FINAL REGULATORY ECONOMIC ANALYSIS

AND

FINAL REGULATORY FLEXIBILITY ANALYSIS

FINAL RULE ON 30 CFR PARTS 72 AND 75

FINAL STANDARDS AND REGULATIONS

DIESEL PARTICULATE MATTER EXPOSURE OF UNDERGROUND COAL MINERS

RIN: 1219-AA74

Office of Standards, Regulations, and Variances

Mine Safety and Health Administration

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I. EXECUTIVE SUMMARY

INTRODUCTION

This rule is designed to reduce exposures of miners in underground coal mines to diesel particulate matter (DPM). Of all groups in the U.S. work force and population at large, underground miners are the population that is by far the most exposed to DPM. MSHA field studies indicate that median DPM concentrations observed for underground miners range up to 200 times as high as average environmental exposures in the most heavily polluted urban areas and up to 10 times as high as median exposures estimated for the most heavily exposed workers in other occupational groups. The DPM rule will reduce DPM exposures in underground coal mines to levels similar to the highest exposure levels found in other occupational groups. These reduced DPM exposure levels will result in reductions in significant health risks of illness and premature death for underground miners.

The rule sets standards for tailpipe DPM emissions of permissible,[1] non-permissible heavy duty,[2] and newly introduced light duty[3] diesel powered equipment in underground coal mines. These standards can be met by use of paper or ceramic DPM filtration systems. In the case of light duty equipment, meeting listed EPA standards for diesel engines is an alternative means of compliance.

The rule also includes other requirements that are ancillary to the DPM emission limits. These include requirements for maintenance training, miner health training, recordkeeping of the training, and ventilation plan modifications. In addition, equipment manufacturers will need to amend many of the existing permissible machine approvals and reconfigure some of their light duty equipment models. Further discussion of regulatory compliance measures is provided in Chapter IV of this document.

Section 101 of the Federal Mine Safety and Health Act of 1977 provides the authority for this rulemaking. Executive Order 12866 requires that regulatory agencies complete a Regulatory Economic Analysis (REA) for any rule having major economic consequences for the national economy, an individual industry, a geographic region, or a level of government. The Regulatory Flexibility Act (RFA) similarly requires regulatory agencies to consider the impact of the rule on small entities. This REA and Regulatory Flexibility Certification have been prepared to fulfill the requirements of Executive Order 12866 and the RFA. MSHA certifies that this final rule will not impose a significant economic impact on a substantial number of small entities.

[1] Permissible diesel powered equipment is required to be used in areas of the mine where methane is expected to be present.

[2] Heavy duty equipment is equipment that cuts or moves rock or coal, that performs drilling or bolting functions, or that moves longwall components, as well as certain equipment involved with transporting diesel fuel and lubricants.

[3] Light duty diesel powered equipment is equipment other than permissible equipment and heavy duty equipment.

SCOPE: MINING SECTORS AFFECTED BY THE RULE

The Coal Mine DPM Rule applies only to underground coal mines that use diesel powered equipment. To date, no anthracite mines use diesel powered equipment. Thus the rule applies only to a portion of SIC 1222, Underground Bituminous Coal Mines.

MSHA data indicate that there are 145 mines affected by this rule, or 16 percent of all underground coal mines. These active underground coal mines employ 15,471 workers, or 32 percent of all employees of underground coal mines. Underground coal mines account for 37 percent of all coal mines and 55 percent of all coal miners. Of the mines affected by the rule, one is large by SBA's definition (500 or more employees), seven are small by MSHA's definition (fewer than 20 employees), and the other 137 are small by SBA's definition and large by MSHA's definition. Further discussion of mining sectors affected by the rule is provided in Chapter II.

BENEFITS

MSHA's DPM rule for coal mines will reduce a significant health risk to underground miners. This risk includes the potential for illnesses and premature death, as well as the attendant costs of the risk to the miners' families, to the miners' employers, and to society at large.

Benefits of the rule include reductions in lung cancers. In the long run, as the mining population turns over, MSHA estimates that a minimum of 1.8 lung cancer deaths will be avoided per year. Note that this lower bound figure could significantly underestimate the magnitude of the health benefits. For example, the estimate based on the mean value of all the studies examined is 13 lung cancer deaths avoided per year.

Benefits of the rule will also include reductions in the risk of death from cardiovascular, cardiopulmonary, or respiratory causes and reductions in the risk of sensory irritation and respiratory symptoms. However, MSHA has not included these health benefits in its estimates because the Agency cannot currently make reliable or precise quantitative estimates of them. Nevertheless, the expected reductions in the risk of death from cardiovascular, cardiopulmonary, or respiratory causes and the expected reductions in the risk of sensory irritation and respiratory symptoms are likely to be substantial.

Further discussion of benefits of the rule is provided in Chapter III of this document.

COMPLIANCE COSTS

Summary of Costs

Yearly Industry Costs. The estimated total yearly cost[4] of this final rule to the underground coal mining industry is $7.07 million. Of these costs:

- $4.47 million (63.2 percent) is attributable to installation and maintenance of paper filters on permissible equipment;

- $2.28 million (32.3 percent) is attributable to installation and maintenance of ceramic filters on non-permissible heavy duty equipment; and

- $0.32 million (4.5 percent) is attributable to other compliance activities.

The estimated annualized cost of this final rule for equipment manufacturers is $30,030. Further discussion of costs and their estimation is provided in Chapter IV of this document.

Initial Costs. Because of phasing, most capital costs will occur in the second and third year after the rule's effective date. Actual estimated industry costs in the first three years will be:

- $1.38 million in the first year, of which
  - $0.65 million is capital costs, and
  - $0.73 million is annual O&M costs;

- $8.12 million in the second year, of which
  - $3.33 million is capital costs, and
  - $4.79 million is annual O&M costs; and

- $8.10 million in the third year, of which
  - $2.60 million is capital costs, and
  - $5.50 million is annual O&M costs.

Thus actual costs peak in the second and third years at a level about $1 million (15 percent) above the average yearly costs.

