity of DPM, carbon black, and silica particles, mouse model used (sc injection into hind footpad).	DPM skew immune response toward T helper 2 (Th2) side, and may facilitate initiation of allergy.	DPM, carbon black particles (CBP) and silica particles (SIP) used. DPM donated by Nijmegen University, CBP and SIP purchased from BrunschwichChemie and Sigma Chemical Co., respectively.
Vincent *et al.,* 2001	In Vivo: assessment of cardiovascular effects following 4–hr exposure to 4.2 mg/m^3 diesel soot, 4.6 mg/m^3 carbon black, or 48 mg/m^3 ambient urban particulates, rat inhalation model used.	Increases in endothelin -1 and -3 (two vasoregulators) following ambient urban particulates and diesel soot exposure. Small increases in blood pressure following exposure to ambient urban particulates.	Diesel soot, carbon black and urban air particulates used. Diesel soot purchased from NIST, carbon black donated by University of California, urban air particulates collected in Ottawa.
Walters *et al.,* 2001	In Vivo: assessment of airway reactivity/responsiveness, and BAL cells and BAL cytokines following exposure to 0.5 mg/ mouse aspirated DPM, ambient PM, or coal fly ash.	Dose and time-dependent changes in airway responsiveness and inflammation following exposure to PM. Increase in BAL cellularity following exposure to DMP, but airway reactivity/ unchanged.	DPM, PM, and coal fly ash used. DPM purchased from NIST, PM collected in Baltimore, and coal fly ash obtained from Baltimore power plant.

TABLE VI–8.—STUDIES ON TOXICOLOGICAL EFFECTS OF DPM EXPOSURE, 2000–2002—Continued

Authors, Year	Description	Key results	Agent(s) of toxicity
Whitekus *et al.,* 2002	In Vitro: assessment of ability of six antioxidants to interfere in DPM-mediated oxidative stress, cell cultures used. In Vivo: assessment of sensitization to OA and/or DPM and possible modulation by thiol antioxidants, mouse inhalation model used.	Thio antioxidants (given as a pretreatment) inhibit adjuvant effects of DPM in the induction of OA sensitization.	DE generated from light-duty diesel engine, DPM collected, dissolved in saline, and aerosolized.

*Key:
(A) immunological and/or allergic reactions.
(B) inflammation.
(C) mutagenicity/DNA adduct formation.
(D) Induction of free oxygen radicals.
(E) airflow obstruction.
(F) impaired clearance.
(G) reduced defense mechanisms.
(H) adverse cardiovascular effects.

TABLE VI–9.—REVIEW ARTICLES ON TOXICOLOGICAL EFFECTS OF DPM EXPOSURE, 2000–2002

Authors, Year	Description	Conclusions	Agent(s) of toxicity
ILSI Risk Science Institute Workshop Participants, 2000.	Review of rat inhalation studies on chronic exposures to DPM and to other poorly, soluble nonfibrous particles of low acute toxicity that are not directly genotoxic.	No overload of rat lungs at lower lung doses of DPM and no lung cancer hazard anticipated at lower doses.	Poorly soluble particles, nonfibrous particles of low acute toxicity and not directly genotoxic (PSPs)
Nikula, 2000	Review of animal inhalation studies on chronic exposures to DE, carbon black, titanium dioxide, talc and coal dust.	Species differences in pulmonary retention patterns and lung tissue responses following chronic exposure to DE.	DE, carbon black, titanium dioxide, talc and coal dust
Oberdoerster, 2002	In Vivo: review of toxicokinetics and effects of fibrous and nonfibrous particles.	High-dose rat lung tumors produced by poorly soluble particles of low cytotoxicity (*e.g.,* DPM) not appropriate for low-dose extrapolation (to humans); lung overload occurs in rodents at high doses.	Fibrous particles, and nonfibrous particles that are poorly soluble and have low cytotoxicity (PSP)
Veronesi and Oortigiesen, 2001	In Vitro: review of nasal and pulmonary innervation (receptors) and pulmonary responses to PM, mainly BEAS cells and sensory neurons used.	Pulmonary receptors stimulated/ activated by PM, leading to inflammatory responses.	PM: residual oil fly ash, woodstove emissions, volcanic dust, urban ambient particulates, coal fly ash, and oil fly ash.

*Key:
(A) immunological and/or allergic reactions.
(B) inflammation.
(C) mutagenicity/DNA adduct formation.
(D) Induction of free oxygen radicals.
(E) airflow obstruction.
(F) impaired clearance.
(G) reduced defense mechanisms.
(H) adverse cardiovascular effects.

VII. Feasibility

A. Background on Feasibility

Section 101(a)(6)(A) of the Federal Mine Safety and Health Act of 1977 (Mine Act) requires the Secretary of Labor to establish health 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 over his or her working lifetime. Such standards must be based upon:

Research, demonstrations, experiments, and such other information as may be appropriate. In addition to the attainment of the highest degree of health and safety protection for the miner, other considerations shall be the latest available scientific data in the field, the feasibility of the standards, and experience gained under this or other health and safety laws. Whenever practicable, the mandatory health or safety standard promulgated shall be expressed in terms of objective criteria and of the performance desired. (Section 101(a)(6)(A)).

The legislative history of the Mine Act states:

This section further provides that ''other considerations'' in the setting of health standards are ''the latest available scientific data in the field, the feasibility of the standards, and experience gained under this and other health and safety laws.'' While feasibility of the standard may be taken into consideration with respect to engineering controls, this factor should have a substantially less significant role. Thus, the Secretary may appropriately consider the state of the engineering art in industry at the time the standard is promulgated. However, as the circuit courts of appeals have recognized, occupational safety and health statutes should be viewed as ''technology-forcing'' legislation, and a proposed health standard should not be rejected as infeasible ''when the necessary technology looms on today's horizon''. AFL–CIO v. Brennan, 530 F.2d 109 (3d Cir. 1975); Society of Plastics Industry v. OSHA, 509 F.2d 1301 (2d Cir. 1975), cert. denied, 427 U.S. 992 (1975). Similarly, information on the economic impact of a health standard which is provided to the Secretary of Labor at a hearing or during the public comment period, may be given weight by the Secretary. In adopting the language of [this section], the Committee wishes to emphasize that it rejects the view that cost benefit ratios alone may be the basis for depriving miners of the health protection which the law was intended to insure. S. Rep. No. 95–181, 95th Cong. 1st Sess. 21 (1977).

Though the Mine Act and its legislative history are not specific in defining feasibility, the courts have clarified the meaning of feasibility. The Supreme Court, in *American Textile Manufacturers' Institute* v. *Donovan* (OSHA Cotton Dust), 452 U.S. 490, 508–509 (1981), defined the word ''feasible'' as ''capable of being done, executed, or effected.''

In promulgating standards, hard and precise predictions from agencies regarding feasibility are not required. The ''arbitrary and capricious test'' is usually applied to judicial review of rules issued in accordance with the Administrative Procedures Act. The legislative history of the Mine Act indicates that Congress explicitly intended the ''arbitrary and capricious test'' be applied to judicial review of mandatory MSHA standards. ''This test would require the reviewing court to scrutinize the Secretary's action to determine whether it was rational in light of the evidence before him and reasonably related to the law's purposes.'' S. Rep. No. 95–181, 95th Cong., 1st Sess. 21 (1977).

Thus, MSHA must base its predictions on reasonable inferences drawn from existing facts. In order to establish the economic and technological feasibility of a new rule, an agency is required to produce a reasonable assessment of the likely range of costs that a new standard will have on an industry, and the agency must show that a reasonable probability exists that the typical firm in an industry will be able to develop and install controls that will meet the standard.

B. Technological Feasibility

At this stage of the rulemaking, MSHA concludes that a permissible exposure limit of 308 micrograms of EC per cubic meter of air (308_{EC} $\mu g/m^3$) is technologically feasible for the metal and nonmetal underground mining industry. Courts have ruled that in order for a standard to be technologically feasible an agency must show that modern technology has at least conceived some industrial strategies or devices that are likely to be capable of meeting the standard, and which industry is generally capable of adopting. *United Steelworkers of America, AFL–CIO–CLC* v. *Marshall,* (OSHA Lead) 647 F.2d 1273 (D.C. Cir. 1981) cert. denied, 453 U.S. 918 (1981) (citing *American Iron and Steel Institute* v. *OSHA*, (AISI–I) 577 F.2d 825 (3d Cir. 1978) at 834; and, *Industrial Union Dep't., AFL–CIO* v. *Hodgson*, 499 F.2d 467 (D.C. Cir.1974)). The existence of general technical knowledge relating to materials and methods which may be available and adaptable to a specific situation establishes technical feasibility. A control may be technologically feasible when Aif through reasonable application of existing products, devices or work methods with human skills and abilities, a workable engineering control can be applied'' to the source of the hazard. It need not be an ''off-the-shelf'' product, but ''it must have a realistic basis in present technical capabilities.'' (*Secretary of Labor* v. *Callanan Industries, Inc.* (Noise), 5 FMSHRC 1900 (1983)).

The Secretary may also impose a standard that requires protective equipment, such as respirators, if technology does not exist to lower exposures to safe levels. See *United Steelworkers of America, AFL–CIO–CLC* v. *Marshall,* (OSHA Lead) 647 F.2d 1164.

MSHA has established that technology is available that can accurately and reliably measure miners' exposures to DPM in all types of underground metal and nonmetal mines. MSHA intends to sample miners' exposures by using a respirable dust sampler equipped with a submicrometer impactor and analyze samples for the amount of elemental carbon using the NIOSH Analytical Method 5040, or any other method that NIOSH determines gives equal or improved accuracy, as stated in existing § 57.5061(b) and in this proposed rule.

MSHA is changing the surrogate that it uses to measure DPM exposures from total carbon (TC) to elemental carbon (EC). This change will avoid interferences associated with organic carbon that could collect on the filter and increase the likelihood of contaminating the sample with OC from non-diesel sources. MSHA agreed to propose this change as dictated by the DPM Settlement Agreement and the entire mining community supports this change.

Control mechanisms also exist that are capable of reducing DPM exposures to the interim PEL of 308 micrograms in all types of underground metal and nonmetal mines. MSHA believes that mine operators will choose from various control options that are currently available, including diesel particulate filter (DPF) systems, ventilation upgrades, oxidation catalytic converters, alternative fuels, fuel aditives, enclosures such as cabs and booths, improved maintenance procedures, newer engines (less DPM emitting), and various work practices and administrative controls. MSHA has given the mining industry flexibility in selecting DPM control options that best suit the mine operator's specific needs.

Based on the current information in the rulemaking record, MSHA concludes that it has a technologically feasible measurement method that operators and the Agency can use to accurately determine if miners' exposures exceed the limit. Both control mechanisms and the DPM sampling method are discussed elsewhere in this preamble. MSHA believes that the proposed standard would adequately address feasibility issues in one of two ways:

(1) Pursuant to § 57.5060(a) and (d) of the proposed rule. If MSHA determines that feasible engineering and administrative controls are being installed, used, and maintained and still do not reduce a miner's exposure to the limit, mine operators would be required to supplement controls with a respiratory protection program; or,

(2) Mine operators may apply to the MSHA district manager for approval for an extension of time in which to reduce miners' exposures to the DPM limit. MSHA is not proposing any maximum limit on the number of extensions an operator may have, since MSHA's decision hinges upon feasibility.

The proposal permits operators greater flexibility in complying with the DPM limit, contrary to the existing prohibition against using administrative controls and respiratory protection. Mine operators who need on-site technical assistance should contact the respective MSHA district manager for assistance. MSHA will continue to assist mine operators in special mining situations that could affect the successful use of DPM filters.

Section IV above contains the executive summary of the 31-Mine Study. As that section explains, the technical feasibility analyses in the 31-Mine Study were based on the highest DPM sample result obtained at each mine and on all major DPM emission sources at each mine in addition to spare equipment. The study found that five mines were already in compliance with the interim concentration limit, and another two mines were already in compliance with the existing lower, final concentration limit.

MSHA predicted that eleven of the 31 mines could achieve compliance with both limits through installation of DPM filters alone. Ventilation upgrades were specified for only 5 of the 31 mines in this study, and then only to achieve the final concentration limit. MSHA projected that compliance with the interim and final concentration limits could be achieved without requiring major ventilation installations such as new main fans and repowering main fans. In the existing standard, the agency based its feasibility projections on an average DPM concentration level of over 800 μg/m³. MSHA believes that miners' exposures are now much lower, probably as a result of the introduction of clean engines, better maintenance, and the elimination of interferences as confirmed by MSHA's compliance assistance baseline sampling.

MSHA collected baseline samples at most underground mines with diesel powered equipment. Samples were collected in the same manner as MSHA intends to sample for enforcement under the proposed rule. MSHA found the average exposure (based on EC × 1.3) in the baseline sampling to be 222 μg/m³ resulting in greater compliance feasibility with the proposed rule.

In spite of the concentrations observed in the 31-Mine Study, the industry parties in the litigation continued to stress that compliance with the existing standard was infeasible in that DPF systems could not be retrofitted properly and could not effectively achieve regeneration. Some operators also noted that they experienced difficulty in ordering and obtaining DPF systems. MSHA could not confirm these statements, but during the 31-Mine Study, the Agency did not find that mine operators were using filtration devices. Moreover, few mine operators actually contacted MSHA to ask for compliance assistance visits, in spite of the Agency's repeated offers to help. Once MSHA initiated its comprehensive compliance assistance work at underground mine sites, the Agency found that most mines did not have complete information on the available control technologies. Accordingly, MSHA stated in its final report on the 31-Mine Study regarding feasibility:

> Compliance with both the interim and final concentration limits may be both technologically and economically feasible for metal and nonmetal underground mines in the study. MSHA, however, has limited in-mine documentation on DPM control technology. As a result, MSHA's position on feasibility does not reflect consideration of current complications with respect to implementation of controls such as retrofitting and regeneration of filters. MSHA acknowledges that these issues influence the outcome of feasibility of controls. The agency is continuing to consult with NIOSH, industry and labor representatives on the availability of practical mine worthy filter technology.

Since this finding, however, MSHA and NIOSH have been working with the metal and nonmetal underground mining community and equipment manufacturers to continually refine and improve application of existing DPM control technology. The Agency has made considerable strides in resolving mine operators' concerns with the mine worthiness of DPF systems.

During data collection for the 31-Mine Study, mine operators also questioned the performance of the SKC sampler, especially in light of modifications to it. Additionally, some commenters requested that MSHA revise its internal sampling methodology and analysis for inspectors and laboratory personnel.

MSHA disagrees. One of the objectives of the 31-Mine Study was to examine the performance of the SKC sampler. The Agency is satisfied with the performance of the SKC cassette in collecting DPM while avoiding mineral dust. NIOSH's laboratory and field data show that the SKC cassette collected DPM efficiently. Under a side protocol of the 31-Mine Study, MSHA tested the efficiency of the SKC cassette in avoiding mineral dust at four mines. In these tests, no mineral dust was measured on the filters of the SKC samplers. This finding was confirmed by NIOSH laboratory tests. However, NIOSH discovered that in many cases, the DPM deposit area was irregular in shape, and the shapes varied among samples. Since the DPM deposit area is used to calculate carbon concentrations attributed to DPM, the varied shapes can cause an error in determining DPM concentrations. With the cooperation of MSHA and the technical recommendations and extensive experimental verification by NIOSH, SKC was able to modify the cassette design to produce a consistent and regular DPM deposit area, satisfactorily resolving the problem.

The fact that the deposit area was assumed constant when in fact there were variations in the boundary (shape) and area of deposit of the SKC cassette samples taken in the 31-Mine Study affects only the reported concentrations of the carbon values (EC, OC, and TC) because deposit area is used in concentration calculation. The results of the inter-laboratory and intra-laboratory studies that compared the analysis of the punches of those (or any) filters from the SKC cassette are unaffected for two reasons: (1) The deposit area does not enter into the calculations (surface densities of carbon in ug/cm² were compared), and (2) the punches were taken from filters inside the boundary of the area of deposits, where the deposits were uniform.

In their comments to the ANPRM, mine operators continued to emphasize the need for more research on control technology. Additionally, NIOSH commented:

> In conclusion, various manufacturers offer the particulate filters for diesel engines rated from 15 to several hundred hp. Although on the market for more than a decade, DPF systems have been only sporadically deployed and tested on underground mining vehicles. The DEEP-sponsored evaluation tests at Noranda BM&S and INCO Stobie Mines are based on our knowledge, the best organized attempts to evaluate DPFs in the underground environment. The results from these tests reveal that the DPF systems that have been evaluated on heavy-duty vehicles powered by engines rated over 277 hp and on light duty vehicles powered by 50 hp engines offer promising technology. However, this technology needs significant additional evaluation and some possible re-engineering for underground mining applications. In-use deficiencies, secondary emissions, engine backpressure, DPF regeneration, DPF reliability and durability are major issues requiring additional research and engineering. In addition, it is been found that deployment of most systems, particularly those which require active means of regeneration, require major changes in miners' attitudes toward engine and DPF maintenance. NIOSH's DEEP experienced showed that emission-based engine maintenance, greater discipline on the part of the vehicle operator, and better operational logistics (*e.g.*, multiple locations of regeneration stations for a single vehicle) are imperative for success of DPF technology.

To the contrary, the NIOSH comments in response to the ANPRM include a summary of their experience with retrofitting existing diesel powered equipment. NIOSH acknowledges that although diesel particulate filters have been available to U.S. mines for many years, they have not been extensively used and documented. NIOSH states that in-mine experience with filters is limited, but NIOSH also related their experience with the Diesel Emissions Evaluation Program (DEEP) in Canada. NIOSH stated:

[The DEEP program] has shown that these filters have significant potential for reducing DPM exposure of miners, but that there are numerous technical and operational issues that need to be addressed through research and in-mine evaluations before they can be readily implemented on a broad-based scale in U.S. mines.

MSHA has found that most mine operators can successfully resolve their implementation issues if they make informed decisions regarding filter selection, retrofitting, engine and equipment deployment, operations, and maintenance. The Agency recognizes that practical mine-worthy DPF systems for retrofitting most existing diesel powered equipment in underground metal and nonmetal mines are commercially available and are mine worthy to effectively reduce miners' exposures to DPM. MSHA also recognizes that installation of DPF systems will require mine operators to work through technical and operational situations unique to their specific mining circumstances. In view of that, MSHA has provided comprehensive compliance assistance to the underground metal and nonmetal mining industry.

Commenters to the ANPR responded to the question of changing a diesel engine model to accommodate a control device by stating that anything other than the original engine model is essentially incompatible and would require prohibitive design engineering analysis and implementation. MSHA agrees that it may not be feasible to change engines on some diesel powered equipment. However, as engine manufacturers develop cleaner engines over time, they are phasing out older models and newer, cleaner engine models are available from the same engine manufacturer. In some cases, the new engine models are direct replacements for an older model. The benefits of retrofitting a machine with a cleaner engine are better fuel economy, less DPM emitted from the tailpipe, better lubrication systems, and better diagnostic tools, especially with the electronic engines. A cleaner engine that emits less DPM will deposit less DPM on the filter, thus permitting more time between regeneration, especially in active regeneration systems or combination active/passive regeneration systems.