Costs by Mine Size. Of the yearly costs to coal mine operators, $6.08 million (86.1 percent) will be incurred by mines with 20 to 500 employees; $0.97 million (13.8 percent) will be incurred by mines with over 500 employees; and $7,400 (0.1 percent) will be incurred by mines with fewer than 20 employees. Thus, using SBA's definition of "small," small mines will incur $6.09 million in yearly costs (86.2 percent). Using MSHA's definition of "small," small

[4] Capital costs are discounted to the present and amortized over the life of the investment using an annual discount rate of 7.0 percent.

mines will incur $7,000 in yearly costs (0.1 percent). Further discussion of costs by mine size is provided in Chapter V of this document.

Reductions in Cost from the Proposed Rule

MSHA has crafted a final rule that is considerably more flexible and cost-effective – and thus less costly -- than the proposed rule. The changes have resulted in a reduction of estimated yearly costs of the rule from $9 million to $7.2 million. These changes and their impacts on costs are discussed below.

A Tailpipe Standard. The proposed rule required use of a highly efficient filtration system that would remove 95 percent of DPM from the exhaust stream. The final rule is based on an alternative on which the agency sought comment: a tailpipe emissions limit. This approach will allow less expensive filters and other devices to be used on cleaner engines. Moreover, this approach will not inhibit development of new technologies and other control techniques that can further reduce the cost of limiting DPM emissions.

Permissible Equipment. In practice, the change from a filter efficiency standard to a tailpipe standard will not cut the costs for permissible equipment. Because exhaust gases of permissible equipment are cooled for safety reasons, the paper filter remains the DPM control of choice. The record confirms that installing such a filter can reduce emissions of this fleet by the required amount, and it is the most cost-effective control. There has been some reduction in the initial estimate of impacts of the proposed rule, however, because MSHA has since determined that nearly 10 percent of diesel powered permissible equipment is already equipped with the sort of paper filters that comply with the rule. Thus, these costs are in the baseline rather than being impacts attributable to the rule.

Heavy Duty Non-Permissible Equipment. Under the proposed rule, such equipment would have required a paper filtration system and a cooling system for the exhaust gases. Even without other features needed for permissible equipment, this would have made DPM control considerably more expensive for a heavy duty non-permissible machine than for a permissible machine with the same model engine. Relieving mine operators of the need to use a 95-percent efficient filter and allowing them to meet a DPM emission limit makes it feasible to use ceramic filters and similar controls designed to filter hot exhaust gases. For the typical piece of heavy duty equipment the estimated yearly cost of a DPM control using such a system is just over one third of the yearly cost of control under the proposed rule. This cost saving is the principal reason for the reduction in costs of the rule.

There are some related factors that also contribute to the cost savings. A very few engines in heavy duty equipment will not require filters at all; they can comply with an oxidation catalytic converter alone. Data that have become available recently indicate that ceramic filters are more efficient than previously understood, so that only a handful of engines in heavy duty equipment will ever need a paper filtration system. Some engines will be able to meet the interim DPM emission limit with a lesser control or no control at all, which results in some further cost savings.

Increases in Cost from the Proposed Rule

Generators and Compressors. The final rule, unlike the proposal, would cover engines on generators and air compressors in the same manner as heavy duty non permissible engines. This equipment was classified as light duty in the safety rule (61 FR 55412). Generators and air compressors, however, include the most powerful engines used in underground coal mines, and their duty cycle—continuous operation for long periods of time—and resultant DPM emissions are generally similar to those of heavy duty equipment. Thus, for purposes of this DPM rule, generators and air compressors are considered to require the same controls as heavy duty equipment. The control costs are relatively modest.

Other Light Duty Equipment. The final rule, unlike the proposal, applies to newly introduced light duty equipment. However:

- Light duty machines (other than generators and air compressors) are grandfathered with respect to the rule so long as their engines continue to be used in the same mine.

- An engine that meets listed applicable EPA standards is deemed to comply with the light duty equipment provisions of the rule even if its uncontrolled DPM emissions exceed 5.0 grams/hour.

Only in rare instances will mine operators find it appropriate to control an engine rather than take advantage of one of these provisions. MSHA's analysis indicates that most light duty equipment either will wear out in place in a relatively short period of time or is far enough beyond its "useful life" that it is of marginal value. Moreover, engines that meet the listed EPA standards are rapidly becoming abundantly available for types of equipment classified as light duty. Thus this provision targets relatively dirty engines for replacement with relatively clean engines in a highly cost-effective manner and with minimal actual cost.

Impacts

Estimated yearly compliance costs are 0.23 percent of revenues of underground coal mines that use diesel powered equipment. This is not a significant economic impact.

By mine size, estimated yearly costs are 0.08 percent of revenue for mines with fewer than 20 employees; 0.21 percent of revenue for mines with 20 to 500 employees; and 1.28 percent of revenues for mines with over 500 employees. This variation is the result of disproportionately small numbers of diesel powered permissible and heavy duty machines in very small mines and disproportionately large numbers in large mines. Impacts on small mines are not significant.

MSHA has determined that compliance by the coal mining industry with the requirements of the final rule is both technologically and economically feasible.

EXECUTIVE ORDER 12866 AND THE REGULATORY FLEXIBILITY ACT

Executive Order 12866 requires that regulatory agencies assess both the costs and benefits of intended regulations. MSHA has fulfilled this requirement for the final rule and determined that this rulemaking is not economically significant but is a significant regulatory action under Executive Order 12866.

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 Administration's (SBA's) criterion for a small entity in determining a rule's economic impact unless, after consultation with the SBA Office of Advocacy, MSHA establishes an alternative definition for a small mine and publishes that definition in the Federal Register for notice and comment. For the mining industry, SBA defines "small" as a mine with 500 or fewer workers. MSHA traditionally has considered small mines to be those with fewer than 20 workers. To ensure that the final rule conforms with the RFA, MSHA has analyzed the economic impact of the final rule on mines with 500 or fewer workers (as well as on those with fewer than 20 workers).

MSHA has determined that the final rule would not have a significant economic impact on small mines, whether a small mine is defined as one with 500 or fewer workers or one with fewer than 20 workers.

Using the Agency's traditional definition of a small mine, which is one employing fewer than 20 workers, the estimated yearly cost of the final rule on small underground coal mines would be about $7,500. This estimated cost for small mines compares to estimated annual revenues of approximately $9.1 million for small underground coal mines.

Using SBA's definition of a small mine, which is one employing 500 or fewer workers, the estimated yearly cost of the final rule on small underground coal mines would be about $6.05 million. This estimated cost for small mines compares to estimated annual revenues of approximately $2,960 million for small underground coal mines, using SBA's criteria.

Based on its analysis, MSHA has determined that the final rule would not have a significant economic impact on a substantial number of small entities. MSHA has so certified these findings to the Small Business Administration. The factual basis for this certification is discussed in Chapter V of this REA.

II. INDUSTRY PROFILE

This industry profile provides background information about the structure and economic characteristics of the mining industry. It provides data on the number of mines, their size, the number of employees, and the diesel powered equipment used.

THE STRUCTURE OF THE COAL MINING INDUSTRY

MSHA divides the mining industry into two major segments based on commodity: (1) coal mines and (2) metal and nonmetal (M/NM) mines. These segments are further divided based on type of operation (e.g., underground mines or surface mines). MSHA maintains its own data on mine type, size, and employment, and MSHA also collects data on the number of independent contractors and contractor employees by major industry segment.

MSHA categorizes mines by size based on employment. For the past 20 years, for rulemaking purposes, MSHA has consistently defined a small mine to be one that employs fewer than 20 workers and a large mine to be one that employs 20 or more workers. To comply with the requirements of the Small Business Regulatory Enforcement Fairness Act (SBREFA) amendments to the Regulatory Flexibility Act (RFA), however, an agency must use the Small Business Administration's (SBA's) criteria for a small entity – for mining, 500 or fewer employees -- when determining a rule's economic impact.

Table II-1 presents the total number of small and large coal mines and the corresponding number of miners, excluding contractors, for the coal mining segment. This table uses three mine size categories based on the number of employees: (1) fewer than 20 employees (small by both SBA's definition and MSHA's traditional), (2) 20 to 500 employees (small by to SBA's definition, but not by MSHA's), and (3) more than 500 employees. Table II-1 further disaggregates data by surface mines and underground mines, as well as (for employees) office workers. Table II-2 presents corresponding data on the number of independent contractors and their employees working in the coal mining segment.

TABLE II-1: Distribution of Coal Mine Operations and Employment (Excluding Contractors) by Mine Type and Size[a]

Size of Coal Mine[b]		Mine Type			
		Underground	Surface	Office Workers	Total Coal
Fewer Than 20 Employees	Mines	382	1,058	-	1,438
	Employees	3,751	6,491	487	10,729
20 to 500 Employees	Mines	522	492	-	1,014
	Employees	39,566	31,731	3,389	74,692
Over 500 Employees	Mines	6	1	-	7
	Employees	3,459	510	189	4,158
All Coal Mines	Mines	910	1,549	-	2,459
	Employees	46,776	38,738	4,065	89,579

[a] Source: U.S. Department of Labor, Mine Safety and Health Administration, Office of Standards, Regulations, and Variances based on 1998 MS data, CM441/CM935LA cycle 1998/198. Data for Total Office workers from Mine Injury and Worktime Quarterly (1997 Closeout Edition) Table 1, p. 5.

[b] Based on MSHA's traditional definition, large mines include all mines with 20 or more employees. Based on SBA's definition, as required by SBREFA, large mines include only mines with over 500 employees.

TABLE II-2: Distribution of Contractors and Contractor Employment by Size of Operation[a]

Size of Contractor[b]		Contractors			
		Underground	Surface	Office Workers	Total
Fewer Than 20 Employees	Mines	1,077	2,403	-	3,480
	Employees	4,078	9,969	1,064	15,111
20 to 500 Employees	Mines	79	242	-	321
	Employees	4,131	11,618	1,192	16,941
Over 500 Employees	Mines	-	-	-	-
	Employees	-	-	-	-
Total Contractors	Mines	1,156	2,645	-	3,801
	Employees	8,209	32,052	2,256	30,052

[a] Source: U.S. Department of Labor, Mine Safety and Health Administration, Office of Standards, Regulations, and Variances based on 1998 MS data, CT441/CT935LA cycle 1998/198. Data for Total Office workers from Mine Injury and Worktime Quarterly (1998 Closeout Edition) Table 5, p. 20.

[b] Based on MSHA's traditional definition, large mines include all mines with 20 or more employees. Based on SBA's definition, as required by SBREFA, large mines include only mines with over 500 employees.

Agency data (Table II-1) indicate that there were about 2,459 coal mines (surface and underground combined) in 1998. When applying MSHA's own definition of a small mine (fewer than 20 workers), 1,438 (58 percent of all coal mines) were small mines and 1,021 (42 percent) were large.[5] Using SBA's definition, only 7 coal mines (0.3 percent) were large.

These data indicate that 910 coal mines (37 percent of all coal mines) were underground coal mines. Of these mines, 382 (42 percent) were small by MSHA's definition, and 528 (58 percent) were large. Six underground coal mines (0.7 percent) were large by SBA's definition.

[5] U.S. Department of Labor, MSHA, 1998 Final MIS data CM441 cycle 1998/198.

The data show that total employment of miners (excluding office workers) in coal mines in 1998 was about 85,500. Of these miners about 10,200 (12 percent) worked at small mines, by MSHA's definition, and 75,300 (88 percent) worked at large mines.[6] Using SBA's definition, 96 percent of coal miners worked at small mines and 4 percent worked at large mines. Using MSHA's definition, small coal mines averaged 7 miners, and large coal mines averaged 74 miners. Using SBA's definition, there were, on average, 33 miners in a small coal mine and 567 miners in a large coal mine.

Underground coal mines employed about 46,750 miners (55 percent of all coal miners). By MSHA's definition, about 3,750 underground coal miners (8 percent) worked in small mines, and about 43,000 (92 percent) worked in large mines. By SBA's definition, about 43,300 miners (92 percent) worked in small mines, and 3,450 (8 percent) worked in large mines. Using MSHA's definition, small underground coal mines averaged 10 miners, and large underground coal mines averaged 81 miners. Using SBA's definition, there were, on average, 48 miners in a small underground coal mine and 577 miners in a large underground coal mine.