Filter Workshops

Recently, government, labor and industry sponsored two workshops on ''Diesel Emissions and Control Technologies in Underground Metal and Nonmetal Mines'' held in Cincinnati, Ohio, on February 27, 2003, and Salt Lake City, Utah, on March 4, 2003. These workshops focused on implementation of DPM control technologies capable of reducing DPM exposures to particulate matter and gaseous emissions from diesel-powered vehicles that are presently available to the underground metal and nonmetal mining industry in this country. The workshops provided an excellent forum for open discussion and the exchange of ideas and experiences relative to the use of diesel powered equipment in underground mines.

At the workshops, industry experts discussed issues pertaining to the installation and use of DPFs in underground mines. Application of technology and mine operators' experiences with using filters on their diesel powered equipment are becoming more commonplace in the mining industry since the promulgation of the DPM rule.

MSHA, NIOSH, and industry speakers presented their first-hand experiences with the implementation and use of diesel particulate filters in underground mines since promulgation of the existing DPM rule. Major diesel filter manufacturers and vendors of control technologies and engines also participated in the workshops.

NIOSH compiled a summary report to capture presentations, comments and discussions rendered at the workshops, including comments offered by industry representatives who shared their experiences with the effectiveness of DPM filters. MSHA believes that NIOSH's account of the workshops helps to demonstrate feasibility of control technology measures that mine operators have found beneficial and effective. MSHA mailed copies of the NIOSH report to mine operators covered by the proposed rule. This information also is available on the NIOSH Diesel List Server. At the workshops, the following information was discussed:

DPF Efficiency: Laboratory and field studies indicate that filtration efficiency for elemental carbon is above 95% and perhaps is as high as 99%.

MSHA worked with NIOSH at MSHA's laboratory to determine the efficiency of several ceramic filters. MSHA ran steady state tests on the dynamometer and collected DPM samples for NIOSH 5040 analysis. The results of the filter tests showed efficiency results close to 99% for elemental carbon. NIOSH commented:

The INCO project includes two Kubota M5400 tractors powered by Kubota F2803B 50 hp engines [Stachulak 2002]. Both are fitted with actively regenerated DPFs that have a silicon carbide (SiC) filter core. The SiC cores come from the same manufacturer; the DPF systems are supplied by different manufacturers. The filtration efficiency at the tailpipe is >99 percent for EC as determined by NIOSH using the EchoChem Analytics PAS 2000 carbon particle analyzer. One DPF system uses active on-board regeneration; electric heating coils are integrated into the unit and the unit is plugged into a regeneration controller mounted off board. The other unit is an active off-board system in which the DPF is removed from the vehicle and exchanged with the previously regenerated filter. The soot-laden filter is placed in a regeneration station. Both vehicles are assigned to ''special groups'' of individuals who ensure that the regenerations are performed as needed.

MSHA stated in the preamble to the January 19, 2001 Final Rule that filter efficiency for cordierite and silicon carbide media used in many DPF systems is 85% and 87% respectively for diesel DPM. These efficiencies were based on whole diesel particulate as collected per part 7, subpart E specifications for measuring DPM. The mining industry has expressed concern that laboratory results do not reflect the real world in both duty cycle and operational environment, so the Metal and Nonmetal Diesel Partnership and MSHA will conduct a set of in-mine tests before mid-2003.

DPF Selection: To use DPF systems successfully, mine operators must do their homework prior to ordering DPF systems. It is critical for filter performance and efficiency to match the filters to the diesel powered equipment and consider how the equipment is to be used in the underground mine. Mine operators should assume that every application is unique.

Following promulgation of the existing DPM rule, most mine operators were unaware that filter selection involves consideration of these factors. Therefore, in February 2003, MSHA and NIOSH posted on their web sites a comprehensive compliance assistance tool titled ''A DPM Filter Selection Guide for Diesel Equipment In Underground Mines'' (Filter Selection Guide). The guide provides mine operators with detailed step-by-step considerations in selecting DPF system compatible with the specific equipment. Also, the Filter Selection Guide provides information on modifications and adjustments to diesel powered equipment that mine operators may have to make to successfully apply DPF systems.

Mine operators should start by making certain that they are properly maintaining their engines and not consuming excessive amounts of crankcase oil. The mine operator may then obtain exhaust temperature logs or traces for several shifts, and use these traces to select the DPF systems with the regeneration options that will work for that piece of equipment. Exhaust temperature traces can be analyzed by mine personnel or given to several DPF suppliers to use to provide the operator with options.

Exhaust temperatures govern the DPF regeneration options. These options are provided in the Table VII–1.

TABLE VII–1.—DPF REGENERATION OPTIONS

Temperature that the exhaust exceeds 30% of the time, degrees C	DPF system (media consists of cordierite or silicon carbide ceramic)	Comments
>550	Uncatalyzed media	Rarely, if ever, occurs.
>390–420	Base metal catalyzed cordierite	No increase in NO_2.
>340	Lightly platinum catalyzed ceramic with CDT fuel additive.	Special provisions must be made to ensure additive is always present in fuel and that equipment w/o DPFs cannot be fueled with additive-containing fuel. No increase in NO_2.
>325	Platinum catalyzed ceramic	Lab results indicate significant NO to NO_2 conversion; field results are mixed.
>Any temperature below 325	Active (Manually) regenerated system	Insufficient exhaust temperature to support spontaneous regeneration during shift. DPFs are regenerated in place with equipment off-duty or DPF is swapped out.

As Table VII–1 shows, a DPF system will function successfully at or above an exhaust gas temperature specified by the manufacturer's regeneration temperature, that is, an active regenerating system will work at all exhaust temperatures, and a platinum catalyzed system at any temperature above 325°C. However, these exhaust gas temperatures must be achieved at least 30% of the time during the day to be sufficient for passive regeneration. In addition, the tune of the engine will also be a factor for proper regeneration. If an engine goes out of tune and begins to emit higher DPM concentrations in the exhaust, the exhaust backpressure may increase more quickly. Therefore, it is recommended that mine operators install backpressure devices on machines equipped with filters in order to properly monitor the condition of the filter and regeneration of the filter.

Table VII–1 also provides information in the ''Comments'' column on the effect of the filters coated with a catalyst on NO_2 emissions. MSHA has tested in their laboratory the types of filters listed and has posted on its Web site a list of the filters that can cause NO_2 increases from the engine and those catalytic formulations that do not significantly increase NO_2.

NO_2 is formed from NO in the engine's exhaust in the presence of the catalyst. This reaction occurs at exhaust gas temperatures at approximately 325°C. This temperature is also the temperature at which the platinum catalyst will allow for passive regeneration. Filter manufacturers have normally wash-coated their filters with large amounts of platinum to make sure that the filters will regenerate. This large concentration of platinum, in combination with longer retention time of the exhaust gas in the filter, results in the formation of NO_2. Manufacturers have been looking at wash-coat formulations containing less platinum loading to lower the NO_2 effects. Catalytic converters are also wash-coated with platinum, however, the loading used on catalytic converters is lower than ceramic filters. Due to faster movement of the exhaust gas through the catalytic converter compared to the ceramic filter, the effect of NO_2 increase is minimized.

MSHA is not aware of overexposures to NO_2 with the use of those catalyzed traps that MSHA has identified. MSHA issued a Program Information Bulletin (PIB 02–04, May 31, 2002) which alerted mine operators that catalyzed traps identified on our Web site could increase NO_2. Mine operators were advised to conduct sampling for NO_2 when these filters were used to ensure miners' are not overexposed or that the filters were causing a general increase of NO_2 in the mine's ambient environment. Mine operators who use catalyzed filters (which have the potential to increase NO_2) should have ventilation systems that are able to remove or dilute the NO_2 to a non-hazardous concentration. However, operators must be aware of localized areas where NO_2 could build up more quickly and create a health hazard for exposed miners.

As discussed in the Greens Creek report, the use of catalyzed filters on those machines used in the study did not indicate any substantial increase in NO_2. MSHA is continuing to work with filter manufacturers to evaluate catalytic formulations on NO_2 generation from the exhaust.

Active regeneration systems discussed below are normally not catalyzed which would then not produce an increase in NO_2. As stated above, NO_2 is generated when exhaust gas temperatures are normally high enough for passive regeneration. If the filter can passively regenerate, then there is a potential for increases in NO_2 emissions.

TABLE VII–2.—SCENARIOS FOR ACTIVE REGENERATION

System name	Regenerating location	Regenerating controller location	Comments
On-board–On-board	On Equipment	On Equipment	Requires source of electric power, normally 440 or 480 VAC.
On-board–Off-board	On Equipment	Designated and fixed-location	Requires equipment to come to a specific regeneration site.

TABLE VII–2.—SCENARIOS FOR ACTIVE REGENERATION—Continued

System name	Regenerating location	Regenerating controller location	Comments
Off-board	Off equipment	Fixed-location	DFPs are exchanged and must be small enough to be handled by one person. Increases number of DPFs needed.
On-board fuel burner	On-equipment	On-equipment during operation	System is complex yet provides advantages of operating during equipment use; manufacture has been discontinued.

Scenarios for active regeneration systems are listed in Table VII–2. The first two systems listed in Table VII–2 may require sufficient machine down time for regeneration, which is usually about one hour between shifts. Also, the equipment should be parked at a designated location during the regeneration period. MSHA recognizes that presently in some mines, production equipment is not brought to a specific location at the end of a shift. At mines where this occurs, mine operators may need to make changes to accommodate such DPF regeneration designs. Alternatively, mine operators may choose to have the equipment operator remove the DPF at the end of each shift and have the next operator replace it with a regenerated unit at the start of the shift. In short, mine operators must plug in the regeneration system at the end of the shift, or DPFs must be transported from the regeneration area to the equipment location. Multiple filters may be installed on a machine in the place of one filter in order to decrease the size and weight of the filters.

Under certain circumstances, some passive DPF systems have exhibited marginal regeneration. This is due to the fact that the duty cycle exhaust temperature is such that some but not all of the DPM is removed during the normal work shift. Slowly the DPM builds up until the DPF must be regenerated manually. In some instances, this needs to be done every 250 hours which would coincide with the regular preventive maintenance cycle for diesel powered equipment.

Achieving a long service life: The key to achieving a long service life from any DPF is to monitor and strictly adhere to exhaust back pressure limits and taking action appropriately. Passive regenerating systems are especially sensitive to equipment duty cycle. A change in duty cycle may reduce exhaust temperatures to a point that regeneration does not spontaneously occur. It is crucial that prompt attention is given to this situation and it is remedied before exhaust backpressures even reach the specified backpressure limit. Continuing to operate with an increasing exhaust backpressure will lead to overloading the DPF with soot. When regeneration is initiated, the large mass of soot may create temperatures hot enough to crack or melt the filter element, thus compromising the filter's efficiency. A similar scenario applies to active systems. Failure to timely regenerate the filter will cause increases in back pressure during a production shift which, if continued, will cause loss of engine power and may invalidate engine warranties.

Thermal runaway may also occur during manual regeneration. Because of the build up of ash, an unburnable component of diesel soot arising from burning lubrication oil, the baseline back pressure of any DPF will rise slowly. Approximately every 1,000 hours, the DPF should be cleaned of the ash following the manufacturer's procedure.

Engine malfunctions and effects on DPF: Normally in mining, engine malfunctions are indicated by excessively smoky exhaust. That indicator will not occur with DPF systems. Malfunctions such as excessive soot emissions, intake air restriction, fouled injector, and over-fueling, may result in an abnormal rise in back pressure in systems that do not spontaneously regenerate. Also, these conditions could lead to abnormal changes in back pressure in passive systems because the malfunction may raise exhaust temperatures causing the excess soot to be burned off. These malfunctions may be detected during the usual 250-hour maintenance and emissions checks conducted upstream of the DPF using carbon monoxide (CO) as an indicator.

The other major filter malfunction is excessive oil consumption that is sometimes associated with blue smoke that could be masked by the performance of the DPF. However, excessive oil consumption leads to a rapid increase in baseline backpressure due to ash accumulation. Excessive oil consumption can be detected if records are kept on oil usage.

Detecting malfunctioning DPF: As noted above, the DPF can be damaged mainly by thermal events such as thermal runaway. Shock, vibration, or improper ''canning'' of the filter element in the DPF can also lead to leaks around the filter element. A Bacharach/Bosch smoke spot test can be used to verify the integrity of a DPF. Smoke spot numbers below ''1'' indicate a good filter; smoke numbers above ''2'' indicate that the DPF may be cracked or leaking. Smoke spot and CO tests during routine 250 hour preventative maintenance is a good diagnostic practice. Note that although a smoke spot number above ''2'' may indicate a cracked or leaking filter, such a result does not necessarily mean the filter has ''failed'' and is not functioning adequately. In MSHA evaluations of DPF performance at the Greens Creek mine, filters that tested with smoke numbers above ''2'' were still shown to be over 90% effective in capturing elemental carbon, based on subsequent NIOSH 5040 analysis of the smoke spot filters.

Some commenters have suggested that diesel particulate filters are not a feasible DPM control option because they are not commercially available for the full range of engine horsepowers used in underground metal and nonmetal mining equipment, especially low horsepower units (less than 50 hp) and high horsepower units (greater than 250 hp). MSHA has found that suitable DPFs for engines of the horsepowers used in underground metal and nonmetal mining equipment are commercially available. The following discussion addresses low horsepower and high horsepower applications, respectively.

Low horsepower engines ranging from around 5 horsepower to around 100 horsepower are frequently used in ancillary and support mining equipment such as personnel transports, utility tractors, ''gators,'' fork lifts, pumps, welders, compressors, and similar equipment, both mobile and stationary. The duty cycle of this type of equipment is not sufficient to support passively controlled regeneration of a DPF. Thus, either on-board or off-board active filter regeneration is necessary.

In sizing an actively regenerated filter for these small horsepower engines, the only significant selection criterion is the desired time interval between active regenerations. For example, if the user wishes to regenerate a filter no more often than once per day, then the filter must have the capacity to store the maximum amount of soot generated by the subject engine over the period of one day while maintaining acceptable engine backpressure. If physical space to mount a filter is limited, the smallest filter having adequate soot storage capacity at the maximum acceptable backpressure would be selected. If space constraints are not an issue, a larger capacity filter would also be acceptable, with the larger size permitting a longer time interval between regenerations.

As a point of reference, a once-per-day actively regenerated DPF for a 60 hp personnel transport tractor operated for one shift per day is about 20 inches long by about 10 inches in diameter, and such filters are commercially available from multiple sources. If the same filter is fitted to a 30 hp engine having the same duty cycle and emission rate (expressed as g/bhp-hr), that filter will function just as well, but the time interval between regenerations would roughly double. Based on this DPF selection process, there is probably no lower limit to the size engine that can be effectively filtered using any of several commercially available active systems.

DPFs for low horsepower engines can also be provided by the original equipment manufacturer (OEM) or distributor as standard or optional equipment. An example is a Series 7 Toyota forklift equipped with a 40 hp 1DZ–II diesel engine for which a DPF–II diesel particulate filter is offered as an OEM or dealer-installed option. The DPF unit is about 14-inches long and about 8-inches in diameter, and is mounted on the rear of the forklift body.

Regarding high horsepower applications of DPF systems, for purposes of this discussion, ''high'' horsepower is meant to include engines of 250 horsepower and higher because this is the horsepower range addressed by the commenter. Engines of this size would typically be installed on production equipment such as loaders and haulage trucks and are commercially available from several manufacturers.

There are two approaches to filtering diesel particulate emissions that can be implemented on high horsepower engines using current commercially available DPF units: large capacity single unit DPFs; and multiple DPFs that are either manifolded to the same exhaust pipe, or separate DPFs that are provided on each side of a dual exhaust system.

An example of a large capacity single unit DPF system is the Engelhard model 9121A 15-inch long by 15-inch diameter Pt-catalyzed filters installed on the LHD and haulage trucks that were the subject of MSHA's compliance assistance diesel emissions tests at the Greens Creek mine. The LHD and all three haulage trucks were equipped with the same MSHA Approved 12.7 L engines rated at 475 hp at 2100 rpm. The LHD engine was derated to 300 hp, but this value still exceeds the commenter's threshold level of concern of 250 hp, and the truck engines were generating the full 475 hp. These DPFs passively regenerated on both the loader and haulage trucks, and the emission testing demonstrated filter efficiencies of greater than 90%.

The other approach to filtering high horsepower engines is to provide multiple filters. When an engine's exhaust is routed through a single exhaust pipe, the exhaust can be split into two parallel paths, with each path being equipped with a filter. When an engine has a dual exhaust system (*i.e.* separate exhaust pipes on either side of the engine, which is the most common arrangement on high horsepower engines), a DPF can be fitted to each exhaust pipe. This approach actually simplifies a DPF installation on an engine with dual exhausts, as installing a single filter would require modification of the exhaust system to join together the dual exhausts into a single exhaust pipe upstream of the filter. On underground equipment where space is at a premium, it may be easier to install two smaller filters than to find a space large enough to install one large filter.

Depending on the horsepower of an engine, space constraints, method of filter regeneration, and other factors, it may be necessary to split an engine's exhaust into more than two parallel paths for DPF installation. For example, each side of a dual exhaust system could be split into two parallel paths to facilitate the installation of DPFs on all four of the resulting exhaust pipes. There is no upper limit on the horsepower of an engine that could be filtered with standard, commercially available DPFs. For example, MSHA is aware of a stationary diesel-powered generator station rated at about 12,000 hp that has been filtered in this manner.

Although sizing a ceramic (SiC or cordierite) DPF is a rather complicated process that must take into account consideration for engine horsepower, engine DPM emissions (g/bhp-hr), duty cycle, constraints on regeneration, and other factors, the ''rule-of-thumb'' starting point for most filter manufacturers is typically 8 cubic inches of filter media volume per horsepower for an engine having a DPM emission rate of 0.1 g/bhp-hr. Due to manufacturing complications for larger units, the filter media is typically limited to a maximum size of 15-inches long by 15-inches in diameter. These dimensions correspond to a maximum of 330 hp per filter for an engine having an emission rate of 0.1 g/bhp-hr. For cleaner engines like those used in the Greens Creek mine testing, these dimensions correspond to a proportionally larger horsepower engine.

If each side of a dual exhaust system is split only once, requiring four separate DPFs, installation of 15x15 filters on each of the four branches would adequately filter a 0.1 g/bhp-hr emission engine rated at greater than 1,300 hp, which is larger than any engine currently used in underground metal and nonmetal mining, or likely to be used in the foreseeable future.

Importance of preventing exhaust leaks: Because the DPF is greater than 95% effective in removing elemental carbon from the exhaust, it is extremely important that the exhaust system upstream of the DPF be leak-tight. Leaks will leave a shadow of soot and are thus self-evident unless covered by insulation that disperses the leaking exhaust so that no distinct soot shadow is produced. Flex-pipe joints should be fastened securely using wide band clamps. Operators should not use flat flanges with gaskets, but use tapered tongue and groove joints to attain a positive seal.

Alternative Options

In addition to the feasibility of engineering control technology that was discussed at the NIOSH workshops (low emission engines, maintenance, fuels, and DPFs), MSHA believes that enhancing ventilation and enclosing miners in cabs or other filtered areas also are effective engineering controls for significantly reducing DPM exposures.

Administrative controls can effectively reduce miners' exposure to DPM. These include such practices as: reducing diesel engine idling time, reducing lugging of engines, designating certain areas ''off limits'' for operating diesel equipment, and establishing speed limits and one way travel.

MSHA acknowledges that depending upon the circumstances in a particular underground mine, some mine operators may face feasibility challenges implementing current DPM control methods. These operators should contact the MSHA district manager for compliance assistance.

Several commenters expressed the view that ventilation system upgrades, though potentially effective in principle, would be infeasible to implement for many mines. Specific problems that could prevent mines from increasing ventilation system capacity include inherent mine design geometry and configurations (drift size and shape), space limitations, and other external prohibitions, as well as economic considerations.

MSHA acknowledges that ventilation system upgrades may not be the most cost effective DPM control for many mines, and for others, ventilation upgrades may be entirely impractical. However, at many other mines, perhaps the majority of mines affected by this rule, ventilation improvements would be an attractive DPM control option, either implemented by themselves or in combination with other types of controls.

At many high-back room-and-pillar stone mines, MSHA has observed ventilation systems that are characterized by (1) Inadequate main fan capacity (or no main fan at all); (2) ventilation control structures (air walls, stoppings, curtains, regulators, air doors, and brattices, etc.) that are poorly positioned, in poor condition, or altogether absent; (3) free standing booster fans that are too few in number, of too small a capacity, and located inappropriately; and, (4) no auxiliary ventilation for development ends (working faces). At some mines, the ''piston effect'' of trucks traveling along haul roads underground provides the primary driving force to move air.

Often, the result of these deficiencies is a ventilation system that provides insufficient dilution of airborne contaminants, short circuiting, and airflow direction and volume controlled only by natural ventilation. These systems are barely adequate (and sometimes inadequate) for maintaining acceptable air quality with respect to gaseous pollutants (CO, CO_2, NO, NO_2, SO_2, etc.), and are totally inadequate as stand-alone controls for maintaining acceptable DPM levels.

Mines experiencing these problems could benefit greatly from upgrading main, booster, and/or auxiliary fans, along with the construction and maintenance of effective ventilation control structures. During DPM compliance assistance visits to several stone mines, MSHA has observed mine operators beginning to implement limited ventilation system upgrades, such as the addition of booster fans, brattice lines, and auxiliary ventilation in development ends, along with replacing older, high-polluting engines with newer, low-polluting models. MSHA believes that such ventilation upgrades, along with the replacement of as few as one to three engines may be sufficient for many stone mines to achieve compliance with the interim DPM limit.

Deep multi-level metal mines have entirely different geometries and configurations from high-back room-and-pillar stone mines. They typically require highly complex ventilation systems to support mine development and production. These systems are professionally designed, they require large capital investments in shafts, raises, control structures, fans, and duct work, and they are costly to maintain and operate. At these mines, ventilation system costs provide a major economic incentive to operators to optimize system design and performance, and therefore, there are typically few if any feasible upgrades to main ventilation system elements that these mines have not implemented already.

Despite these built-in incentives, however, MSHA has observed aspects of ventilation system operation at those types of mines that can be improved, usually relating to auxiliary ventilation in stopes. Auxiliary fans are sometimes sized inappropriately for a given application, being either too small (not enough air flow) or incorrectly placed (causing recirculation). Auxiliary fans that are poorly positioned draw a mixture of fresh and recirculated air into a stope. Auxiliary fans are sometimes connected to multiple branching ventilation ducts, so that the air volume reaching a particular stope face may be considerable less than the fan is capable of delivering. Perhaps most often, the ventilation duct is in poor repair, was installed improperly, or has been damaged by blasting or passing equipment to the extent that the volume of air reaching the face is only a tiny fraction of that supplied by the fan. MSHA believes that these, and similar problems, exist at many mines, even if the main ventilation system is well designed and efficiently operated.

Optimized auxiliary ventilation system performance alone, as one commenter noted, will not necessarily insure compliance with the DPM interim limit. Auxiliary ventilation systems simply direct air to a stope face so that the DPM generated within the stope can be diluted and carried back to the main ventilation air course. If air is already heavily contaminated with DPM when it is drawn into a stope by the auxiliary system, as could happen at mines employing series or cascading ventilation, the auxiliary system's ability to dilute newly-generated DPM is diminished.

In these situations, the intake to the auxiliary system must be sufficiently free of DPM to achieve the desired amount of dilution, requiring implementation of effective DPM controls upstream of the auxiliary system intake. Such upstream controls might include a variety of approaches, such as DPM filters, low-polluting engines, alternative fuels, and various work practice controls, as well as main ventilation system upgrades at the few mines where they might be feasible. Toward the return end of a series or cascading ventilation system, if the DPM concentration of the auxiliary system intake is still excessive, other engineering control options would include enclosed cabs with filtered breathing air on the equipment that operates within the stope, or remote control operation of the equipment in the stope to remove the operator from the stope altogether. Some commenters stated that feasibility was extensively reviewed in the existing rulemaking. These commenters noted that MSHA already determined that feasibility established for the existing rule must be presumed feasible until proven otherwise. In response to these commenters, MSHA emphasizes that since the agency is engaged in rulemaking that involves changing the surrogate, the DPM limit, as well as the hierarchy of controls, the Agency must review its existing position on feasibility of compliance for the mining industry. MSHA has done so in this preamble. Other commenters stated that mine operators have attempted to purchase and install DPM controls and they are either unavailable or, are neither technically and economically feasible. One issue raised by the commenters was the availability of filters for engines below 50 hp. Filter manufacturers supply filters for all horsepower sizes. MSHA is not aware of any gaps in filter availability. As stated at the recent workshops, most filter vendors stated that they have experience installing DPM filters on all horsepower size engines. However, normally with smaller engines, it would be expected that these systems would have to be regenerated with an active system. Again, MSHA is not aware of any problems with an active system for smaller engines. In regard to larger horsepower engines, again, at the workshops filter vendors stated that most had experience with larger horsepower engines. They referred to installations that were greater than 500 hp. As stated by the manufacturers, this is normally accomplished with multiple filters to accommodate the larger engines' higher exhaust flow rates. Again, either passive or active regeneration systems have been identified as being available for these large engines.

As discussed elsewhere in this preamble, the work conducted at the Greens Creek mine in Alaska showed that large horsepower engines, 475 hp used at this mine, could be equipped with ceramic filters and these DPFs were regenerated through passive regeneration. A filter rotation issue was identified at the beginning of this study, however, after further discussions with the filter vendor, it was determined that the problem was a manufacturing issue and was being worked out between the mine and the vendor. Even with the observed cracks due to the rotation of the filters, the results of tests showed that the filters continued to significantly reduce DPM from the engine, thus lowering the DPM in the test area.

A commenter also related a filter scenario that failed. This was reported as a cooperative effort between the machine manufacturer, engine manufacturer, and filter manufacturer for selection of a filter system for a 300 hp truck. The commenter stated that with this group working together, the filter system installed failed. MSHA was aware of this situation and understands that the problem was related to regeneration of the filter and not a filtration issue. MSHA believes that even with this cooperation, a vital piece of information concerning the duty cycle and exhaust gas temperatures generated from this truck was not properly communicated to the parties involved. This would lead to a failure where the system would have been set up to regenerate through a passive method, but in actuality, the machine needed an active system or active/passive system. As stated elsewhere, accurate information on the duty cycle/exhaust gas temperature of a vehicle is critical for successful filter installations. The condition of the engine and backpressure monitoring is also essential in choosing and installing a filter system.

As discussed previously in this preamble, MSHA and NIOSH developed the filter guide which makes mine operators and machine manufacturers aware of the issues that must be addressed to successfully engineer a filter to work on a machine. MSHA believes that if mine operators and equipment manufacturers utilize this guide, many of the problems identified with regeneration would be eliminated.

Other commenters stated that the existing limits are not feasible unless MSHA allows mine operators to use administrative controls and personal protective equipment, both of which are prohibited under the existing DPM rule. Consistent with the DPM settlement agreement, MSHA proposes to require its long-standing hierarchy of controls for engineering, administrative, and personal protective equipment. Some commenters stated that if elemental carbon (EC) is used, periodic diagnostic emission tests similar to those required under MSHA's existing standards for underground coal mines at § 75.1914(g) should be required for metal and nonmetal underground mines in order to compare emissions against an engine baseline to determine if elevated organic carbon levels are actually DPM rather than an interferent. These commenters also stated that OC and EC may not increase proportionally in an engine that is in a state of deterioration.

Section 75.1914(g) for underground coal mines requires weekly emission checks on the engine to determine the tune of the engine. The CO concentration must be measured during a repeatable loaded engine test, namely at torque stall. By measuring the CO on a weekly basis, a baseline is established for each engine. Any changes to the baseline of the CO concentration when the repeatable engine test is performed could be an indication that the engine is out of tune. This could be the result, for example, of a clogged intake air filter or a faulty injector. Whereas MSHA agrees that this type of engine testing could be useful as a diagnostic tool to determine the tune of the engine, MSHA noted in its ANPRM as well as in this proposal that the scope of this rulemaking is limited to the terms of the settlement agreement. However, MSHA requests specific comments from the mining community as to whether this test should be required in the final rule. Commenters should include whether or not any aspects of the current provision at § 75.1914(g) should be adopted or revised as part of the final rule.

It is well documented that an engine that is not in tune will emit higher levels of gaseous emissions and DPM emissions. An engine that is not tuned could have an immediate effect on miners' personal DPM exposures. The same commenter stated that the out-of-tune engine could be dismissed in the results of the ambient Method 5040 sampling as an interferent instead of an increase in DPM. The effects of individual engines would be very hard to localize with ambient testing. MSHA agrees that maintenance procedures that could detect any increases in exhaust emissions would aid in limiting miners' DPM exposures. The Agency's current DPM standard at § 57.5066 addresses both maintenance and tagging of equipment for out-of-tune engines. Poor engine performance will most likely result in black smoke that must be the reported to the mine operator and promptly given attention by a mechanic.

The Agency is aware of another diagnostic tool to determine the effectiveness of a ceramic filter. In a diagnostic ''smoke test,'' a sample of DPM is collected as a smoke dot on a filter paper and visually compared against a colorimetric scale. The test would be conducted while the diesel powered equipment is in a torque stall condition, which is a repeatable, high engine load condition for making this comparison. Normally, the raw exhaust before a filter would give a black spot. A sample taken after the filter should be basically white, indicating that the filter was working at its highest efficiency. Any cracks or defects in a ceramic filter would give a darker, grayish to black spot. This would be an indication to the mine operator of the current condition of the filter and of possible filter deterioration.

Smoke dot tests were conducted at the Greens Creek mine as a part of DPM compliance assistance activities at that mine. On one particular filter, the smoke dot produced after the DPM filter appeared to be as dark as the smoke dot before the DPM filter. Visual examination of the DPM filter showed cracks along its outer edges. When quantitative analysis of the dots was conducted using the NIOSH Method 5040 analysis, DPM filter efficiency was determined to be 92%. The efficiency of a different filter without any visual cracks was determined to be 99%. This demonstrates the value of the smoke dot test to detect a filter problem before filter performance has deteriorated significantly. However, even though defects in the DPM filter can affect its efficiency, this may or may not affect a miner's personal exposure to DPM. The smoke test can be done with a commercially available ECOM AC gas analyzer or a Bacharach/Bosch smoke test Apparatus. MSHA believes that this also is a good diagnostic tool for DPM filters. Running this test on a routine basis would give indications with any changes in the filter media. However, changes in the color of the smoke dot may not indicate that miners would be overexposed to DPM or that the filter should be removed from service. This test may give an indication to the mine operator that a fault is starting in the filter, and subsequently, that the DPM emissions could be increasing.

MSHA asked for comments concerning what technical assistance the Agency should provide to mine operators in retrofitting DPM control devices and evaluating ventilation systems or filtration of cabs. Commenters stated that MSHA should provide guidance in all these areas that involve control technologies. MSHA has been and will continue to provide these types of compliance assistance to underground metal and nonmetal mine operators. Mine operators are encouraged to use the Agency's DPM Single Source Page that includes comprehensive compliance assistance tools addressing the aforementioned issues as well as others.

MSHA has been instrumental in providing compliance assistance to the mining industry. MSHA conducted a number of outreach workshops throughout the country to discuss requirements of the DPM standard and sampling and control technology information. These meetings were held in Lexington, Kentucky; Kansas City, Missouri; Green River, Wyoming; Albuquerque, New Mexico; Elko, Nevada; Coeur d'Alene, Idaho; Knoxville, Tennessee; Des Moines, Iowa; and Ebensburg, Pennsylvania. MSHA also completed baseline sampling at the underground mines covered by the DPM standard, and made site-specific compliance assistance visits.

To further assist mine operators, MSHA and NIOSH have developed compliance assistance tools, many of which are currently available to operators on MSHA's DPM Single Source Page on MSHA's web site. The NIOSH mining web page is available to mine operators as well. Mine operators should give special attention to MSHA/NIOSH's Filter Selection Guide. As explained earlier in this preamble, this document provides mine operators with detailed step-by-step selection factors that can be applied to particular pieces of diesel-powered equipment in their mine. It is an interactive compliance assistance tool that allows mine operators to answer questions on their individual mining operation to select, retrofit and maintain the best available filter technology. This guide will be updated as new technologies are introduced in the underground mining industry.

Also included on MSHA's DPM sole source web page are the Estimator computer program; a list of available filters and manufacturers; the draft DPM compliance guide which contains MSHA's enforcement policy; MSHA sampling procedures; the slide presentation from MSHA's outreach seminars on the requirements of the DPM standard; information on how MSHA calculated the error factor to be used when making compliance determinations; a troubleshooting guide for addressing problems with control technology; along with the NIOSH notes from the filter workshops as discussed above. In addition, MSHA has posted "Best Practices" for various issues concerning the use of DPM filters.

MSHA also provided compliance assistance at individual mines through its involvement with bio-diesel projects, fuel catalyst installations, and in-mine evaluations of DPM filter technologies. MSHA's diesel testing laboratory located in Triadelphia, WV has been active in evaluating many of these control technologies. The Agency tested and provided information on the effects, if any, on nitrogen dioxide production for specific catalyzed DPM filters.

The Agency continues to consult with the Metal and Nonmetal Diesel Partnership (the Partnership). The Partnership is composed of NIOSH, industry trade associations, and organized labor. MSHA is not a member of the Partnership due to its ongoing DPM rulemaking activities.

A discussion of additional comments follows.

One commenter responded to MSHA's ANPRM questions regarding retrofitting engines by stating that anything other than the original engine model is unsuitable for a piece of diesel powered equipment. According to this commenter, this would require prohibitive design engineering analysis and implementation. MSHA agrees that on some machines it may not be feasible to change engines. As engine manufacturers develop cleaner engines, however, the older models are being phased out and newer, cleaner engine models are available from the same engine manufacturer. In some cases, the new engine models are direct replacements for an older model. Among the benefits of retrofitting a piece of diesel powered equipment with a cleaner engine are better fuel economy, reduced DPM emissions, improved lubrication systems, and better diagnostic tools, especially with the electronic engines. A cleaner engine that emits less DPM will deposit less DPM on the filter, thus resulting in longer intervals between regenerations, especially in active regeneration systems or combination active/passive regeneration systems.

MSHA asked for comments on whether cabs would be feasible and appropriate for controlling DPM exposures. Commenters responded that operators normally would not purchase a cab to control DPM. Cabs are used for controlling exposures to respirable dust, however, and the results of MSHA's sampling at the Greens Creek mine (MSHA, January 2003) show approximately 85% reduction in DPM when using a filtered cab on a loader. Cabs, however, do not protect workers outside the cab or downwind in series ventilation systems.

Another commenter stated that dimensional constraints of their mine preclude use of cabs on equipment. MSHA is aware that some mines may not be able to use cabs due to dimensional constraints. Environmental cabs can be an effective feasible DPM control device for some mine operators. Many new pieces of diesel powered equipment are sold with enclosed cabs. Besides DPM exposure, an enclosed cab with filtered breathing air would also help reduce exposure to other airborne contaminants and noise.

Commenters provided information on the cost of filters, for both passive and active systems. Information stated that active systems, depending on product specifications, had a higher cost. MSHA agrees with the commenters on cost. However, some of the higher costs of the active system can be spread out over several vehicles. This means that several filters that need active regeneration can be done at the same regeneration station when filters are removed from the machine. The mine can purchase backup filters for each machine and only one regeneration station. If operators chose active, on-board, regeneration, the unit that the machine plugs into can be available for several machines. As stated previously, mine operators may need to administratively adjust machine operating schedules to accommodate active regeneration. MSHA believes that this filter technology is economically feasible for the industry.

One commenter stated that there has been little experience with off board regeneration. MSHA is aware of successful applications in M/NM mines with active regeneration units. MSHA has posted on its homepage best practices for active regeneration stations in M/NM mines. Several problems that have been reported on active regeneration stations are discussed below in association with regeneration stations located at mines greater than 5000 feet in elevation.

The Agency requested data and information from the mining community in its ANPRM on high altitude effects on control devices. Commenters noted that MSHA had conducted the test in an underground coal mine located in a high altitude area and that used diesel powered equipment. MSHA worked with the coal mining industry to determine whether high altitudes affected the performance of ceramic filters in controlling DPM emissions. The Agency found no evidence to conclude that altitude affects filtration performance. Some initial verbal comments were received stating that active regeneration stations could not operate effectively at higher altitudes, but further investigation by the coal mine operators and the filter manufacturers indicated that the problem was due to improper use of the equipment. One situation was that an incorrect setting in the control panel on an active regeneration station was determined to be the problem. In another instance, the mine was not following the schedule for active regeneration and allowed the filter to become overloaded with DPM thus preventing proper regeneration. MSHA has made mine operators aware of these problems.

The Agency believes that at high altitudes, excessive DPM is produced whenever the engine is improperly derated for elevation, such as, the fuel:air ratio is not properly set. Mine operators should check with the engine manufacturer or the engine distributor to verify that the engine is set to the proper fuel setting specification, especially when the engine is operating above 1000 feet in elevation. Increases in DPM emitted could overload the filter and not allow proper regeneration of either a passive or active system. Mine operators should install backpressure monitoring devices when a filter is installed and follow engine manufacturers' recommendations for maximum allowable exhaust backpressure.