ECONOMIC CHARACTERISTICS OF THE COAL MINING SECTOR

MSHA classifies the U.S. coal mining segment into two major commodity groups: bituminous and anthracite. About 92 percent of total coal production is bituminous. The remaining 8 percent is the product of lignite and anthracite mines.[7]

Mines east of the Mississippi accounted for about 51 percent of coal production in 1998. For the period 1949 through 1998, coal production east of the Mississippi River fluctuated relatively little, from a low of 395 million tons in 1954 to a high of 630 million tons in 1990; 1998 production was estimated at 571 million tons. Coal production west of the Mississippi, by contrast, increased each year from a low of 20 million tons in 1959 to a record high of 548 million tons in 1998.[8] The growth in western coal has been due, in part, to environmental concerns that led to increased demand for low-sulfur coal, which is abundant in the West.

In addition, surface mining, with its higher average productivity, is much more prevalent in the West. Surface mining methods for coal, which include drilling and blasting, are also practiced in surface mines for other commodity types. Most surface mines use front-end loaders, bulldozers, shovels, or trucks for haulage.

The U.S. coal sector produced a record 1.12 billion short tons of coal in 1998, at an average price of $17.58 per ton. The total value of U.S. coal production in 1998 was estimated as $19.7 billion. Small mines (by MSHA's definition) accounted for about 4 percent (40 million

[6] U.S. Department of Labor, MSHA, 1998 Final MIS data CM441 cycle 1998/198.

[7] U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1998, July 1999, p. 191.

[8] U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1998, July 1999, p. 191.

tons) of domestic coal production valued at $0.7 billion, and large mines (by MSHA's definition) accounted for about 96 percent (1.08 billion tons) valued at $19.0 billion.[9]

The U.S. coal industry enjoys a fairly constant domestic demand. Over 90 percent of U.S. coal demand was accounted for by electric utilities in 1998.[10] Due to the high conversion costs of changing a fuel source, MSHA does not expect a substantial change in coal demand by utility power plants in the near future.[11]

UNDERGROUND COAL MINES THAT USE DIESEL POWERED EQUIPMENT

The Coal Mine DPM Rule applies only to underground coal mines that use diesel powered equipment. MSHA data indicate that there are 145 mines affected by this rule, or 16 percent of all underground coal mines. To date, no anthracite mines use diesel powered equipment. Thus the rule applies only to a portion of SIC 1222, Underground Bituminous Coal Mines.

MSHA maintains an inventory of all diesel powered equipment used in underground coal mines, by mine. For each piece of equipment, the inventory provides (among other data) the equipment category (permissible, heavy duty, and light duty), the type of equipment, the equipment manufacturer, and the engine manufacturer and model. This inventory, supplemented by MSHA data on employment in each mine that was based on inspections, is the basis for the industry profile of this portion of SIC 1222.

In developing the industry profile, MSHA has performed a number of adjustments to the inventory that were not done in the PREA. As a result, the number of mines with diesel powered equipment has been reduced slightly and the number of small mines (by MSHA's definition) has decreased dramatically. Thus this industry profile is not directly comparable to the industry profile in the PREA, and no attempt should be made to analyze trends or changes. The data corrections reflected in this industry profile include the following:

- MSHA's inventory classifies mines as "active," "intermittent," "nonproducing," and "abandoned." In the PREA, all such mines were included as "small" if they had fewer than 20 employees. For this industry profile, MSHA has dropped all mines that were classified as nonproducing or abandoned. The diesel powered equipment in these mines, however, has been included in the analysis, under the assumption that the equipment has been transferred to active underground coal mines with 20 to 500 employees. These mines (but not their

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[9] U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1998, July 1999. 203, U.S. Department of Energy, Energy Information Administration, Coal Industry Annual 1997, December 1998, pp. ix and 154, and U.S. Department of Labor, Mine Safety and Health Administration, Division of Mining Information Systems, 1998 Final MIS data (quarter 1 - quarter 4) CM441 cycle 1998/198.

[10] U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1998, July 1999, p. 187.

[11] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2000, p. 68.

diesel powered equipment) were deleted from the inventory for purposes of this industry profile.

- Several mines with only a few employees, which were classified as “intermittent,” had dozens of pieces of diesel powered equipment. MSHA believed that such mines were probably not operating at the time the inventory was taken, and that they would have at least 20 employees when actually operating. MSHA checked these mines with the district offices and ascertained that these mines were closed and their equipment transferred elsewhere. (The few employees on site were usually security guards.) These mines (but not their diesel powered equipment) were deleted from the inventory for purposes of this industry profile.

- Based on this experience, MSHA verified the status of all mines with fewer than 50 employees that were classified as “intermittent.” Several additional mines (mostly with only a handful of employees) were also found to be closed, with their equipment transferred elsewhere. These mines (but not their diesel powered equipment) were deleted from the inventory for purposes of this industry profile.

- MSHA’s data failed to indicate the number of employees for several mines. Some of these were already classified as “abandoned.” MSHA verified the status of these mines, and all but one (a small, active mine) were reported to be closed with their equipment transferred elsewhere. These mines (but not their diesel powered equipment) were also deleted from the inventory for purposes of this industry profile.

- MSHA also examined serial numbers for duplicates. Some pieces of equipment are shared and used in more than one mine, so that the same piece of equipment was reported more than once. MSHA removed all such duplicate reporting.

The results of these adjustments are shown in Table II-3. The Coal Mine DPM Rule covers 145 active underground coal mines with 15,471 employees. Of these mines, one is large by SBA’s definition (500 or more employees), and seven are small by MSHA’s definition (fewer than 20 employees). Overall, about 15 percent[12] of underground coal mines use diesel equipment, but very few of these mines are small by MSHA’s definition. One of the six underground coal mines with over 500 employees; 26 percent of mines with 20 to 499 employees; and only 2 percent of mines with fewer than 20 employees use diesel powered equipment. Coverage of miners by the Coal DMP rule is even more skewed toward larger mines. Overall, 32 percent of underground coal miners work in mines using diesel powered equipment. For mines with over 500 employees, 22 percent of miners work in mines using diesel powered equipment; for mines with 20 to 499 employees, 36 percent; and for mines with fewer than 20 employees, just over one percent.

[12] Since the data for all underground coal mines (Table II-1) and underground coal mines using diesel equipment (Table II-3) came from different sources, these percentages may not be accurate in absolute terms. Nevertheless the differences in data sources should make little difference for comparisons between mine size classes.

TABLE II-3: Underground Coal Mines Using Diesel Powered Equipment and Miners in Those Mines, by Mine Size Class

	Size of Mine					
	Fewer Than 20 Miners		20 to 500 Miners		Over 500 Miners	
	Mines	Miners	Mines	Miners	Mines	Miners
Number	7	50	137	14,669	1	752
Percent of All Underground Coal Mines/Miners in Size Class[a]	1.8%	1.3%	26%	36%	17%	22%
Percent of Underground Coal Mines/Miners With Diesel Equipment	4.9%	0.3%	94.4%	94.7%	0.7%	5.0%

[a] Data on all underground coal mines, by size class, were presented in Table II-1, above.

INVENTORY OF DIESEL POWERED EQUIPMENT

Diesel powered equipment in underground coal mines is classified into three equipment types (permissible, heavy duty, and light duty) and one subtype. These classifications originated in the diesel equipment rule published in 1996.

- **Permissible Equipment.** Permissible diesel powered equipment is required to be used in areas of the mine where methane is expected to be present. This includes areas of the mine where active mining is proceeding. Special design features are incorporated and components are attached to the engine to prevent the ignition of methane by flame or sparks originating within the engine, or the ignition of combustible coal dust or materials that may be present on the engine surfaces. Engines and the attached safety components are evaluated and approved as permissible by MSHA.

- **Heavy Duty Equipment.** Heavy duty equipment is equipment that cuts or moves rock or coal, that performs drilling or bolting functions, or that moves longwall components, as well as certain equipment involved with transporting diesel fuel and lubricants. MSHA approves diesel engines for use in heavy duty equipment, and under MSHA's 1996 diesel equipment rule all heavy duty diesel powered equipment is required to have an MSHA-approved engine.

- **Light Duty Equipment.** Light duty diesel powered equipment is equipment other than permissible equipment and heavy duty equipment. Types of light duty equipment include personnel carriers, tractors, man lifts, rock dusters, fork lifts, utility trucks, and various other types of light general-purpose and special-purpose trucks. Light duty equipment that must be moved by being carried or dragged because it is not self-propelled is further described as "portable." Although air compressors and generators are considered light duty equipment under the diesel equipment rule, they are required to meet the same particulate emissions standards as heavy duty equipment by this regulation, unless their exhaust is directed away from areas where miners work. MSHA approves diesel engines for use in light duty equipment, and under MSHA's 1996 diesel equipment rule all light duty diesel powered equipment is required to have an MSHA-approved engine. [13]

Table II-4 summarizes the inventory of diesel powered equipment by equipment category and mine size. Over 95 percent of the costs of this rule stem from the requirements of Section 72.500 and Section 72.501. Mines with only light duty diesel equipment are spared these costs, and mines with very little equipment covered by Section 72.500 or Section 72.501 will incur correspondingly low costs. The percentages of permissible diesel equipment (which will require controls under Section 72.500 of this rule) and heavy duty equipment, generators and air compressors (which will require controls under Section 72.501) rise with mine size. Permissible equipment, heavy duty equipment, and generators and air compressors make up:

- 10 percent of diesel powered equipment in mines with fewer than 20 miners;

- 33 percent of diesel powered equipment in mines with 20 to 499 miners; and

- 55 percent of diesel powered equipment in the mine with over 500 miners.

Smaller mines are also more likely not to have any equipment covered by Section 72.500 or Section 72.501:

- Of mines with fewer than 20 employees, 71 percent have only light duty diesel powered equipment;

- Of mines with 20 to 69 miners, 66 percent have only light duty diesel equipment; and

- Of mines with 70 to 120 employees, 32 percent have only such diesel equipment.

- Only two mines with more than 120 miners have only light duty diesel powered equipment.

[13] The diesel equipment rule exempts ambulances and fire fighting equipment from this requirement. This DPM rule retains this exemption.

TABLE II-4: Diesel Powered Equipment in Underground Coal Mines, by Mine Size

Equipment Category	Size of Mine			
	Fewer Than 20 Miners	20 to 500 Miners	Over 500 Miners	All Mines
Permissible	1			528
Heavy Duty Non-Permissible	1	465	31	497
Generators/ Compressors[a]	-	60	6	66
Light Duty[b]	18	1,849	96	1,963
Other Portable[c]	-	63	4	67
TOTAL	20	2,874	227	3,121

[a] Classified as light duty portable equipment, but subject to the same requirements in this rule as heavy duty non-permissible equipment.

[b] Excludes portable light duty equipment.

[c] Includes pumps, water sprayers, and welders.

III. BENEFITS

INTRODUCTION

MSHA's DPM rule for coal mines will reduce a significant health risk to underground miners. The benefits of reducing this risk include a reduction in the incidence of illness and premature death, as well as a reduction in the attendant costs to the miners' employers, their families, and society at large.

MSHA estimates that underground coal mines have approximately 46,800 employees, of whom an estimated 15,500 work in mines that use diesel powered equipment.[14] Of these employees, MSHA estimates that approximately 14,700 are miners who are exposed to DPM, approximately 11,750 work in mines with permissible and non-permissible heavy duty diesel powered equipment, approximately 5,750 work in mines that use permissible diesel powered face equipment, and approximately 2,300 miners actually operate diesel powered equipment.[15]

The risks that are addressed by this rule arise because underground miners who work with diesel powered equipment are exposed to extremely high concentrations of the very small particles produced by engines that burn diesel fuel. Diesel engines have the advantages of providing excellent mobility and a full range of power for all types of equipment, while avoiding the explosive hazards associated with gasoline. Underground mines are confined spaces, however. Despite ventilation requirements, they can accumulate significant concentrations of particles and gases – both those produced by the mine itself (e.g., methane gas and mine dust liberated by mining operations) and those produced by equipment used in the mine (i.e., DPM and exhaust gases).