Some commenters to the ANPRM stated that diesel particulate filters cannot work in their mines, or DPM filters are not feasible for a number of reasons. MSHA has stated that all commercially available ceramic filters can significantly reduce DPM levels. Regeneration schemes have been identified in this preamble that can be feasibly applied to all types of underground mining machines. Commenters also stated that active regeneration systems are not feasible in their mining operations although no specific scenarios were provided to the Agency to respond to the concern. MSHA believes that the active systems offer a variety of advantages, such as no dependence on exhaust gas temperature or duty cycle, no increases in NO_2, and easier installation due to less restraints for installation of filters close to the exhaust outlet. MSHA understands that active regeneration systems may require mines to make adjustments in their fleet management in order to guarantee that active regeneration works. However, active regeneration systems are commercially available and feasible. MSHA requests that mine operators provide more specific information on the issues associated with the diesel powered equipment that would need active regeneration systems.

Several commenters expressed the view that ventilation system upgrades, though potentially effective in principle, would be infeasible to implement for many mines. Specific problems that could prevent mines from increasing ventilation system capacity include inherent mine design and configurations (drift size and shape), space limitations, and other external prohibitions, as well as economic considerations. MSHA acknowledges that ventilation system upgrades may not be a cost effective DPM control for mines with these limitations. To the contrary, MSHA anticipates the metal and nonmetal underground mining industry will comply with the DPM interim limit primarily through the application of DPF systems rather than ventilation upgrades.

At this time, MSHA estimates that mine operators may not be able to achieve compliance with the proposed DPM limit for every underground miner on every shift, particularly those engaged in inspection, maintenance and repair activities. Existing § 57.5060(d)(2) identifies exceptional conditions where MSHA anticipates that it may not be feasible for many mine operators to use engineering and administrative controls. These conditions, which presently exist in some mines include inspection, maintenance, and repair activities conducted exclusively outside of environmentally controlled cabs or enclosed booths. The existing rule requires mine operators to apply to the Secretary for relief from applying control technology to reduce the concentration limit. MSHA traditionally does not accept use of personal protective equipment for compliance with its other exposure-based standards applicable to metal and nonmetal mines, except while establishing controls or during occasional entry into hazardous atmospheres to perform maintenance or investigations. This proposal would allow the use of personal protective equipment when all feasible and administrative controls have been implemented. MSHA has included in this proposed rule a tiered approach in controlling miners' exposures that operators must use in achieving compliance. MSHA anticipates that very few mine operators will have significant compliance problems with meeting the proposed DMP limit in circumstances other than inspection, maintenance, and repair activities.

The exposure data relied on by MSHA in making its technological feasibility determinations include the final report on the 31-Mine Study, and results of MSHA's DPM baseline compliance assistance sampling conducted at each underground mine covered by the standard. In the 31-Mine Study, the data showed that many miners' exposures are below the proposed DPM limit without application of any additional engineering or administrative controls. The sampling data includes miners' exposures by job category to permit the Agency to pinpoint those occupations in need of additional controls to achieve compliance with the interim PEL.

DPM engineering controls are not new technology. Moreover, the existing DPM standard was promulgated on January 19, 2001 (66 FR 5706) with an effective date of July 19, 2002 for existing § 57.5060(a). As a result of the settlement agreement, MSHA allowed mine operators to take an additional year in which to begin to install appropriate controls to reduce DPM concentrations due to feasibility constraints. Any controls currently used to meet the existing concentration limit may also be used to reduce miners' exposures to DPM required under this rulemaking.

Because of the lack of documented feasibility data for an interim proposed PEL of less than 308 micrograms per cubic meter of air, MSHA has concluded that there is insufficient information available to support the feasibility of lowering the DPM limit at this time. The Agency believes that this level is a reasonable interim limit for which MSHA currently can document feasibility across the affected sector of underground metal and nonmetal mines. MSHA is continuing to gather information on the feasibility of compliance with a final DPM PEL of less than 308 micrograms.

C. Economic Feasibility

MSHA believes the requirements for engineering and administrative controls clearly meet the feasibility requirements of the Mine Act, its legislative history, and related case law. A PEL of 308 micrograms per cubic meter of air is economically feasible for the metal and nonmetal mining industry. Demonstrating economic feasibility does not guarantee the continued viability of individual employers. It would not be inconsistent with the Mine Act to have a company which turned a profit by lagging behind the rest of an industry in providing for the health and safety of its workers to consequently find itself financially unable to comply with a new standard; *Cf, United Steelworkers,* 647 F.2d at 1265. Although it was not Congress' intent to protect workers by putting their employers out of business, the increase in production costs or the decrease in profits would not be sufficient to strike down a standard. *Industrial Union Dep't.,* 499 F.2d at 477. On the contrary, a standard would not be considered economically feasible if an entire industry's competitive structure were threatened. *Id.* at 478; see also, AISI–II, 939 F.2d at 980; *United Steelworkers,* 647 F.2d at 1264–65; AISI–I, 577 F.2d at 835–36. This would be of particular concern in the case of foreign competition, if American companies were unable to compete with imports or substitute products. The cost to government and the public, adequacy of supply, questions of employment, and utilization of energy may all be considered.

MSHA determined that an elemental carbon PEL comparable to the existing concentration limit, along with primacy of engineering and administrative controls as proposed would reduce the cost for compliance required under the existing rule, and industry agrees. Industry commenters stated that operator costs will be reduced since MSHA would be changing the DPM surrogate from TC to EC which would reduce the likelihood of contamination and eliminates the necessity to re-sample. MSHA describes its finding in this preamble under section VIII, ''Summary of Costs and Benefits,'' and in more detail in section X, ''Regulatory Impact Analysis.'' A more comprehensive version is available in the Preliminary Regulatory Economic Analysis on MSHA's web site.

MSHA also believes that the proposed effective date of 30 days for a final rule is feasible for underground mine operators in this sector since the EC surrogate standard is comparable to the existing TC surrogate standard which has been in effect since July 2002. Additionally, as a result of a DPM partial settlement agreement mine operators were given an additional year to begin to develop a written strategy of how they intended to comply with the interim DPM concentration limit. Operators with DPM levels above the concentration limit were to begin to order and install controls to be in compliance by July 20, 2003.

Nevertheless, MSHA recognizes that, in a few cases, individual mine operators, particularly small operators, may have difficulty in achieving full compliance with the interim limit immediately because of a lack of financial resources to purchase and install engineering controls. However, MSHA expects that these mine operators will be able to achieve compliance with the recommended interim limit of 308 micrograms. Whether controls are feasible for individual mine operators is based in part upon legal guidance from the Federal Mine Safety and Health Review Commission (Commission). According to the Commission, a control is feasible when it: (1) Reduces exposure; (2) is economically achievable; and (3) is technologically achievable. *Secretary of Labor* v. *Callanan Industries, Inc.,* 5 FMSHRC 1900 (1983). In determining the technological feasibility of an engineering control, the Commission in Callanan has ruled that a control is deemed achievable if, through reasonable application of existing products, devices, or work methods, with human skills and abilities, a workable engineering control can be applied. The control does not have to be an ''off-the-shelf'' item, but it must have a realistic basis in present technical capabilities. *Ibid.* at 1908.

In determining the economic feasibility of an engineering control, the Commission has ruled that MSHA must assess whether the costs of the control is disproportionate to the expected benefits, and whether the costs are so great that it is irrational to require its use to achieve those results. The Commission has expressly stated that cost-benefit analysis is unnecessary in order to determine whether a noise control is required. *Ibid.*

Consistent with Commission case law, MSHA considers three factors in determining whether engineering controls are feasible at a particular mine: (1) The nature and extent of the overexposure; (2) the demonstrated effectiveness of available technology; and (3) whether the committed resources are wholly out of proportion to the expected results. A violation under the final standard would entail an Agency determination that a miner has been overexposed, that controls are feasible, and that the mine operator failed to install or maintain such controls. According to the Commission, an engineering control may be feasible even though it fails to reduce exposure to permissible levels contained in the standard, as long as there is a significant reduction in a miner's exposure. *Todilto Exploration and Development Corporation* v. *Secretary of Labor,* 5 FMSHRC 1894, 1897 (1983). In *Todilto,* the Commission ruled that engineering controls may also be feasible even though they fail to reduce exposure to permissible levels contained in the standard, as long as there is a significant reduction in exposure.

Current data establishes that DPF systems are extremely efficient in that they reduce elemental carbon emissions from the tailpipe of a piece of diesel powered equipment by as much as 99%. MSHA believes that this is an exceptionally high efficiency rate for a single engineering control in the mining industry. Therefore, MSHA intends to identify the source or sources of DPM emissions leading to a miner's overexposure. A mine operator would be required to install a single control or a combination of controls that is capable of reducing the miners' DPM exposure by 25%.

MSHA evaluated various engineering and administrative controls and their related costs. Mine operators would have the flexibility under the proposed rule to select the type of engineering and administrative controls of their choice in order to reduce a miner's exposure to the DPM limit. MSHA, however, believes that the most cost effective control would be to install DPF systems due to their high rate of efficiency, especially with respect to EC.

If MSHA finds that a miner is overexposed to the DPM standard, and determines that engineering and administrative controls are feasible, and that the operator failed to install or maintain such controls, MSHA would issue a citation to the mine operator for overexposing the miner to DPM. The citation would include an appropriate abatement date for installing feasible controls. In the interim, a respiratory protection program would be required while controls are being installed. As long as miners' DPM exposures are reduced to or below the DPM limit, mine operators have the flexibility under the proposed rule to choose the engineering or administrative controls that best suit the mines' circumstances. MSHA emphasizes that it is available to provide compliance assistance to mine operators to help them select appropriate control methods for reducing miners exposures based upon demonstrated experience.

MSHA asked for comments concerning what type of technical assistance the Agency should provide to mine operators in retrofitting DPM control devices, evaluating ventilation systems or filtration of cabs. Commenters stated that MSHA should be providing guidance in all areas that involve control technologies. MSHA agrees and will continue to assist mine operators, however, MSHA expects mine operators to make good faith efforts in attempting to achieve compliance, such as beginning to order control technology to reduce DPM exposures.

VIII. Summary of Costs and Benefits

The provisions in this proposed rule will assist mine operators in complying with the existing rule, thereby reducing a significant health risk to underground miners. This risk includes lung cancer and death from cardiovascular, cardiopulmonary, or respiratory causes, as well as sensory irritation and respiratory symptoms. In Chapter III of the Regulatory Economic Analysis in support of the January 19, 2001 final rule (2001 REA), the Agency demonstrated that the rule will reduce a significant health risk to underground miners. This risk included the potential for illnesses and premature death, as well as the attendant costs to the miners' families, to the miners' employers, and to society at large. Benefits of the January 19, 2001 final rule include reductions in lung cancers. MSHA estimated that in the long run, as the mining population turns over, a minimum of 8.5 lung cancer deaths per year will be avoided. MSHA noted that this estimate was a lower bound figure that could significantly underestimate the magnitude of the health benefits. For example the estimate based on the mean value of all the studies examined in the January 19, 2001 rule was 49 lung cancer deaths avoided per year.

The proposed rule results in net cost savings of approximately $15,641 annually, primarily due to reduced recordkeeping requirements. All MSHA cost estimates are presented in 2001 dollars. This represents an average savings of $86 per mine for the 182 underground metal/non-metal mines that would be affected by this proposed rule. Of these 182 mines, 65 have fewer than 20 workers, 113 have 20 to 500 workers; and 4 have more than 500 workers. The cost savings per mine for mines in these three size classes would be $102, $77, and $77, respectively. In the 2001 REA, the Agency estimated that the costs per underground dieselized metal or nonmetal mine to be about $128,000 annually, and the total cost to the mining sector to be about $25.1 million a year, even with the extended phase-in time. Nearly all of those anticipated costs would be investments in equipment to meet the interim and final concentration limits.

IX. Section-by-Section Discussion of the Proposed Rule

A. Section 57.5060(a)

Existing § 57.5060(a) establishes an interim DPM concentration limit of 400 micrograms of TC per cubic meter of air (400_{TC} µg/m^3). In the settlement agreement, MSHA agreed to propose to change the surrogate from TC to EC, and to propose to establish an interim limit based on a miner's personal exposure rather than an environmental concentration. Accordingly, the proposed rule would establish an interim permissible exposure limit (PEL) of 308 micrograms of EC per cubic meter of air (308_{TC} µg/m^3). This proposed EC-based limit represents the existing TC limit divided by a conversion factor of 1.3, as established in the settlement agreement. MSHA believes that the proposed limit is equivalent to the existing interim concentration limit of 400_{TC} µg/m^3.

MSHA's position at this time is that a limit of 308 µg/m^3, based on EC, is both technologically and economically feasible for the metal and nonmetal mining indutry to achieve. Although the risk assessment indicates that a lower interim DMP limit would enhance miner protection, it would be infeasible for the underground metal and nonmetal mining industry to reach a lower interim limit.

MSHA is not reducing the protection for miners afforded by the existing interim TC concentration limit. MSHA intends to finalize an interim EC limit that provides at least the same degree of protection to miners as the existing interim limit. MSHA believes that establishing a standard that focuses control efforts on diminishing the DPM level in air breathed by the miner is at least as protective as the interim concentration limit.

The basis for this position is found in the 31-Mine Study, which concluded that the submicron impactor was effective in removing the mineral dust, and therefore its potential interference, from the DPM sample. Remaining carbonate interference is removed by subtracting the 4th organic peak from the analysis. No reasonable method of sampling was found that would eliminate interferences from oil mist or that would effectively measure DPM levels in the presence of environmental tobacco smoke (ETS) with TC as the surrogate.

Using EC as the surrogate would enable MSHA to directly sample miners, such as those who smoke or load ANFO, for whom valid personal sampling would be difficult when TC is the surrogate.

Because EC comprises only a fraction of the TC, a conversion factor must be used to convert the interim concentration limit to an EC exposure limit. To convert the interim TC concentration limit in § 57.5060(a) to an equivalent EC exposure limit, MSHA is proposing to use a factor of 1.3, to be divided into 400_{TC} µg/m^3. Thus, the measured value of EC times 1.3 produces a reasonable estimate of TC. This 1.3 factor was specified under the terms of the settlement agreement to convert an EC measurement into an estimate of TC without interferences and is based on the median total carbon to elemental carbon (TC/EC) ratio observed for valid samples in the 31-Mine Study. The 1.3 factor is also consistent with information supplied by NIOSH indicating that the ratio of TC to EC in the 31-Mine Study is 1.25 to 1.67. Most commenters to MSHA's ANPRM supported an interim EC PEL of 400_{TC} µg/m^3 ÷ 1.3 = 308_{EC} µg/m^3.

Commenters representing the metal and nonmetal mining industry and labor strongly supported a change in the surrogate from TC to EC. These commenters stated that, given the interferences known to be present in underground mining environments, using EC as the surrogate would improve the validity of samples. They also pointed out that this change is consistent with the settlement agreement. Other commenters opposed changing the surrogate. Some of these commenters stated that since DPM has many components, and there is no formula for the exact amount of EC in diesel exhaust, TC is a more accurate measure of DPM than is EC, presumably because it includes more of the DPM.

Some commenters also stated that there is no evidence in the rulemaking record to support this change. According to these commenters, NIOSH must provide a clear statement that EC is an accurate surrogate over the full range of mining conditions and must also provide a formula for converting EC to DPM that meets the NIOSH accuracy criterion. In response, the existing DPM rulemaking record contains NIOSH's position on an appropriate surrogate, and NIOSH recommended that EC rather than TC should be used as the surrogate for DPM. MSHA agrees.

MSHA has found that EC more consistently represents DPM. In comparison to using TC as the DPM surrogate, using EC would impose fewer restrictions or caveats on sampling strategy (locations and durations), would produce a measurement much less subject to questions, and inherently would be more precise. Furthermore, NIOSH, the scientific literature, and the MSHA laboratory tests indicate that DPM, on average, is approximately 60 to 80% elemental carbon, firmly establishing EC as a valid surrogate for DPM.

Some commenters opposing a change in the surrogate stressed that the mix of EC + OC (to equal TC) is highly variable. Some commenters questioned the use of EC as a surrogate for DPM because the EC:TC ratio varies with each engine and EC is emitted from other sources. Other commenters, noting that a specific mine in the 31-Mine Study had an EC:TC ratio of 85%, stated that there is no perfect way to monitor DPM using surrogates.

MSHA agrees that the EC:TC ratio can vary significantly, not only from mine to mine but also within a mine, depending on equipment configuration and usage. MSHA also agrees that there is no perfect way to precisely quantify DPM. Using EC as a surrogate, however, results in a much more accurate assessment of miners' exposures to DPM than using TC. MSHA seeks information and data on the appropriateness of 1.3 as the factor to convert EC to TC, and an interim EC limit of 308 micrograms.

As part of the settlement agreement, MSHA agreed that the Agency will issue citations for violations of the interim exposure limit only after MSHA and NIOSH are satisfied with the performance characteristics of the SKC sampler and the availability of practical mine worthy filter technology, and MSHA has had the opportunity to train inspectors, conduct baseline sampling and provide compliance assistance at underground metal and nonmetal mines using diesel-powered equipment. MSHA will continue consulting with NIOSH, industry and labor representatives on the performance of the SKC sampler and the availability of practical mine-worthy filter technology.

MSHA trained the Metal and Nonmetal district health specialists and industrial hygienists on diesel particulate sampling in Beckley, West Virginia in September 2002. These individuals returned to their respective districts and trained MSHA compliance specialists on diesel particulate sampling. MSHA has completed the commpliance assistance baseline sampling. As part of its compliance assistance efforts, MSHA personnel were available during the baseline sampling to provide guidance to mine operators on sampling procedures.

Additionally, MSHA trained members of the mining industry on conducting DPM sampling and made that training available to industry personnel at compliance assistance workshops following the Outreach Seminars on Diesel Particulate Rules for Underground Metal and Nonmetal Mines. These seminars and workshops were conducted at nine cities during September and October 2002.

MSHA and NIOSH have reviewed the performance characteristics of the SKC sampler and are satisfied that it accurately measures exposures to DPM. Results of the 31-Mine Study demonstrated that the SKC submicron impactor removed potential interferences from mineral dust from the collected sample. MSHA concluded in its findings in the study, however, that:

> No reasonable method of sampling was found that could eliminate interferences from oil mist or that would effectively measure DPM levels in the presence of ETS with TC as the surrogate.

Furthermore, MSHA has found that use of elemental carbon eliminates potential sample interference from drill oil mist, tobacco smoke, and organic solvents.

Some industry commenters stated that the sampling and analytical processes are too new for regulatory use. According to these commenters, SKC recently changed the impactor, and NIOSH should test the new SKC sampler and evaluate its comparability to the model used in the 31-Mine Study. One of these commenters stated that the shelf life of the prior sampler affected TC measurements by adsorbing OC from the polystyrene assembly onto the filter media and increasing TC measurement. Some commenters also stated that there are significant back-order and manufacturing delays for samplers and that operators who sample alongside MSHA need ample notice to have enough samplers available.