It is widely recognized that respirable particles can create adverse health effects. Environmental regulations in effect for some years already restrict the exposure of the general public to particles less than 10 microns in diameter. Moreover, as discussed in part III of the preamble, evidence collected in recent years indicates that much of the health hazard is due to the smallest particles. Since airborne particles less than 2.5 microns in diameter have specifically been identified as posing significant health problems, further environmental restrictions have recently been established to limit public exposure to particles of this size range – a size range that includes DPM. These restrictions are in addition to a series of regulations issued over the years (and not yet entirely in effect) by the Environmental Protection Agency to directly limit the particulate output of new diesel engines.

Similarly, the need to control worker exposure to respirable dusts has long been recognized, and controls have been implemented. While exposure of working miners to certain other respirable dusts (e.g., silica) is controlled, there are no current restrictions specifically on occupational exposure to DPM. Moreover, EPA's rules limiting the particulate output of new diesel engines offer little prospect of immediate help, since the mining industry has a fleet of

[14] See Table II-1 and Table II-3.

[15] See Table IV-7b.

engines that largely predate these rules, and EPA's rules do not directly apply to engines used underground. Engines used for underground mining purposes are exempted from EPA regulations.

In evaluating the health risks that underground miners currently face (and thus the potential benefits of controlling that risk), it is particularly significant to note that the exposures of underground miners constitute a special and exceptional class. Among all groups in the U.S. work force and population at large, underground miners are the population that is exposed to by far the highest levels of DPM. Based on MSHA field studies, which are discussed in part III of the preamble and summarized in Figure III-1 in the preamble, median DPM concentrations observed for underground miners range up to 200 times as high as average environmental exposures in the most heavily polluted urban areas and up to 10 times as high as median exposures estimated for the most heavily exposed workers in other occupational groups.

SPECIFIC BENEFITS OF THE RULE

Overview

As described in detail in MSHA's risk analysis (part III of the preamble), the available scientific information indicates that miners exposed to the extremely high DPM concentrations found in underground mines are at significant excess risk of experiencing three kinds of material impairment to their health:

- Increased risk of lung cancer has been linked to chronic occupational DPM exposure. Although the scientific community has not established a definitive dose-response relationship for DPM and lung cancer:
    - NIOSH has concluded that miners are at an elevated risk of contracting lung cancer as a result of the very high exposures of this population to DPM.
    - NIOSH has also reaffirmed its 1988 recommendation that whole diesel exhaust be regarded as a "potential occupational carcinogen," and that reductions in workplace exposure be implemented to reduce cancer risks.
    - The International Agency for Research on Cancer declared that "diesel engine exhaust is probably carcinogenic to humans…"
    - In 1995, the American Conference of Governmental Industrial Hygienists (ACGIH) added diesel particulate matter to its "Notice of Intended Changes" for 1995-1996, recommending a threshold limit value (TLV^R) for a conventional 8 hour work day of 150 micrograms per cubic meter of air.
    - In 1996 the international Programme on Chemical Safety (IPCS) concluded that inhalation of diesel exhaust is of concern with respect to both neoplastic and non-neoplastic diseases and that the particulate phase appears to have the greatest effect on health.
    - In 1998 the California Environmental Protection Agency identified DPM as a toxic air contaminant as defined in their Health and Safety Code, Section 39655.
    - In 1999, the American Conference of Governmental Industrial Hygienists (ACGIH) proposed a Threshold Limit Value of 50 micrograms/m^3 for the DPM component of diesel exhaust and placed DPM on its Notice of Intended Changes.
    - Germany already regulates exposure to diesel particulate, and Canada is looking closely at the problem.

- Increased acute risk of death from cardiovascular, cardiopulmonary, or respiratory causes has been linked to short or long term exposures to fine particulates, such as DPM.

- Sensory irritations and respiratory symptoms can result from even short term DPM exposures. These include:
    - Eye, nose, and throat irritations,
    - Headaches, nausea, and/or vomiting, and
    - Chest tightness and wheeze.

Besides being potentially debilitating, such effects can distract miners from their responsibilities in ways that could pose safety hazards for everyone in the mine.

Scientific evidence currently available may not be sufficient to generate definitive dose-response estimates for exposure to DPM. MSHA believes, however, that evidence of adverse health effects arising from such exposure is strong, and that reducing miners' exposure to DPM will reduce the number of sensory irritations and respiratory symptoms; reduce the number of deaths due to cardiovascular, cardiopulmonary, or respiratory causes; and reduce the number of lung cancers.

Lung Cancer Risk Reduction

Estimation Models. Estimates of the exposure-response relationship have been made for lung cancer using both data on miner exposures and other data. The different estimates, however, entail considerable uncertainty, as they vary considerably with different model specifications. The best available data for estimation of the benefits of DPM controls in mines are studies by Johnston,[16] Säverin,[17] and Steenland.[18] All the estimates based on these studies are extrapolations well outside of the range of data on which the models are estimated. These studies, and the resulting estimates, are described in greater detail in part III of the preamble. The salient points of the studies for benefit estimation can be summarized as follows:

- Johnston's estimates are based on a cohort study of coal miners in mines that did and did not use diesel powered equipment. In the Johnston models, cited in the preamble, cumulative DPM exposure is lagged by 15 years to reflect the long latency period of lung cancer. For these models Johnston estimated the exposure-response relationship using two model structures:
    - A "mine-unadjusted" model used only cumulative DPM exposure and miner characteristics as explanatory variables for lung cancer.
    - A "mine-adjusted" model also identified the specific mines as explanatory variables.

- Säverin's estimates are based on a cohort study of potash miners, with comparisons to lung cancer rates in the general population. Säverin used two data sets:
    - The full cohort of underground miners, and
    - A subcohort of miners who had worked underground, in relatively stable jobs, for at least 10 years.

- Säverin also used two statistical specifications for his models:
    - A Poisson model specification, and
    - A Cox model specification.

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[16] Johnston, et al., 1997.

[17] Säverin, et al., 1999.

[18] Steenland, et al., 1998.

- Steenland's estimates are base on a study of exposures in the trucking industry. In Steenland's study cumulative DPM exposure is lagged by 5 years and two statistical specifications are used:
  - A logistic model specification using a linear cumulative dose term, and
  - A logistic model specification using the logarithm of cumulative exposure.