MSHA purchased many of the initial production runs of these samplers to conduct its compliance assistance baseline sampling. Once the initial orders were filled, the sampler became more widely available.

Prior to the 31-Mine Study, MSHA had determined the deposit area of the sample filter to be 9.12 square centimeters with a standard deviation of 3.1 percent. During the initial phases of the 31-Mine Study, it became apparent that the variability of the deposit area was greater than originally determined. The filter area is critical to the concentration calculation. The filter area (square centimeters) is multiplied times the results of the analysis (micrograms per square centimeter) to get the total filter loading (micrograms). While individual filter areas could be measured, it is more practical to have a uniform deposit area for the calculations. As a result, NIOSH and MSHA consulted with SKC to develop an improved filter cassette design. SKC, in cooperation with MSHA and NIOSH, then modified the DPM cassette following the 31-Mine Study.

The modification was limited to replacing the foil filter capsule with a 32-mm ring. This was done to give a more uniform deposit area (8.04 square centimeters) and to accommodate two 38-mm quartz fiber filters in tandem (double filters). These double filters are assembled into a single cassette along with the impactor. The 32-mm ring gives a filter deposit area of 8.04 square centimeters, with negligible variability. The 38-mm filters also eliminate cassette leakage around the filters. These modifications were completed and incorporated into units manufactured after November 1, 2002. Because the design of the inlet cyclone, impaction nozzles, the impaction plate and the flow rate did not change, the modifications to the filter assembly did not alter the collection or separation performance of the impactor. Throughout the compliance baseline sampling, the impactor has been a consistent and reliable sampling cassette.

Tandem filters were used in the oil mist and ANFO interference evaluations. The top filter collects the sample and the bottom filter is a ''dynamic blank.'' The dynamic blank provides a unique field blank for each DPM cassette. The proposed use of elemental carbon as a surrogate would resolve the commenter's concern about shelf life and OC out-gassing on the filter. Shelf life and OC out-gassing are issues relative to organic carbon measurements. These two issues do not apply to an elemental carbon measurement. Once the cassettes have been preheated, during manufacturing, there is no source, other than sampling, to add elemental carbon to the sealed cassette filters.

In the ANPRM, MSHA asked questions on three topics relating to DPM sampling and analysis:

(1) Interferences

In response to the question on interferences when EC is used as the surrogate, some commenters stated that interferences were thoroughly discussed in the final rule preamble and that reasonable practices to avoid them were stipulated in the rule itself. According to these commenters, this problem should not be revisited in this rulemaking.

Other commenters maintained that the 31-Mine Study did not contain the necessary protocols to address all potential interferences. Thus, in their view, MSHA does not have all the data required to answer this question. More specifically, some commenters stated that carbonaceous particulate in host rock has a smaller diameter than the impactor cut point and so may contaminate EC samples. No data were presented to support this claim. These commenters concluded that MSHA should propose additional research and seek comments on the research before concluding that sampling EC with an impactor will eliminate all interference problems. On the other hand, NIOSH, in its response to the ANPRM, stated that the only non-diesel source of EC that is known to be present in a metal/non-metal mine is graphitic mineral ore dust. NIOSH further stated that collection of this dust on the sample filter is prevented by the impaction plate in the SKC DPM cassette.

(2) Field Blanks

A field blank is an unexposed control filter meant to account for background interferences and systematic contamination in the field, spurious effects due to manufacturing and storage of the filter, and systematic analytical errors. The tandem filter arrangement in the sample cassette provides a primary filter for collecting an air sample and a second filter, behind (after) the primary, that provides a separate control filter for each sample. This is especially convenient for industry sampling, since it eliminates the need to send a separate control filter to the analytical lab. MSHA requests comments as to industry experience with this sampling equipment.

In its comments on the ANPRM, NIOSH noted that two types of blanks, media and field, are normally used for quality assurance purposes. A media blank accounts for systematic contamination that may occur during manufacturing or storage. A field blank accounts for possible systematic contamination in the field. NIOSH does not recommend use of field blanks when EC is the surrogate. This is because EC measurements are not subject to sources of contamination in the field that would affect OC and TC results. Quartz-fiber filters are prone to OC vapor contamination in the field and to contamination by less volatile OC (*e.g.,* oils) during handling. However, such contamination is irrelevant when EC is the surrogate.

Several commenters supported the use of field blanks, even if EC is the surrogate. These commenters pointed out that using field blanks is standard IH practice and stated that manufacturing problems with SKC impactor provide further justification. One commenter asked that we use one blank from the same and one from a different manufacturer lot.

MSHA agrees both media and field blanks are desirable, even when elemental carbon is used as the surrogate. The use of such blanks is standard laboratory procedure and adds credibility to sample results. Field blanks adjust for systematic laboratory errors and for systematic contamination of samples from unforeseen or uncontrollable sources. Accordingly, MSHA will adjust the EC result obtained for each sample by the result obtained for the corresponding media blank when a compliance concentration is measured and by the field blank (tandem filter) result when a noncompliance determination is made.

(3) Error Factor

MSHA intends to cite a violation of the DPM_{EC} exposure limit only when there is validated evidence that a violation actually occurred. As with all other measurement-based metal/nonmetal compliance determinations, MSHA would issue a citation only if a measurement demonstrated noncompliance with at least 95-percent confidence. We would achieve this 95-percent confidence level by comparing each EC measurement to the EC exposure limit multiplied by an appropriate ''error factor.''

Most commenters concurred with MSHA's intention to apply such an error factor, though they differed as to how this error factor should be established. Some other commenters, however, recommended citing at a substantially lower confidence level, using the limit of detection of the sampling instrument as replacement for the error factor. These commenters gave two reasons in support of this recommendation: (1) In issuing a citation for noncompliance, the standard of proof should, according to this commenter, be preponderance of evidence rather than beyond a reasonable doubt. The preponderance of evidence indicates a violation whenever a measurement exceeds the exposure limit plus the limit of detection. (2) Conventional public health reasoning and legal precedents call for caution on the side of protecting health, rather than preventing unwarranted citations. In addition, commenters stated that if a measurement failed to demonstrate compliance at a 95-percent confidence level, then this should trigger some action such as additional sampling, *i.e.,* the EC measurement should be divided, rather than multiplied, by MSHA's proposed error factor to provide an ''action level.''

Contrary to these commenters' suggestions, the historical and prevailing practice, in both OSHA and MSHA, traditionally has been to cite noncompliance only when noncompliance is indicated at a high level of confidence. Although, the citation threshold value suggested by these commenters accounts for some analytical imprecision, as quantified by the limit of detection, it fails to account for other sources of measurement uncertainty, such as random variability of airflow through the filter.

Another commenter questioned the use of any constant error factor, because of changes in the EC:OC ratio under varying maintenance and operating conditions. Although MSHA regards such variability as relevant to the issue of choosing an appropriate surrogate, it is not relevant to determining an appropriate error factor if EC is selected as the surrogate. EC is the quantity to be measured under the proposal, and variability in the EC:OC ratio has no known impact on the accuracy of an EC concentration measurement made using the SKC sampler and the NIOSH 5040 analytical method.

Among those commenters supporting MSHA's use of an error factor providing 95-percent confidence in each citation, some advocated continued use of the factor specified in the settlement agreement: 12.2% for an interim EC limit of 308 $\mu g/m^3$. This value was based on the paired punch data obtained from the 31-Mine Study, combined with independent estimates of variability in airflow and the deposit area on the sample filter. Other commenters, noting changes in the design of the SKC sampler since the 31-Mine Study, stated that sampler accuracy should be re-evaluated based on the redesigned sampler and that establishment of the error factor should be made a part of the rulemaking process.

MSHA disagrees that the establishment of an error factor for an airborne contaminant should be part of the rulemaking process. MSHA is not proposing an error factor in this rulemaking, but rather, discussing the procedure used to obtain the error factor. This procedure is further discussed on the MSHA web site—Single Source Page for Metal and Nonmetal Diesel Particulate Matter Regulations. Error factors are based on sampling and analytic errors. The manufacturers of sampling devices thoroughly investigate and quantify the error factors for their devices. While

MSHA does not frequently change an error factor, it retains that latitude should significant changes to either analytical or sampling technology occur.

The formula for the error factor was based on three factors included in the DPM settlement agreement and involved in an eight-hour equivalent full-shift measurement of EC concentration using Method 5040: (1) Variability in air volume (*i.e.,* pump performance relative to the nominal airflow of 1.7 L/min), (2) variability of the deposit area of particles on the filter (cm^2), and (3) accuracy of the laboratory analysis of EC density within the deposit ($\mu g/cm^2$). Modifications made to the sampler since the time of the 31-Mine Study have no bearing on the first and third of these factors. For the error factor specified in the settlement agreement, variability of the filter deposit area was represented by a 3.1 percent coefficient of variation, based on an experiment carried out before the foil filter capsule in the sampling cassette was replaced by a 32-mm ring. Measurements subsequent to introduction of the ring show that variability of the filter deposit area is now less than 3.1 percent (Noll, J. D., *et al.,* ''Sampling Results of the Improved SKC Diesel Particulate Matter Cassette''). This change slightly reduces the error factor stipulated for EC measurements in the settlement agreement, but not by enough to be of any practical significance.

Another commenter, stressing the interdependence of inter- and intra-laboratory analytical variability, stated:

> MSHA should create an error factor model that accounts for the joint and related variability in laboratory analysis, and then combine that variability with pump flow rate, sample collection size, other sampling and analytic variables * * * [t]hen, based upon a statistically strong database, determine the appropriate error factor for elemental carbon samples.

MSHA agrees and this was done for the error factor stipulated in the settlement agreement.

This commenter also suggested that the error factor should include a ''component accounting for location on the filter from which the sample punch was collected.'' The analytical method (NIOSH 5040) relies on a punch taken from inside the deposit area on the sample filter. In effect, the punch is a sample of the dust sample. Presumably, the purpose of the suggested error factor component would be to account for uniformity in the distribution of DPM deposited on the filter, as reflected by different possible locations at which a punch might be extracted. MSHA agrees that uniformity of the DPM deposit should be included in the error factor. The method MSHA used to evaluate the accuracy of the analytical method involved comparing two punches taken from different locations on the same filter. Therefore, variability between punch results due to their location on the filter is already included in the error factor as calculated by MSHA.

The commenter further recommended that MSHA implement sample review and chain of custody procedures, that MSHA retain a portion of each sample for further analysis by the operator, and that the Agency institute inter- and intra-lab analysis of spiked EC samples, along the lines of an AIHA PAT (American Industrial Hygiene Association Proficiency Analytical Testing) program, in order ''to obtain reliable, reproducible information.''

The MSHA Analytical Laboratory is AIHA (ISO 17025) accredited. As such, the Laboratory is required to develop and follow specified measurement assurance procedures. These procedures include calibration, assessing limits of detection, and determining sampling and analytical errors. These are done by standard laboratory methods, which are outside the scope of this rulemaking. MSHA would encourage the laboratories that would perform NIOSH 5040 analysis to develop and institute a PAT-like round-robin program. However, establishing such a program is not only outside the scope of this rulemaking but also outside MSHA's mandate.

MSHA will be extracting and analyzing a second punch from any sample filter that indicates an overexposure (the two punch results will be averaged for purposes of determining noncompliance). As a result, sufficient sample will not be available to send to other laboratories for analysis. The inter-laboratory paired punch comparison, conducted on data from the 31-Mine Study, provided a rigorous evaluation of intra- and inter-laboratory variability in EC analysis. Based on 642 matched pairs of punches analyzed at four laboratories, the coefficient of variation in analytical EC measurement error, reflecting the combination of intra- and inter-laboratory imprecision, was estimated to be 6.5 percent at filter loadings corresponding to an EC concentration at or above the proposed interim limit of 308_{EC} $\mu g/m^3$. This is considered an excellent degree of agreement for an inter-laboratory comparison.

Sample collection procedures and chain of custody, along with other sampling issues, are addressed in the MSHA Metal and Nonmetal Health Inspection Procedures Handbook. Operators are aware that MSHA inspects without prior notice. Therefore, operators who wish to collect side-by-side samples should have filter cassettes and other sampling equipment and supplies available.

Final Concentration Limit

B. Section 57.5060(c)

Existing § 57.5060(c) addresses application and approval requirements for an extension of time for mine operators to reduce the concentration of DPM to the final TC concentration limit of 160 micrograms per cubic meter of air. Mine operators seeking an extension must apply to the Secretary. Only consider technological constraints can be considered as a basis for approving an extension. The current rule allows only one special extension per mine, and this extension is limited to two years. Operators must certify that one copy of the application was posted at the mine site for at least 30 days prior to the date of application. Operators also must give the authorized representative of miners a copy of the plan. The current rule does not apply to the interim concentration limit.

In the settlement agreement, MSHA agreed to propose to adapt this provision to the interim limit, include consideration of economic feasibility, and allow for annual renewals of special extensions. Proposed § 57.5060(c) would apply to both the interim and the final DPM limits. The proposed section would add consideration of economic feasibility in weighing whether operators qualify for an extension. Economic constraints as well as technological constraints may limit a mine operator's ability to come into compliance with either the interim or the final DPM concentration limit. An example of such an economic limitation is the case where the cost of modification to a piece of diesel-powered equipment that would be required to bring the equipment operator's exposure into compliance with the PEL would exceed the value of the equipment. In such an instance, additional time may be required to purchase and implement other effective controls, such as newer equipment with engines that emit less DPM or changes in the ventilation system of the mine.

The proposed section would remove the limit on the number of extensions that may be granted to each mine, but would limit each each extension to one year. The MSHA district manager, rather than the Secretary, could grant extensions. The application for an extension would include information that demonstrates how the economic or technological feasibility issues affect the mine operator's ability to comply with the standard. The application would also include the most recent DPM monitoring results.

Section 57.5060(c)(vi) would require the mine operator to specify the actions that the operator intends to take during the extension period to minimize miner's exposures to DPM. These actions may include maintaining existing controls, conducting periodic monitoring of miner's exposures, and providing appropriate respiratory protection and requiring miners to use such respirators. MSHA does not intend that personal protective equipment be permitted during the extension as a substitute for engineering and administrative controls that can be implemented immediately. In these circumstances, MSHA would consider such controls to be feasible and would require mine operators to implement them prior to granting an extension.

Finally, the proposed rule would retain the requirement that operators certify to MSHA that one copy of the application was posted at the mine site for at least 30 days prior to the date of application, and another copy was provided to the authorized representative of miners. This record would continue to be subject to records requirements under § 57.5075 of the existing standard.

Existing § 57.5060 requires the mine operator to comply with the terms of any approved application for a special extension, and post a copy of the approved application for a special extension at the mine site for the duration of the special extension period. MSHA's proposed rule also would require operators to provide a copy of the approved application to the authorized representative of miners.

The ANPRM solicited comments on circumstances that would necessitate an extension of time to come into compliance with the PEL and the final concentration limit. Some commenters stated that there were no circumstances that would necessitate an extension of time. Various commenters stated that there should be no extensions. Some commenters also said that the Mine Act does not require a feasibility determination for each mine. Others stated that the technology is available and referenced in the 1998 Verminderung der Emissionen von Realmaschinen en Tunnelbau (VERT) study.

Some commenters favored granting extensions based on operators' good faith efforts to reduce DPM. One commenter said that the 31-Mine Study showed that many mines would be unable to comply with either the interim or final limit. Some commenters said that extensions would be necessary when technological or economic feasibility precludes compliance and that granting extensions should be site-specific.

MSHA also solicited comments on the duration of the extension. Some commenters wanted one-year, renewable extensions. A few commenters stated that extensions should be granted automatically until control technology is feasible, while others felt that extensions should be granted liberally and renewed as long as the mine is making good faith efforts. Several commenters also stated that in-mine applications of control technology can differ from lab results and that manufacturers are developing new technology for EPA compliance, thus research and development for control technology on existing engines is not cost effective.

MSHA asked for comments on what actions mine operators must take to minimize DPM exposures if they are operating under an extension. Some commenters stated that a detailed compliance plan specifying how the limit would be met should be required. These same commenters said that a public hearing on granting an extension should be held at the operator's or union's request. Use of administrative controls and PPE were recommended by several commenters. Commenters also said that research on respiratory protective devices such as PAPRs (powered air purifying respirators) is needed.

MSHA agrees that applications for extension should include the actions a mine operator will take during the extension to reduce the miner's exposure level to the interim PEL or the final concentration limit such as monitoring, ordering controls, adjusting ventilation, respiratory protection, and other good faith actions of the mine operator. The circumstances under which MSHA would propose to require respiratory protection are in new § 57.5060(d).

MSHA is proposing to revise § 57.5060(c) as agreed to in the DPM settlement agreement. MSHA has further reviewed and analyzed the effect of this standard and is concerned that it would duplicate the regulatory objectives addressed under new § 57.5060(d) and the intended hierarchy of controls for the DPM rule. In the preamble to the existing rule at page 5861, MSHA stated:

> Extension application. § 57.5060(c)(1) provides that if an operator of an underground metal or nonmetal mine can demonstrate that there is no combination of controls that can, due to technological constraints, be implemented within five years to reduce the concentration of DPM to the limit, MSHA may approve an application for an extension of time to comply.

The Agency intended for the existing provision to address circumstances where mine operators would need additional time to implement a technological solution to controlling DPM in their individual mines. When MSHA promulgated the DPM rule, it intended for this provision to give flexibility to a regulatory scheme that prohibited use of administrative controls and respiratory protection.

MSHA requests comments on whether the proposed provision for the extension of time to comply with the interim PEL and the final concentration limit would be necessary, and examples of how this requirement would benefit mine operators if included in the final regulatory framework. MSHA is interested in avoiding duplication and requiring additional paperwork from the mining industry in order to resolve feasibility issues at individual mining operations. The Agency needs further input from the public on the effectiveness of proposed § 57.5070(c) and how this provision fits within the comprehensive structure of this rulemaking.

C. Section 57.5060(d)

Existing § 57.5060(d) permits miners engaged in specific activities involving inspection, maintenance, or repair activities, to work in concentrations of DPM that exceed the interim and final limits, with advance approval from the Secretary. MSHA specifies in the standard that advance approval is limited to activities conducted as follows:

> (i) For inspection, maintenance or repair activities to be conducted:
>
> (A) In areas where miners work or travel infrequently or for brief periods of time;
>
> (B) In areas where miners otherwise work exclusively inside of enclosed and environmentally controlled cabs, booths and similar structures with filtered breathing air; or
>
> (C) In shafts, inclines, slopes, adits, tunnels and similar workings that the operator designates as return or exhaust air courses and that miners use for access into the mine or egress from the mine;

Operators must meet the conditions set forth in the standard for protecting miners when they engage in the specified activities in order to qualify for approval of the Secretary to use respiratory protection and work practices. MSHA considers work practices a component of administrative controls.

In tandem with this requirement is existing § 57.5060(e) which prohibits use of respiratory protection to comply with the concentration limits, except as specified in an approved extension under § 57.5060(c) and as specified in approved conditions related to inspection, repair, or maintenance activities. Section 57.5060(f) prohibits use of administrative controls to comply with the concentration limits.

MSHA agreed under the DPM settlement agreement to propose a revision of the existing § 57.5060(d) and implement the current hierarchy of controls as adopted in the Agency's other exposure-based health standards for metal and nonmetal mines, and consider requiring application to the Secretary before respirators could be used to comply with the DPM standard. The settlement agreement further specifies that employee rotation would not be allowed as an administrative control for compliance with this standard.

When a miner's exposure exceeds the PEL or the concentration limit, proposed § 57.5060(d) would require that operators reduce the miner's exposure by installing, using and maintaining feasible engineering and administrative controls; except operators would then be prohibited from rotating a miner to meet the DPM limits. Under its current policy, MSHA allows mine operators to abate a citation for an overexposure to airborne contaminants (air quality) by using feasible engineering or administrative controls to reduce the miner's exposure to the contaminant's enforcement level (*See* MSHA Program Policy Manual, Volume IV, Parts 56 and 57, Subpart D, Section .5001(a)/.5005, 08/30/1990). When controls do not reduce a miner's exposure to the DPM limits, controls are infeasible, or controls do not produce significant reductions in DPM exposures, operators would have to continue to use all feasible controls and supplement them with a respiratory protection program, the details of which are discussed below in this preamble.

Therefore, MSHA is proposing to remove current § 57.5060(e) prohibiting respiratory protection as a method of compliance in the DPM rule, and § 57.5060(f) which prohibits the use of administrative controls for compliance. Administrative controls, however, were uniquely defined in the existing rule as ''worker rotation.'' MSHA has historically considered other types of controls, besides worker rotation, to be administrative controls.

Administrative controls, such as work practice controls, were permitted. In the context of the existing rule, engineering controls were intended to refer to controls that remove the DPM hazard by applying such methods as substitution, isolation, enclosure, and ventilation.

Work practice controls were referred to as specified changes in the manner work tasks are performed in order to reduce or eliminate a hazard. The Agency strongly believes that these types of administrative controls do not compromise miners' health and safety and would not reduce the level of their protection as provided under the existing final rule. Moreover, mine operators should be given the flexibility to use them to control miners' exposures under a revised DPM rule. Commenters should submit information and supporting data on appropriate administrative controls for a final rule.

At the present time, operators are not required to develop written administrative control procedures, nor a written respiratory protection program when using these control methods to reduce miners' exposures to airborne contaminants in MSHA's air quality standards at 30 CFR 57.5001/57.5005.

In the ANPRM, MSHA asked commenters for information and data on the appropriate role for administrative controls and respirators in underground metal and nonmetal mines in a proposed rule. Most commenters supported removing the prohibition in order to have greater compliance flexibility.

MSHA asked the mining community whether it should require written administrative control procedures when operators are required to use controls to reduce miners' exposures. Commenters were divided on this issue.

MSHA received some objections from the public as to written administrative control strategies. The commenters stated that such a requirement would increase compliance costs and reduce efficiency and personnel availability. Other commenters recommended that MSHA require operators to have written administrative control strategies and post them on the mine's bulletin board. Commenters should submit to MSHA any information on the benefits and cost implications of including in a final rule a requirement to develop written administrative control procedures and post the procedures on the mine's bulletin board.

The proposed changes to § 57.5060(d) described above might appear to alter the way mine operators will be required to control DPM exposures compared to the requirements contained in the existing rule. However, in most cases, the proposed changes and the existing rule impose similar requirements. The mining community will find that these proposed changes are largely intended to simplify understanding of the rule's requirements for controlling DPM exposures and to reduce unnecessary paperwork.

MSHA would consider an engineering or administrative control to be effective in reducing DPM exposure if credible scientific or engineering studies or analysis using similar diesel equipment operated under similar conditions have demonstrated the capability, either by itself or in combination with other controls, to achieve significant DPM exposure reductions, in either laboratory or field trials. MSHA believes that a 25% or greater reduction in DPM exposure should be considered significant. MSHA, however, requests further comments on what would constitute a significant reduction in a miner's DPM exposure.

MSHA considers an engineering control to be technologically achievable if through reasonable application of existing products, devices, or work methods, with human skills and abilities, a workable engineering control can be applied. The control does not have to be ''off the shelf,'' but it must have a realistic basis in present technical capabilities.

As discussed elsewhere in this preamble (Feasibility), MSHA would consider, for example, a ceramic DPM filter to be a technologically feasible control for a piece of diesel equipment if there was evidence that the filter had been successfully applied to a similar engine subjected to similar operating conditions. The fact that a ceramic DPM filter had not been previously applied to that particular make and model of engine, or to that particular make and model of mining equipment would not, by itself, constitute a basis for determining that the application would be technologically infeasible.

Also, the fact that the duty cycle of a particular piece of mining equipment might not be sufficient for passive controlled regeneration of a ceramic DPM filter would not, by itself, constitute a basis for determining that the application of that filter to that piece of mining equipment is technologically infeasible.

In this example, unless additional substantive information establishing the technological infeasibility of the application is presented, MSHA would consider the filter to be a technologically feasible engineering control. Furthermore, MSHA would consider the filter to be technologically feasible even though a certain amount of applications engineering might be required to produce a workable or optimal system, including the need to re-locate, re-route or otherwise modify exhaust system components to facilitate filter installation, and the possible need for either on-board or off-board active or active/passive filter regeneration.

MSHA would also consider certain traditional methods for control of exposure to airborne contaminants to be technologically feasible for controlling exposures to DPM, such as improved ventilation (main and/or auxiliary) and enclosed cabs with filtered breathing air. Improving ventilation may involve upgrading main fans, use of booster fans, and use of auxiliary fans that may or may not be connected to flexible or rigid ventilation duct, as well as installation of ventilation control structures such as air walls, stoppings, brattices, doors, and regulators. At most mines, cabs with filtered breathing air are technologically feasible for many newer model trucks, loaders, scalers, drills, and other similar equipment. However, use of enclosed cabs with filtered breathing air may not be feasible as a retrofit to certain older equipment or where the function performed by miners using a particular piece of equipment is inconsistent with any type of cab (*e.g.,* loading blastholes from a powder truck, installing utilities from a scissors-lift truck) or where the height of the mine roof is not sufficient for cab clearance. Other examples of engineering controls that MSHA would consider to be technologically feasible include certain alternative fuels, fuel blends, fuel additives, and fuel pre-treatment devices, and replacement of older, high-emission engines with modern, low-emission engines.

In determining economic feasibility, MSHA would consider whether the costs of implementing the control are disproportionate to the expected DPM concentration or exposure reduction, and whether the costs are so great that it would be unreasonable to require its use to achieve those results. MSHA would, for example, expect ceramic DPM filters ranging in cost from $5,000 for smaller engines to $20,000 for larger engines to be economically feasible, particularly given the significant reduction these filters can achieve.

In the ANPRM, MSHA asked for comments on the appropriate role for respirators. Most commenters indicated that respirators with some restriction on their use should be permitted as a means of compliance with the DPM limits. Some commenters disagree on the types of restrictions that MSHA should place on their use, while other commenters believe that PPE may be far more effective in protecting miners from suspected DPM health effects than any available and feasible engineering control technology. According to still other commenters, respirators are uncomfortable and difficult to properly use over an extended period of time. They restrict visibility and create breathing resistance, thereby causing an additional hazard to miners. Finally, MSHA was notified that if the final rule allows respirators at all, such respirators should only be used with approval of the Secretary, and only as a supplemental control for other feasible controls.

Generally, commenters agreed with proposing MSHA's current hierarchy of controls for reducing miners' exposures to DPM. Some commenters to the ANPRM stated that MSHA properly prohibited the use of PPE in the current rule and no change should be made to this provision. Others stated that MSHA should state and enforce its preference for engineering controls rather than personal protective equipment, and that standard industrial hygiene practice supports this position. In response to these commenters, MSHA agrees that engineering controls should be included in the first tier of the agency's methods of compliance. The proposed rule reflects this position but does not place preference for engineering controls over use of administrative controls for reducing miners' exposure to DPM. Mine operators would be required to use all feasible engineering and administrative controls as a first response to miners' overexposures. MSHA intends for mine operators to have the flexibility to choose to start with engineering or administrative controls, or a combination of both, as the control method that best suits their circumstances.

Engineering controls are very effective in altering the sources of miners' DPM exposures in the underground mining environment, thereby decreasing DPM exposures. Unlike respiratory protection, engineering controls do not depend upon individual performance or direct human involvement to function. Based on its observations and experience in underground metal and nonmetal mines, MSHA continues to believe that feasible engineering and administrative controls exist to adequately address most DPM overexposures to the interim limit. However, MSHA is not persuaded that all DPM overexposures can be eliminated through implementation of feasible engineering and administrative controls alone, and that extra protective measures should be taken to protect miners in such circumstances.

Some commenters suggested that various commercially available respirators, including those with filtering facepieces, were suitable for protection against particles smaller than DPM, and would therefore be suitable for DPM as well. NIOSH recommended that respirators used for protection against DPM have an R–100 or P–100 certification per 42 CFR part 84. NIOSH recommended against using N-rated respirators since diesel exhaust contains oil, and aerosols containing oil can degrade the performance of N-rated filters. MSHA agrees.

Proposed § 57.5060(d)(1) would require that respirators be NIOSH certified as a high-efficiency particulate air (HEPA) filter, certified per 42 CFR part 84 (approval of Respiratory Protection Devices) as 99.97% efficient, or certified by NIOSH for diesel particulate matter. Proposed § 57.5060(d)(2) would require that non-powered, negative-pressure, air purifying, particulate-filter respirators shall use an R- or P-series filter or any filter certified by NIOSH for diesel particulate matter. The proposal further specifies that R- series filters shall not be used for longer than one work shift.

NIOSH also recommended that combination filters capable of removing both particulates and organic vapor be specified, since organic vapors and gases can be adsorbed onto DPM. The proposal does not require respirators to be certified for organic vapor because MSHA does not have data substantiating that a DPM overexposure would necessarily indicate an associated overexposure to organic vapors. If simultaneous sampling for DPM and organic vapors indicate overexposure to both contaminants, any subsequent citation(s) relating to the overexposures would require that respirators be used and equipped with a filter or combination of filters rated for both DPM and organic vapors.

MSHA also asked for information as to whether mine operators should be required to implement a written respiratory protection program when miners must wear respiratory protection. Commenters were divided on this issue. Some commenters stated that MSHA should require that the respiratory protection program be in writing. NIOSH recommended in its comments that ''mine operators be required to have a written respiratory protection program, analogous to that required by OSHA for general industry in 29 CFR 1910.134 Respiratory protection, that is work-site specific and includes administration by a trained program administrator, respirator selection criteria, worker training, a program to determine that the workers are medically able to use respiratory protective equipment, and provisions for regular evaluation of the program's effectiveness.''

Other commenters opposed a written program. MSHA requests the mining community to submit further information for justifying a written respiratory protection program, including cost data and benefits to miners' health.

The proposed standard is based on the 1969 ANSI documentation that has been updated several times since the air quality standards were promulgated in 1973 (30 CFR 56/57.5005). The ANSI, nevertheless, recommended in its 1969 version, as well as in subsequent versions, that a standard respiratory protection program should include written procedures that address implementation information such as respirator selection, fit testing procedures, cleaning and sanitizing procedures, all of which are critical to an appropriate program. MSHA invites further comments on whether the final DPM rule should include provisions for a written respiratory protection program. Comments should address health benefits for miners, projected paperwork burden and compliance costs to the metal and nonmetal underground mining industry, and should include supporting data.

MSHA also received comments on the need for including a requirement for operators to have a miner medically examined before that miner could be required to work in an area where respiratory protection would be required. In addition, some commenters asked the agency to protect miners' jobs by implementing the requirements of § 101(a)(7) of the Mine Act. Section 101(a)(7) of the Mine Act establishes the statutory authority for MSHA to promulgate medical surveillance and transfer of miner requirements in order to prevent the miner from being exposed to health hazards. This provision of the Mine Act states, in pertinent part:

> Where appropriate, such mandatory standard shall also prescribe suitable protective equipment and control or technological procedures to be used in connection with such hazards and shall provide for monitoring or measuring miner exposure at such locations and intervals, and in such manner so as to assure the maximum protection of miners. In addition, where appropriate, any such mandatory standard shall prescribe the type and frequency of medical examinations or other tests which shall be made available, by the operator at his cost, to miners exposed to such hazards in order to most effectively determine whether the health of such miners is adversely affected by such exposure. Where appropriate, the mandatory standard shall provide that where a determination is made that a miner may suffer material impairment of health or functional capacity by reason of exposure to the hazard covered by such mandatory standard, that miner shall be removed from such exposure and reassigned. Any miner transferred as a result of such exposure shall continue to receive compensation for such work at no less than the regular rate of pay for miners in the classification such miner held immediately prior to his transfer. In the event of the transfer of a miner pursuant to the preceding sentence, increases in wages of the transferred miner shall be based upon the new work classification.

Currently, MSHA standards do not require medical transfer of metal and nonmetal miners. Existing standards at 30 CFR 56/57.5005(b) for control of miners' exposure to airborne contaminants require that mine operators establish a respiratory protection program consistent with the ANSI Z88.2–1969 ''American National Standard for Respiratory Protection'' which includes medical determinations for potential respirator wearers. MSHA standards at 30 CFR part 90 address medical removal for coal miners and provide miners with a medical examination and an opportunity to transfer to an area of the mine having lower dust levels, at the same level of pay, when the miner has x-ray evidence of the development of pneumoconiosis.

OSHA acknowledges within its current standards addressing respiratory protection at 29 CFR 1910.134(e) that use of a respirator may place a physiological burden on workers while using them. At a minimum, OSHA requires employers to provide medical evaluations before an employee is fit tested or required to use respiratory protection. Employers are required to have a physician or other licensed health care professional have the worker complete a questionnaire, or in the alternative, conduct an initial medical examination in order to make the determination. If the worker has a positive response to certain specified questions, the employer must provide a follow-up medical examination. The questionnaire is contained in the body of the OSHA rule. The preamble to the OSHA final rule states:

> Specific medical conditions can compromise an employee's ability to tolerate the physiological burdens imposed by respirator use, thereby placing the employee at increased risk of illness, injury, and even death (Exs. 64–363, 64–427). These medical conditions include cardiovascular and respiratory diseases (*e.g.*, a history of high blood pressure, angina, heart attack, cardiac arrhythmias, stroke, asthma, chronic bronchitis, emphysema), reduced pulmonary function caused by other factors (*e.g.*, smoking or prior exposure to respiratory hazards), neurological or musculoskeletal disorders (*e.g.*, ringing in the ears, epilepsy, lower back pain), and impaired sensory function (*e.g.*, a perforated ear drum, reduced olfactory function). Psychological conditions, such as claustrophobia, can also impair the effective use of respirators by employees and may also cause, independent of physiological burdens, significant elevations in heart rate, blood pressure, and respiratory rate that can jeopardize the health of employees who are at high risk for cardiopulmonary disease (Ex. 22–14). One commenter (Ex. 54–429) emphasized the importance of evaluating claustrophobia and severe anxiety, noting that these conditions are often detected during respirator training. [*See* 63 FR 1152, 01/08/1998]

MSHA seeks information from the public as to whether the final rule should include requirements for medical examination and transfer of miners under the proposed DPM respiratory protection standard. Commenters should also submit cost implications of such a program and other related data.

The Agency also considered whether mine operators should be required to apply in writing to the Secretary for approval to use respiratory protection. Some commenters recommended requiring approval by the Secretary before respiratory protection should be permitted as a means of compliance with the applicable DPM limit, but MSHA was not persuaded that such a step would be necessary and MSHA's proposed § 57.5060(d) does not include this recommendation. Respiratory protection functions as a supplemental control. Operators must have ready access to respirators when they must be used as is the case where the agency has allowed metal and nonmetal mine operators to do so for many years under MSHA's air quality standards. Moreover, the proposed control plan requirements in § 57.5062 and the application for extension in § 57.5060(c) would effectively require that mine operators specify when they plan to use respirators to control a miner's DPM exposure. MSHA, therefore, would know when mine operators intend to use respirators as an interim measure until compliance can be achieved through the application of engineering and administrative controls. Further, when a mine operator is issued a citation under proposed § 57.5060(d) for a miner's exposure exceeding the applicable DPM limit, and the mine operator intends to use respiratory protection as an interim control measure, MSHA would make certain that a respiratory protection program is established and appropriate respirators are used in accordance with § 57.5005(a), (b) and proposed paragraphs § 57.5060(d)(1) and (d)(2) concerning filter selection for air-purifying respirators. Accordingly, this requirement can be deleted from the existing rule without reducing protection to the miners.

D. Section 57.5060(e)

Existing § 57.5060(e) prohibits mine operators from using personal protective equipment (respirators) to comply with the DPM concentration limit except under specific circumstances and only with the advance approval of the Secretary based on an application submitted by the mine operator. The effect of this provision would be to require mine operators, in most situations, to control DPM concentrations by implementing engineering and work practice controls, with limited respirator usage as provided under § 57.5060(d).

MSHA emphasizes that the hierarchy of controls presupposes that certain types of industrial hygiene controls are inherently superior to other types of controls in reducing or eliminating hazardous exposures. Preference is given to controls that remove or eliminate the hazard from the work place. Engineering controls and changes in work practices that remove or eliminate the hazard are therefore the preferred methods for controlling hazardous exposures, and in accordance with the principle of hierarchy of controls, must be implemented first before resorting to the use of personal protective equipment as a means of compliance. Personal protective equipment is considered an acceptable control option only after all feasible engineering and administrative controls have been fully implemented. Under the hierarchy of controls concept, if engineering and administrative controls alone are not capable of reducing exposures to the applicable limit, these controls would need to be used and maintained, but in addition, the mine operator would be required to provide appropriate personal protective equipment to affected miners and would have to ensure the equipment is properly used.

Engineering controls, in both the existing rule and the proposal, are meant to refer to controls that reduce or remove the DPM hazard from the workplace by applying such methods as substitution, isolation, interception, enclosure, and ventilation. In the existing rule, administrative controls were uniquely defined as ''worker rotation'' and prohibited as an acceptable DPM control method because it fails to eliminate the exposure hazard and results in placing more miners at risk. In the proposal, this unique definition is removed and administrative controls are meant to refer to the historically recognized controls such as specified changes in the way work tasks are performed that reduce or eliminate the hazard. Worker rotation is then specifically prohibited as an administrative control in proposed § 57.5060(e).