The fact that Steenland's data involved DPM exposures very much lower than those found in mines raises considerable uncertainty about the applicability of the results to mines. To apply the model to underground mines requires extrapolation far outside the range of exposures on which the model was estimated. The fact that the linear and logarithmic specifications yield very different results highlights the uncertainties involved in such extrapolation. Nevertheless, the results do fall within the range of estimates from the other models, and the two specifications bracket most of the other estimates rather symmetrically. Thus, while Steenland's results probably should not be given much weight as estimates for underground mining environments under current conditions, they do generally corroborate the estimates of models based on underground mine data.

Risk Reduction Estimates. Table III-1 summarizes the exposure-response relationships from the various models estimated in these three studies. These results are presented in the form of an excess lifetime risk from a cumulative occupational exposure over a working life. That is, the occupational DPM exposure is assumed to be cumulative over 45 years (beginning at age 20), and the excess risk of dying from lung cancer (i.e., risk above that of an occupationally unexposed worker) is accumulated from age 20 through age 85 – a span of 65 years. Table III-1 presents the excess risk per 1,000 occupationally exposed workers at two points along the exposure-response function estimated by each model:

- Lifetime exposure to DPM at the mine face at a concentration of 644 micrograms/m^3 (the average level under current conditions measured by MSHA for underground mines with diesel face equipment), [19] and

- Lifetime exposure to DPM at a concentration of 200 micrograms/m^3 (which is an upper bound of several approaches that MSHA used to estimate the DPM concentrations that would result from the coal DPM standard).

Table III-1 also shows the reduction in excess risk (as estimated by each model) that would result from lowering the lifetime DPM exposure rate from 644 micrograms/m^3 to 200 micrograms/m^3. The estimates of lifetime excess lung cancer rates shown in Table III-1 fall into several rather distinct groups:

[19] For justification of the 644 micrograms/m^3, see the discussion in the preamble, Part III, concerning Table III-1.

Table III-1: Estimates of Lifetime Excess Risk of Lung Cancer Death at Current and Controlled DPM Concentrations in Underground Coal Mines

Study	Model		Estimate of Lifetime Excess Lung Cancer Deaths per 1,000 Occupationally Exposed Workers[a]		
	Data and Structure	Specification	Current[b]	With Rule[c]	Change
Johnston	Mine-unadjusted		811	513	298
	Mine-adjusted		770	313	457
Säverin	Full Cohort	Poisson	61	15	46
		Cox	422	71	351
	Subcohort	Poisson	563	94	469
		Cox	762	182	580
Steenland	5-Yr. Lag	Simple Cumulative Exposure	721	159	562
		Log of Cumulative Exposure	95	67	28
Averages	Median	All Studies	642	127	404
		Mines Only[d]	663	138	404
	Mean	All Studies	526	177	349
		Mines Only[d]	565	198	367

[a] Assumes 45-year occupational exposure from age 20 to retirement at age 65. Lifetime risk of lung cancer adjusted for competing risk of death from other causes and calculated through age 85. Source: Preamble Table III-7.

[b] Average measurement of 644 milligrams/m^3 DPM.

[c] Estimated at 200 milligrams/m^3 DPM.

[d] Johnston and Säverin only.

- Säverin's full cohort Poisson model and Steenland's logarithmic model estimate:
  - Relatively low[20] current excess lung cancer risks (61 to 95 per 1,000 affected[21] miners),
  - Relatively low excess lung cancer risks with the rule (15 to 67 per 1,000), and
  - Relatively small reductions in risk (28 to 46 per 1,000).

- Johnston's mine-adjusted model and Säverin's subcohort Poisson model estimate:
  - Medium (relative to other estimates) to high current excess lung cancer risks (563 to 770 per 1,000 affected miners),
  - Medium excess lung cancer risks with the rule (94 to 313 per 1,000), and
  - Medium-large reductions in risk (457 to 469 per 1,000).

- Johnston's mine-unadjusted model estimates:
  - A high current excess lung cancer risk (811 per 1,000 affected miners),
  - A high excess lung cancer risk with the rule (513 per 1,000), and
  - A medium reduction in risk (298 per 1,000).

- Säverin's subcohort Cox model, and Steenland's linear model estimate:
  - High current excess lung cancer risks (721 to 762 per 1,000 affected miners),
  - Medium excess lung cancer risks with the rule (159 to 182 per 1,000), and
  - Large reductions in risk (562 to 580 per 1,000).

Several considerations appear to be germane for assessment of this range of estimates of excess risk and risk reduction:

- Since they are restricted to miners with relatively stable job histories, Säverin's subcohort data may provide a more accurate representation of long-term cumulative exposure to DPM than Säverin's full cohort. Therefore, the subcohort estimates should probably be credited more than the full cohort estimates.

- Because of the long latency period of cancer, the lagged specification used in Johnston's models appears preferable to an unlagged specification.

As previously noted, all of the estimates of the benefits of DPM controls in mines are based on extrapolations well outside of the range of data on miner exposures on which the various models were estimated. As a result, these estimates are subject to a high degree of uncertainty, which suggests that they be treated with caution. For that reason, we propose using the lower-range of the estimates, rather than the middle-range of the estimates, to represent the range in which the exposure-response relationship actually lies.

[20] These estimates are low relative to other estimates for underground coal mines. All of these risks are extremely large relative to any other occupational group than underground miners.

[21] Underground miners at mines using diesel equipment, who are occupationally exposed to DPM for 45 years at a mean concentration of 644 micrograms/m^3.

Benefit Estimates. Since exposure data were collected in mines that use permissible diesel powered face equipment, the number of coal miners working at the face in these underground mines (1,725) appears to be a reasonably conservative number[22] on which to base an estimate of the benefits of the rule. Table III-2 summarizes the benefits estimated over three different time frames:

- Lifetime benefits[23] for the population of miners currently working;
- One-year benefits for a population of miners working at any one time; and
- Average annual benefits over the long run, as the population of miners turns over because of new hires and retirement.