Since existing § 57.5060(e) provided certain exceptions to the prohibition on the use of personal protective equipment, MSHA does not believe that its proposed revisions will result in significantly greater respirator usage or decrease the level of protection afforded to miners. The Agency's proposal, therefore, serves primarily to simplify the understanding of the rule's requirements for controlling DPM exposures, to achieve consistency with MSHA's other exposure-based rules for metal and nonmetal mines, and to reduce unnecessary paperwork.

E. Section 57.5061(a)

Under existing § 57.5061(a), the Secretary would have determined compliance with ''an applicable limit on the concentration of diesel particulate matter pursuant to § 57.5060.'' In accordance with the DPM settlement agreement, the Agency proposes that § 57.5061(a) be changed to specify that MSHA would determine compliance with ''the PEL''. MSHA is proposing to replace the term Aconcentration limit'' in this section with the term ''PEL'' to reflect that MSHA proposes to enforce a personal exposure limit to limit miners' exposure to DPM. These are conforming changes and do not result in a decrease of protection to the miners.

F. Section 57.5061(b)

Compliance determinations under existing § 57.5061(b) are based on total carbon measurements. MSHA is proposing that compliance determinations made under § 57.5061(b) would be based on elemental carbon measurements instead of total carbon in accordance with the proposed change in the interim limit in § 57.5060. Copies of the NIOSH 5040 Analytical Method can be obtained at *www.cdc.gov/niosh,* or by contacting MSHA's Pittsburgh Safety and the Health Technology Center, P.O. Box 18233, Cochrans Mill Road, Pittsburgh, PA 15236.

G. Section 57.5061(c)

Under existing § 57.5061(c), the Secretary would have determined the appropriate sampling strategy for conducting compliance sampling utilizing personal sampling, occupational sampling, or area sampling, based on the circumstances of a particular exposure. The Agency proposes that § 57.5061(c) be changed to specify that only personal sampling would be utilized for compliance determination.

The Agency believes that personal sampling alone will result in an accurate determination of miner exposure to DPM. Proposed § 57.5060(a) establishes a DPM limit that specifically relates to the exposure of miners to DPM. Since the proposed limit relates to the exposure of miners, the appropriate sampling method to determine compliance is personal sampling. In this respect, the proposed rule's sampling method for compliance determination is consistent with the Agency's longstanding practice of utilizing personal sampling to determine compliance with exposure limits for airborne contaminants in the metal and nonmetal sector.

Under proposed § 57.5061(b), MSHA would utilize elemental carbon as the surrogate for DPM sampling. This is a conforming change in the paragraph. Personal sampling allows for the accurate determination of DPM exposure when elemental carbon is utilized as the DPM surrogate.

The Agency anticipates several benefits of standardizing personal sampling as the compliance sampling method. MSHA expects that mine operators and miners are already familiar with personal sampling, since MSHA utilizes it routinely when compliance sampling for noise, dust, and other airborne contaminants. Utilizing personal sampling eliminates possible disputes that could have arisen over whether an area sample was obtained ''where miners normally work or travel.'' Mine operators who choose to conduct environmental monitoring for DPM under § 57.5071 using MSHA's compliance sampling method will not need to anticipate which sampling method MSHA would most likely have selected, personal, area, or occupational, based on the circumstances of a particular exposure. Personal sampling avoids situations where area sampling is intended to capture the exposure of a particular miner for most or all of the work shift, but that miner moves to a new location during the shift. Personal sampling for elemental carbon avoids the problem of determining compliance for an equipment operator who is a smoker and who works inside an enclosed cab. Under the existing rule, this miner could not be sampled inside the cab due to interference from tobacco smoke, and area sampling outside the cab would not capture that miner's DPM exposure.

MSHA received numerous comments in response to the ANPRM concerning the proposed elimination of area and occupational sampling. Most supported the change for the reasons expressed above. One commenter observed:

We agree that personal sampling more accurately measures personal exposure. However, area sampling can also be useful for checking the reliability of personal sampling, and the degree to which that sampling is representative. Area sampling can also provide important information about the quality of compliance plans. MSHA should retain the ability to collect area samples for such purposes, and to require that operators collect them, even if area samples cannot, in themselves, trigger a citation.

The Agency agrees that personal sampling is more representative of personal exposure, which is why the change to personal sampling for compliance determinations is being proposed. The Agency also agrees that area sampling can be a useful tool for quantifying DPM concentrations at specific locations in a mine, which can greatly facilitate evaluation of DPM controls. MSHA has conducted extensive area sampling for DPM to assist Agency personnel, mine operators, and miners to better understand DPM baseline conditions in mines, and to evaluate the effectiveness of various DPM controls. MSHA intends to continue to conduct area sampling for DPM as necessary, but on a compliance assistance basis only, and not for compliance determinations or enforcement.

A few commenters were opposed to the elimination of area and occupational sampling for compliance determination. Two commenters suggested that relying on personal sampling alone would enable a mine operator to influence the sampling result to the mine operator's advantage by re-assigning a miner being sampled to an area with lower DPM levels. MSHA believes that although a mine operator may attempt to defeat compliance sampling by re-assigning the miner being sampled, MSHA's existing enforcement authority is adequate to ensure a valid and representative sample can nonetheless be obtained.

If the miner being sampled for DPM is re-assigned to a different workplace with lower DPM levels, or the miner's DPM exposure is deliberately manipulated by some other means, such as by withdrawing a ''dirty'' piece of equipment from the area where the miner is working, the inspector has the authority to investigate the circumstances, and invalidate the sample if the inspector determines that the miner's workday was not ''normal.'' In egregious cases, where there is clear indication of intent and proof, the inspector may cite the mine operator under 103(a) of the Mine Act for impeding an inspection. In either case, sampling may be conducted subsequently to obtain a valid and representative sample of that miner's DPM exposure.

One commenter suggested that personal sampling is not appropriate for miners who work inside enclosed cabs, because although they may be protected against DPM, other downstream miners who do not work inside enclosed cabs would not be protected. MSHA believes that the compliance status of any miner can be determined by personal sampling, whether they work in an enclosed cab or not. Personal sampling of the miner in an enclosed cab can determine whether the cab air filtration system or other DPM controls are adequate to maintain compliance for that miner. Downstream miners who do not work in enclosed cabs and who are suspected of high DPM exposures can also be sampled, and in accordance with MSHA's health sampling policy that targets miners with the highest exposures for sampling, the inspector would likely do so.

Several comments were also received that responded specifically to the questions asked in the ANPRM relating to existing § 57.5061(c) and proposed changes.

(a) What would be the cost implications for mine operators to conduct personal sampling of miners' DPM exposures if EC is the surrogate?

One commenter indicated that costs are secondary to whether the policy of conducting personal sampling for compliance determination is reasonable. Other comments suggested no change in expected costs because the NIOSH Method 5040 is in place at several commercial labs. Several commenters noted that costs may be lower if EC is the surrogate due to ''fewer false readings and contaminated samples.'' On the whole, MSHA believes valid and representative samples can be obtained through personal sampling, and MSHA does not expect differences in sampling cost, if any, to be significant.

(b) What experience do mine operators have with DPM sampling and analysis?

The commenters indicated that mine operators' experience with DPM sampling and analysis varies widely across the underground metal and nonmetal mining industry. Some mine operators, especially those that have been parties to the DPM litigation and/or involved in the 31-Mine Study, have acquired considerable experience, while many other operators have had little or no experience. Several commenters mentioned that mining company health and safety staff capable of conducting DPM sampling ''are overburdened with other MSHA initiatives (HazCom, noise, silica) and will not be able to complete the required DPM tasks.'' These commenters recommended that AMSHA should provide in-mine training, sampling assistance [and] outreach meetings'' and that MSHA health staff should help mine operators that lack DPM sampling experience ''without enforcement, by providing comprehensive in-mine training and sampling assistance.''

MSHA largely agrees that many mine operators are unfamiliar with MSHA's DPM sampling and analytical methods. Accordingly, MSHA intends to provide numerous opportunities for mine operators and miners to obtain training on DPM sampling. MSHA will target these compliance assistance training opportunities to small mine operators in particular. MSHA conducted a 3-day, in-mine, hands-on DPM sampling workshop at an underground limestone mine near Louisville, KY in December 2002, and other similar workshops are planned.

MSHA has also posted information on its Web site relating to the specialized DPM sampling cassette with integral submicron impactor. Also posted on the MSHA web site are a Compliance Guide on the standard itself, which includes considerable information about sampling, the draft chapter from MSHA's Metal and Nonmetal Health Inspection Procedures Handbook detailing the compliance sampling procedures that MSHA inspectors will follow, and the field notes form that MSHA inspectors will use to document DPM compliance sampling. All of this information is also available in hardcopy form for mine operators and miners who do not have internet access. MSHA intends to develop and provide additional DPM sampling-related compliance assistance materials as needed to mine operators and miners in both hard-copy form and on its Web site.

As a result of some of the changes in the rule language that have been proposed through this rulemaking, MSHA's DPM compliance sampling procedures will conform more closely to existing MSHA sampling practices for dust and other airborne contaminants. As a consequence, mine operators that have had no previous experience with DPM sampling, but have had experience with, or at least knowledge of, MSHA respirable dust sampling, will discover they have very little more to learn. Except for the sample filter cassette itself, the mechanics of DPM sampling will be almost identical to respirable dust sampling. For example, the same pump and sampling train are used (sample pump, hose, cyclone holder, Dorr-Oliver 10 mm nylon cyclone), and the pumps must be pre- and post-calibrated at the same 1.7 liters per minute flow rate. Sampling for both respirable dust and DPM is for the full shift, and the same chain-of-custody procedures must be followed for handling the cassettes. For both respirable dust and DPM, the miners with the highest expected exposure will be targeted for sampling, and much of the same information will need to be documented in the sampler's field notes (mine, date, person conducting sampling, person being sampled, sources of exposure, controls used, etc.).

As with respirable dust sampling, compliance sampling, for DPM would be personal rather than a combination of personal, area, and occupational. Also, since the surrogate for DPM would be EC instead of TC, the sampling complications associated with avoiding OC interferents are eliminated (*e.g.* sampling too close to smokers, sampling too close to sources of drill oil mist, etc.).

Mine operators should already be familiar with MSHA's sampling procedures for respirable dust. Because respirable dust sampling and DPM sampling will be so similar, and because numerous DPM sampling training opportunities will be made available across the industry, MSHA expects few if any mines will be unable to conduct their own DPM sampling or to comply with the DPM sampling requirements of this standard. Regarding the issue of mine operator DPM sampling being an added burden on mine safety and health staff, MSHA acknowledges that it is almost unavoidable that some staff time will need to be allocated to DPM sampling. However, MSHA does not believe that this added burden will be significant for most mines. A specific DPM monitoring schedule is not included in the standard. Mine operators are required to monitor as often as necessary to verify continuing compliance. Once compliance has been verified, MSHA would not anticipate that extensive additional monitoring would be required. However, if conditions affecting DPM emissions or in-mine DPM concentrations change significantly, such as by the addition of new equipment or changes in the ventilation system, the mine operator would be expected to verify that these changes have not resulted in DPM overexposures.

(c) Is there experience with DPM sampling in other industries and other countries?

One commenter suggested that many coal mine operators know enough about sampling to influence the outcome, and that MSHA should therefore use a combination of personal, area and occupational sampling to properly evaluate the levels of DPM in the ambient atmosphere. However, as noted above, MSHA believes it has sufficient enforcement authority to appropriately deal with any incidents of deliberate sample tampering, should they arise.

Other commenters were aware that a group in Canada (DEEP) has been researching technology to reduce DPM in occupational settings and mentioned the EPA studies on diesel exposure. They did not feel the EPA sampling was applicable to occupational exposure assessments. Some of them felt that MSHA should stay its DPM enforcement until the DEEP study and NIOSH research yielded more data.

MSHA is also aware of these studies and considered them during this rulemaking. The Agency believes that there is sufficient information available to support feasibility of the proposed $308_{EC}\mu g/m^3$ interim limit, as discussed previously in this preamble under Technological and Economic Feasibility. As a result of the settlement agreement, MSHA allowed mine operators to take an additional year after the effective date of the existing interim DPM concentration limit during which mine operators could begin to install appropriate controls to reduce DPM concentrations.

H. Section 57.5062 Diesel Particulate Matter Control Plan

Existing § 57.5062 requires mine operators to establish a DPM control plan, or modify the plan, upon receiving a citation for an overexposure to the concentration limit in § 57.5060. A single citation triggers the plan. A violation of the plan is citable without consideration of the current DPM concentration level. The operator must demonstrate that the new or modified plan will be effective in controlling the DPM concentration to the limit. The existing rule also sets forth a number of other specific details about the plan, including a description of controls that the operator will use to maintain the DPM concentration; a list of diesel-powered units maintained by the mine operator; information about each unit's emission control device; demonstration of the plan's effectiveness; verification sampling; retention of a copy of the control plan at the mine site for the duration of the plan plus one year; and a plan duration of three years from the date of the violation resulting in establishment of the plan.

In accordance with the DPM settlement agreement, MSHA agreed to publish a notice of proposed rulemaking to revise current § 57.5062. The settlement agreement, however, did not specify how MSHA should revise this section. In the ANPRM, MSHA requested comments and ideas from the mining community as to how the control plan requirements should be revised.

Some commenters stated that there was no reason for MSHA to change this provision. These commenters emphasized that control plans are good industrial hygiene practice and should be the standard of practice for the mining industry. Other commenters felt strongly that the control plan was unnecessary in light of MSHA's intent to propose its long-standing hierarchy of controls for metal and nonmetal exposure-based standards. Some commenters opposed to a control plan stated that the purpose of the existing control plan was to prevent chronic excursions above the allowable concentration limit rather than allowing these excursions as part of the daily DPM control scheme. These commenters believed that the controls in place are sufficient to protect miners from DPM overexposures without introducing a cumbersome plan approval process. They further stated that MSHA could accomplish this through existing mechanisms such as section 104(b) of the Federal Mine Safety and Health Act of 1977 (30 U.S.C. 814) sanctions currently employed for failure to abate violations.

Other commenters opposing a control plan stated that not only was it unnecessary, but it also imposed upon mine operators unwarranted costs. They suggested that MSHA assess compliance by the operator's environmental monitoring and MSHA compliance sampling. Furthermore, following a hierarchy of controls approach would ensure miners' protection during non-compliance. They stated that formal plans would add little or nothing to established systems.

Some other comments that MSHA received on its question of whether to retain the control plan in a final rule included two which stated that a control plan was not necessary if mine operators put forth good-faith efforts in complying with the standard; and, that MSHA could monitor an operator's good faith efforts and obtain supporting documentation during regular inspections.

MSHA also asked in its ANPRM whether there was any benefit derived from retaining the control plan since the Agency intended to propose its longstanding hierarchy of controls for controlling miners' exposures to DPM. In response, some commenters felt that substituting the hierarchy of controls for a DPM control plan would be unacceptable.

Commenters in favor of retaining the control plan stated that it requires mine operators to develop an organized written approach to controlling exposure and does not preclude developing a policy on the hierarchy of controls. The effectiveness of the standard depends on preparing and following a detailed control plan. Commenters believe that control plans are cost effective by forcing operators to control DPM efficiently. Control plans help MSHA determine if the company is acting in good faith. They help compliance assistance and provide information for the miners' representative to participate in safety and health programs. Commenters believe that an alternative would be a plan with more specific requirements for maintenance, vehicle inspection, emission controls, and fuel quality.

Although some commenters believe that a control plan is unnecessary, MSHA is proposing to retain this requirement. As expressed in the preamble to the existing rule, MSHA's rationale for requiring a DPM control plan is derived from the rule's approach to setting control requirements. MSHA recognizes that every mine covered by this rule has unique conditions and circumstances that affect DPM exposures such as the number and sizes of diesel-powered engines, idling duration and frequency, emission controls, diesel maintenance practices, and ventilation.

The Agency is interested in developing uniform DPM control requirements that are effective in protecting miners' health and practical for the mining industry to implement. MSHA acknowledges that there are numerous approaches in accomplishing this objective.

Operators may choose to control DPM emissions by filtering the diesel-powered equipment; installing cleaner-burning engines; increasing ventilation; improving fleet management; utilizing administrative controls; or using a variety of other readily available controls, all without consulting with, or seeking approval from MSHA. Given the wide variety of options and alternatives available to operators for controlling DPM exposures, the Agency believes that it needs to know what strategy the operator will be utilizing to control DPM exposures, particularly if compliance cannot be achieved within a short period of time.

Although MSHA is proposing to retain the control plan, the Agency, however, requests further comment on whether the control plan should be retained since MSHA is also proposing a DPM rule that includes hierarchy of controls. It is not MSHA's intent to duplicate compliance requirements in this rulemaking.

In proposed § 57.5062, MSHA would require an operator to establish a written control plan, or modify an existing control plan, if it will take the mine operator more than 90 calendar days from the date of a citation to achieve compliance. A single violation of the PEL would continue to be the basis for triggering the requirement for a control plan. The control plan would remain in effect for a one-year period following termination of the citation. Mine operators would also be required to include in the plan a description of the controls that will be used to reduce the miners' exposures to the PEL. MSHA intends to cite for a violation of the plan without regard for a miner's exposure to the PEL. MSHA believes that these requirements would prompt mine operators to properly maintain existing DPM controls at their mines.

Existing § 57.5062(e)(1) specifies that the control plan remain in effect for 3 years from the date of the violation which caused it to be established. MSHA asked the mining community for input regarding the appropriate duration of a revised control plan. Commenters responded that if the violation was minor and easily corrected, that the control plan could be simple in content and brief in duration.

MSHA believes that it is important to maintain the plan as long as the operator is working to reduce DPM exposures to the applicable limits. However, once the operator achieves compliance, MSHA believes that the need for maintaining a plan decreases. Accordingly, MSHA is proposing in § 57.5062(a) that a plan remain in effect for a period of one year after the citation is terminated.

MSHA does not intend to include a monitoring provision under the control plan because generic monitoring provisions in § 57.5071 would continue to apply during the existence of a control plan. MSHA expects mine operators to monitor as frequently as necessary to confirm that controls are effective in reducing the miners' exposure to the PEL. MSHA seeks further comment on the duration of time that the control plan should continue in effect once a citation for overexposure to DPM is terminated.

Existing § 57.5062(b) requires that the operator include in the plan a description of the controls that will be used to maintain the concentration of diesel particulate matter to the applicable limit specified by § 57.5060, a list of the diesel-powered units maintained by the mine operator, and information about each unit's emission control device. MSHA is proposing to simplify the contents of the plan and require that it only include a description of the controls the operator will use to reduce the miners' exposures to the PEL. MSHA believes that there could be a wide variety of information that operators may want to include in their plan, and that it is not beneficial to specify a few while leaving out many others. Therefore, MSHA intends to provide maximum flexibility of compliance for mine operators. This description should include all controls that the operator is using to reduce miners' exposures, including engineering controls, administrative controls, personal protective equipment, and maintenance procedures, to name a few.

Existing § 57.5062(e)(3) requires an operator to modify a DPM control plan during its duration as required to reflect changes in controls, mining equipment or circumstances. MSHA did not receive any comments in response to its ANPRM regarding modifications to the plan.

MSHA is proposing to retain this particular requirement consistent with the existing rule, with one minor modification. Proposed § 57.5062(c) would require that the operator modify the plan to reflect changes in controls, mining equipment, or continuing noncompliance. This would require mine operators to modify their plan when the results of sampling conducted by MSHA or the mine operator indicates that a miner's exposure exceeds the PEL. MSHA does not believe that this change will result in an increase in compliance costs or paperwork. The change is intended to clarify the existing provision. MSHA did not receive comments to its ANPRM on this issue.

Existing § 57.5062(a)(2) requires that the operator demonstrate that the new or modified DPM control plan parameters control the concentration of DPM to the concentration limit specified in § 57.5060. Mine operators must demonstrate plan effectiveness by monitoring, using the measurement method specified by § 57.5061(b) which addresses compliance determinations. Such monitoring must be sufficient to verify that the plan will control the concentration of DPM to the limit under conditions that can be reasonably anticipated in the mine. Further, the operator must retain a copy of each verification sample result at the mine site for five years. Monitoring must be conducted in addition to, and not in lieu of, any other sampling the Secretary performs.

MSHA is proposing to delete the requirements for plan verification monitoring. The Agency believes that such monitoring is adequately addressed under § 57.5071, which requires mine operators to monitor in order to determine, under conditions that can be reasonably anticipated in the mine, whether DPM exposures exceed the applicable limits specified in § 57.5060. No monitoring frequency is specified under existing DPM monitoring requirements. MSHA believes that these requirements provide an effective alternative to the existing plan verification sampling requirements. Further, MSHA will conduct additional compliance sampling whenever the Agency suspects that miners' exposures to DPM are not being maintained to the PEL.

The Agency also believes that operator sampling may not always be necessary to determine if controls are being used or maintained. The proposed control plan would require that mine operators specifically describe the controls being used to reduce the miners' exposures to the DPM limit. If MSHA finds during an inspection that specified controls were missing or not being maintained, MSHA has existing enforcement tools to require that mine operators correct the situation.

MSHA is proposing to retain the requirement that mine operators keep a copy of the current control plan at the mine site for its duration. Existing § 57.5062(f) specifies that an operator's failure to comply with the provisions of the diesel particulate matter control plan in effect at a mine, or to conduct required verification sampling is a violation of this part without regard for the concentration of diesel particulate matter that may be present at any time. MSHA intends to adopt this position and cite mine operators for a violation of the plan without consideration of a miner's exposure to the DPM limit. The Agency is proposing to delete this requirement in the rule language only and explain this enforcement position in the preamble.

Existing § 57.5062(d) requires the operator to provide access to records maintained under this section to specified individuals and agencies. The existing rule further requires the mine operator to maintain a copy of the plan and the plan verification monitoring results. As explained earlier in this preamble, MSHA does not believe that verification monitoring is justified in a proposed rule. Pursuant to § 57.5071, MSHA has access to any record listed in the DPM rule, including an operator's control plan. This access, among other things, provides the Agency with the means to verify an operator's control plan without requiring additional compliance from mine operators. Therefore, MSHA intends to delete this requirement.

MSHA believes that this proposal would provide an alternative method of protecting miners' health provided for under the existing standard. MSHA is interested in providing compliance flexibility to mine operators where such flexibility does not compromise miners' health or safety. The Agency is proposing to retain the current requirement for a control plan with modifications to eliminate unnecessary requirements.

MSHA emphasizes that the proposed modifications do not compromise miners' health or safety under § 101(a)(9) of the Mine Act. Section 101(a)(9) provides: ''No mandatory health or safety standard promulgated under this title shall reduce the protection afforded miners by an existing mandatory health or safety standard.'' MSHA interprets this provision of the Mine Act to require that all of the health or safety benefits resulting from a new standard be at least equivalent to all of the health or safety benefits resulting from the existing standard when the two sets of benefits are evaluated as a whole. *Int'l Union* v. *Federal Mine Safety and Health Admin.*, 920 F.2d 960, 962–64 (D.C. Cir. 1990); *Int'l Union* v. *Federal Mine Safety and Health Admin.*, 931 F.2d 908, 911 (D.C. Cir 1991). The Agency believes that the proposal meets this test.

I. Section 57.5071 Exposure Monitoring

Proposed § 57.5071 would make conforming changes to the existing requirements for mine operators to monitor DPM levels to be consistent with the other changes being proposed. While the existing rule limits DPM concentration in the mine, the proposed rule would limit a miner's DPM exposure. Therefore, existing paragraph (a) requiring the mine operator to monitor the concentration of DPM would be revised to require mine operators to monitor a miner's full-shift airborne exposure.

Similarly, existing paragraph (c) requiring mine operators to take prompt corrective action when the concentration limit is exceeded would be revised to substitute ''PEL'' for ''concentration limit.''

J. Section 57.5075 Diesel Particulate Records

Existing § 57.5075(a) summarizes the recordkeeping requirements of the DPM standards contained in §§ 57.5060 through 57.5071. Proposed § 57.5075(a) would number the Diesel Particulate Recordkeeping Requirements table within the section without changing the requirements under existing § 57.5075(a). MSHA intends to delete table entries for existing § 57.5060(d), approved plan for miners to perform inspection, maintenance or repair activities in areas exceeding the concentration limit, and § 57.5062(c), compliance plan verification sample results. MSHA intends to add the requirement for maintaining a copy of the control plan for the duration of the plan in accordance with proposed § 57.5062(d). As a clarifying change to the table, MSHA also intends to add the existing requirement for posting notice of corrective action being taken under § 57.5071(c).

X. Regulatory Impact Analysis

This part of the preamble reviews several impact analyses which the Agency is required to provide in connection with its proposed rulemaking. The full text of these analyses can be found in the Agency's Preliminary Regulatory Economic Analysis (PREA).

A. Cost and Benefits: Executive Order 12866

Executive Order 12866 requires regulatory agencies to assess both the costs and benefits of regulations. In making this assessment, MSHA determined that although this final rule will not have an annual effect of $100 million or more on the economy, and therefore is not a significant regulatory action as defined by 3(f)(1) of E.O. 12866, the rule meets the § 3(f)(4) definition, that is, the rule may ''* * * raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive Order.'' MSHA completed a Preliminary Regulatory Economic Analysis (PREA) which estimates both the costs and benefits of the rule. This PREA is available from MSHA and is summarized below.

Table X–1 presents the total yearly compliance costs by provision and mine size for the proposed revisions. All MSHA cost estimates are presented in 2001 dollars. The proposed rule would result in a net cost of $4,539 per year for underground metal and nonmetal mine operators. This would be an average cost of $25 for each of the 182 underground metal and non-metal mines that would be affected by this proposed rule. Of these 182 mines, 65 have fewer than 20 workers, 113 have 20 to 500 workers; and 4 have more than 500 workers. The average cost per mine for mines in these three size classes would be −$34 (a cost savings), $58, and $58, respectively.

TABLE X–1.—TOTAL YEARLY COMPLIANCE COSTS

Provision	Mine size			Total
	<20	20–500	>500	
Special Extensions 57.5060(c)	$6,179	$21,117	$748	$28,044
Respirator Protection 57.5060(d)	−2,569	−4,466	−158	−7,192
DPM Control Plan 57.5062	−5,826	−10,128	−359	−16,313
Total	−2,215	6,523	231	4,539

B. Regulatory Flexibility Act Certification

The Regulatory Flexibility Act (RFA) requires regulatory agencies to consider a rule's economic impact on small entities. Under the RFA, MSHA must use the Small Business Act definition of a small business concern in determining a rule's economic impact unless, after consultation with the SBA Office of Advocacy, and after opportunity for public comment, MSHA establishes a definition which is appropriate to the activities of the agency and publishes that definition in the **Federal Register**. For the mining industry, SBA defines ''small'' as having 500 or fewer workers. MSHA has traditionally considered small mines to be those with fewer than 20 workers. To ensure that the rule conforms with the RFA, MSHA analyzed the economic impact on mines with 500 or fewer workers and also on mines with fewer than 20 workers. MSHA concluded that the rule will not have a significant economic impact on a substantial number of small entities under either definition.

C. Unfunded Mandates Reform Act of 1995

For purposes of the Unfunded Mandates Reform Act of 1995, the rule does not include any Federal mandate that may result in increased expenditures of more than $100 million incurred by state, local, or tribal governments, or by the private sector.

D. Paperwork Reduction Act of 1995 (PRA)

This proposed rule contains changes to two information collection requirements, both of which were approved by the Office of Management and Budget (OMB) as part of Information Collection No. 1219–0135, which expires on September 30, 2004.

The proposed changes were submitted to OMB for review pursuant to the PRA, as codified at 44 U.S.C. 3501–3520 and implemented by OMB in regulations at 5 CFR part 1320. The PRA defines collection of information as ''the obtaining, causing to be obtained, soliciting, or requiring the disclosure to third parties or the public of facts or opinions by or for an agency regardless of form or format.''

The proposed paperwork requirement changes are contained in §§ 57.5060 and 57.5062. There are burden hours and associated costs that will occur only in the first year that the provision is in effect, and there are burden hours and associated costs that will occur every year the rule is in effect, starting with the first year (''annual'' burden hours and costs). Due to different requirements in these provisions for the interim and final limits, the effective dates vary. In the first year, mine operators will incur a net of 1,047.78 burden hours and associated costs of $2,479. in year one.

In year two only, mine operators will incur 613.17 burden hours and associated annualized costs of $1,776. There is a reduction of 931.96 burden hours occurring only in year three. The present value of the cost savings associated with these burden hours is $6,343. Starting in year three, there is a reduction in annual burden hours of 103.55. The discounted value of the cost savings associated with these burden hours is $3,738 annually. Mine operators will incur 613.17 annual burden hours starting in year four. The discounted value of the cost associated with these burden hours is $22,161 annually.

Included in these estimates are the time for reviewing instructions, gathering and maintaining the data needed, and completing and reviewing the collection of information. MSHA invites comments on: (1) Whether any proposed collection of information presented here (and further detailed in the Agency's PREA) is necessary for proper performance of MSHA's functions, including whether the information will have practical utility; (2) the accuracy of MSHA's estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used; (3) ways to enhance the quality, utility, and clarity of information to be collected; and (4) ways to minimize the burden of the collection of information on respondents, including through the use of automated collection techniques, when appropriate, and other forms of information technology.

The Agency has submitted a copy of this proposed rule to OMB for its review and approval of these information collections. The complete paperwork submission is contained in the Preliminary Regulatory Economic Analysis and Preliminary Regulatory Flexibility Analysis (PREA/PRFA) and includes the estimated costs and assumptions for each proposed paperwork requirement (these costs are also included in the Agency's cost and benefit analyses for the proposed rule). A copy of the PREA/PRFA is available at *http://www.msha.gov/regsinfo.htm.* These paperwork requirements have been submitted to the Office of Management and Budget for review under section 3504(h) of the Paperwork Reduction Act of 1995. Respondents are not required to respond to any collection of information unless it displays a current valid OMB control number.

F. Executive Order 12630: Government Actions and Interference With Constitutionally Protected Property Rights

This proposed rule is not subject to Executive Order 12630, Government Actions and Interference with Constitutionally Protected Property Rights, because it does not involve implementation of a policy with takings implications.

G. Executive Order 12988: Civil Justice Reform

The Agency has reviewed Executive Order 12988, Civil Justice Reform, and determined that the proposed DPM rule would not unduly burden the Federal court system. The proposed rule has been written so as to provide a clear legal standard for affected conduct and has been reviewed carefully to eliminate drafting errors and ambiguities.

H. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

In accordance with Executive Order 13045, MSHA has evaluated the environmental health and safety effects of the proposed DPM rule on children. The Agency has determined that the proposed rule would not have an adverse impact on children.

I. Executive Order 13132: Federalism

MSHA has reviewed the proposed DPM rule in accordance with Executive Order 13132 regarding federalism and has determined that it would not have any federalism implications. The proposed rule would 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.

J. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

MSHA has determined that the proposed DPM rule would not impose substantial direct compliance costs on Indian tribal governments.

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

In accordance with Executive Order 13211, the Agency has reviewed proposed DPM rule for its energy impacts. The rule would have no effect on the supply, distribution or use of energy.

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

In accordance with Executive Order 13272, MSHA has thoroughly reviewed the proposed DPM rule to assess and take appropriate account of its potential impact on small businesses, small governmental jurisdictions, and small organizations. As discussed in Chapter V of the PREA, MSHA has determined that the proposed rule would not have a significant economic impact on a substantial number of small entities.

XI. References

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List of Subjects in 30 CFR Part 57

Diesel particulate matter, Metals, Mine safety and health, Reporting and recordkeeping requirements.

For the reasons set forth in the preamble, MSHA proposes to amend Chapter I of Title 30 as follows:

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

Authority: 30 U.S.C. 811 and 813.

2. Section 57.5060 is amended by revising paragraphs (a), (c)(1), (c)(2), (c)(3), (c)(4), (d), and (e) and removing paragraphs (c)(5) and (f) to read as follows:

§ 57.5060 Limit on concentration of diesel particulate matter.

(a) A miner's personal exposure to diesel particulate matter (DPM) in an underground mine shall not exceed an average eight-hour equivalent full shift airborne concentration of 308 micrograms of elemental carbon per cubic meter of air (308_{EC} µg/m^3). [This interim permissible exposure limit (PEL) shall remain in effect until the final DPM exposure limit becomes effective.]

* * * * *

(c)(1) If a mine requires additional time to come into compliance with the applicable limits established in paragraphs (a) and (b) of this section due to technological or economic constraints, the operator of the mine may file an application with the district manager for a special extension.

(2) The mine operator must certify on the application that the operator has posted one copy of the application at the mine site for at least 30 days prior to the date of application, and has provided another copy to the authorized representative of miners.

(3) No approval of a special extension shall exceed a period of one year from the date of approval. Mine operators may file for additional special extensions provided each extension does not exceed a period of one year. An application must include the following information:

(i) A statement that diesel-powered equipment was used in the mine prior to October 29, 1998;

(ii) Documentation supporting that controls are technologically or economically infeasible at this time to reduce the miner's exposure to the DPM limit.

(iii) The most recent DPM monitoring results.

(iv) The actions the operator will take during the extension to minimize exposure of miners to DPM.

(4) A mine operator must comply with the terms of any approved application for a special extension, post a copy of the approved application for a special extension at the mine site for the duration of the special extension period, and provide a copy of the approved application to the authorized representative of miners.

(d) The mine operator shall install, use, and maintain feasible engineering and administrative controls to reduce a miner's exposure to or below the DPM limit established in this section. When controls do not reduce a miner's DPM exposure to the limit, controls are infeasible, or controls do not produce significant reductions in DPM exposures, controls shall be used to reduce the miner's exposure to as low a level as feasible and shall be supplemented with respiratory protection in accordance with § 57.5005(a), (b), and paragraphs (d)(1) and (d)(2) of this section.

(1) Air purifying respirators shall be equipped with the following:

(i) Filters certified by NIOSH under 30 CFR part 11 (appearing in the July 1, 1994 edition of 30 CFR, parts 1 to 199) as a high efficiency particulate air (HEPA) filter;

(ii) Filters certified by NIOSH under 42 CFR part 84 as 99.97% efficient; or

(iii) Filters certified by NIOSH for diesel particulate matter.

(2) Nonpowered, negative-pressure, air purifying, particulate-filter respirators shall use an R- or P-series filter or any filter certified by NIOSH for diesel particulate matter. An R-series filter shall not be used for longer than one work shift.

(e) Rotation of miners shall not be considered an acceptable administrative control used for compliance with this section.

3. Section 57.5061 is revised to read as follows:

§ 57.5061 Compliance determinations.

(a) MSHA shall use a single sample collected and analyzed by the Secretary in accordance with the requirements of this section as an adequate basis for a determination of noncompliance with the DPM limit.

(b) The Secretary will collect samples of diesel particulate matter by using a respirable dust sampler equipped with a submicrometer impactor and analyze the samples for the amount of elemental carbon using the method described in NIOSH Analytical Method 5040, except that the Secretary also may use any methods of collection and analysis subsequently determined by NIOSH to provide equal or improved accuracy for the measurement of diesel particulate matter.

(c) The Secretary will use full-shift personal sampling for compliance determinations.

4. Section 57.5062 is revised to read as follows:

§ 57.5062 Diesel particulate matter control plan.

(a) When it will take the operator more than 90 calendar days from the date of a citation for violating § 57.5060 to achieve compliance, the operator shall establish and implement a written plan to control the miner's exposure. The plan shall remain in effect for a period of one year after the citation is terminated.

(b) The plan must include a description of the controls the operator will use to reduce the miner's exposure to the DPM limit.

(c) The operator must modify the plan to reflect changes in controls, mining equipment, or continuing noncompliance.

(d) The operator must retain a copy of the plan at the mine site for the duration of the plan.

5. Section 57.5071 is amended by revising the section heading and by revising paragraphs (a) and (c) to read as follows:

§ 57.5071 Exposure monitoring.

(a) Mine operators must 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 specified in § 57.5060.

* * * * *

(c) If any monitoring performed under this section indicates that a miner's exposure to diesel particulate matter exceeds the DPM limit specified in § 57.5060, the operator must promptly post notice of the corrective action being taken on the mine bulletin board, initiate corrective action by the next work shift, and promptly complete such corrective action.

* * * * *

6. Section 57.5075 is amended to revise paragraph (a) to read as follows:

§ 57.5075 Diesel particulate records.

(a) Table 57.5075(a), ''Diesel Particulate Recordkeeping Requirements'' lists the records the operator must retain pursuant to §§ 57.5060 through 57.5071, and the duration for which particular records need to be retained.

TABLE 57.5075(A).—DIESEL PARTICULATE RECORDKEEPING REQUIREMENTS

Record	Section reference	Retention time
1. Approved application for extension of time to comply with exposure limits.	§ 57.5060(c)	Duration of extension.
2. Control plan	§ 57.5062(a)	Duration of plan.
3. Purchase records noting sulfur content of diesel fuel	§ 57.5065(a)	1 year beyond date of purchase.
4. Maintenance log	§ 57.5066(b)	1 year after date any equipment is tagged.
5. Evidence of competence to perform maintenance	§ 57.5066(c)	1 year after date maintenance performed.
6. Annual training provided to potentially exposed miners	§ 57.5070(b)	1 year beyond date training completed.
7. Record of corrective action	§ 57.5071(c)	Until the citation is terminated.
8. Sampling method used to effectively evaluate particulate concentration, and sample results.	§ 57.5071(d)	5 years from sample date.

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Dated: July 25, 2003.

Dave D. Lauriski,

Assistant Secretary of Labor for Mine Safety and Health.

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