The estimated benefits of the rule in terms of lung cancers avoided over the lifetimes of these miners are as follows:

- Benefits probably fall within the range of 514 to 809[24] lifetime excess lung cancers avoided.
- A point estimate, based on mean values of the risk reduction estimates, is 602[25] lifetime excess lung cancers avoided.
- A reasonable lower bound, based on Säverin (full cohort, Poisson) is 79[26] lifetime excess lung cancers avoided.
- A reasonable upper bound, based on Säverin (subcohort, Cox) is 1,001[27] lifetime excess lung cancers avoided.

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[22] This estimate is conservative for two reasons. First, miners working at the face will benefit from the full reduction in DPM levels used in the estimate, whereas other miners may enjoy lesser reductions. Second, excluding miners who work elsewhere than the face has the clear effect of understating benefits. This procedure makes the resulting estimate more robust. The number of miners that work in underground mines that use diesel powered face equipment is 5,750. However, according to estimates provided by MSHA's Safety and Health Technology Center, only 30 percent of these miners (1,725) actually work at the face. Using 1,725 as the number of miners who benefit from the rule assumes zero benefits related to lung cancer for the 4,025 miners that do not work at the face as well as the 6,000 coal miners that work in underground mines that use only other permissible diesel powered equipment and heavy duty diesel powered equipment, and an additional 2,950 coal miners who work in underground mines that use only light duty diesel powered equipment.

[23] There will be additional health benefits from this final rule if coal mines in states that currently do not allow diesel equipment (e.g., West Virginia) or allow limited use of diesel equipment (Pennsylvania) begin to use diesel equipment on a large scale under state regulations that are less stringent than this rule.

[24] 514 lifetime cases = (298 cases/1,000 miners) x (1,725 miners); 809 lifetime cases = (469 cases/1,000 miners) x (1,725 miners)

[25] 602 lifetime cases = (349 cases/1,000 miners) x (1,725 miners)

[26] 79 lifetime cases = (46 cases/1,000 miners) x (1,725 miners)

[27] 1,001 lifetime cases = (580 cases/1,000 miners) x (1,725 miners)

The lifetime risk is measured over 65 years (ages 20 through 85). The lifetime benefits summarized above can also be expressed as average one-year benefits over the lifetimes of a cohort of miners of all ages who worked in the mines at any one time. The estimated benefits of the rule in terms of lung cancers avoided in any one year for such a cohort of 1,725 miners are as follows:

- One-year benefits probably fall within the range of 8 to 12[28] excess lung cancers avoided.

- A point estimate of one-year risk, based on mean values of the risk reduction estimates, is 9[29] excess lung cancers avoided.

- A reasonable lower bound for one-year risk, based on Säverin (full cohort, Poisson) is 1.0[30] excess lung cancers avoided.

- A reasonable upper bound, based on Säverin (subcohort, Cox) is 15[31] excess lung cancers avoided.

In the long run the average annual reduction becomes considerably larger, because each 45-year time span of exposure includes not only lung cancers experienced by miners who are currently working miners, but also lung cancers experienced by older generations of miners who retired over the previous 20 years. As the cumulative benefits to successive generations of miners build up, the estimates of annual benefits will approach (and in 65 years are estimated to reach) the following steady-state values:

- Long-run annual benefits probably fall in the range of 11 to 18[32] lung cancers avoided.

- A point estimate for long-run annual benefits is 13[33] lung cancers avoided.

- A reasonable lower bound for long-run annual benefits is 1.8[34] lung cancers avoided.

- A reasonable upper bound for long-run annual benefits is 22[35] lung cancers avoided.

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[28] 8 one-year cases = (298 lifetime cases/1,000 miners) x (1,725 miners) / (65 years); 12 one-year cases = (469 lifetime cases/1,000 miners) x (1,725 miners) / (65 years)

[29] 9 one-year cases = (349 lifetime cases/1,000 miners) x (1,725 miners) / (65 years)

[30] 1.0 one-year cases = (46 lifetime cases/1,000 miners) x (1,725 miners) / (65 years)

[31] 15 one-year cases = (580 lifetime cases/1,000 miners) x (1,725 miners) / (65 years)

[32] 11 cases = (298 lifetime cases/1,000 miners) x (1,725 miners) / (45 years); 18 cases = (469 lifetime cases/1,000 miners) x (1,725 miners) / (45 years)

[33] 13 cases = (349 lifetime cases/1,000 miners) x (1,725 miners) / (45 years)

[34] 1.8 cases = (46 lifetime cases/1,000 miners) x (1,725 miners) / (45 years)

[35] 22 cases = (580 lifetime cases/1,000 miners) x (1,725 miners) / (45 years)

Because lung cancer associated with DPM typically arises from cumulative exposure and after some latency period, the health benefits of reduced incidence of lung cancer will not materialize until some years after implementation of the rule. The yearly reduction in excess lung cancer deaths due to reduced exposure to DPM can be expected to build up gradually, depending on the historical cumulative exposure to DPM among the veteran workforce. Since the average latency period for lung cancer is about 20 years, the full level of even the initial benefit associated with a DPM concentration of 200 microgram/m^3 may not be seen before then.

Table III-2: Lung Cancer Reduction Benefits of Rule

Range	Study	Time Frame	Miners	Reduction per 1,000	Total Reduction
Upper Bound	Säverin, subcohort Cox	Lifetime[a]	1,725	580	1,001
		One-Year[b]			22
		Long-Run Annual[c]			15
Middle Range	Säverin, subcohort Poisson	Lifetime[a]	1,725	469	809
		One-Year[b]			12
		Long-Run Annual[c]			18
	Johnston, mine-adjusted	Lifetime[a]	1,725	459	792
		One-Year[b]			12
		Long-Run Annual[c]			18
	Mean, all studies	Lifetime[a]	1,725	349	602
		One-Year[b]			9
		Long-Run Annual[c]			13
	Johnston, mine-unadjusted	Lifetime[a]	1,725	298	514
		One-Year[b]			8
		Long-Run Annual[c]			11
Lower Bound	Säverin, full cohort Poisson	Lifetime[a]	1,725	46	79
		One-Year[b]			1.2
		Long-Run Annual[c]			1.8

[a] Source: Table III-1

[b] Lifetime value divided by 65.

[c] Lifetime value divided by 45.

Reduction of Acute Health Risks

Estimation Procedures. Unlike the case of lung cancer, acute health risks of DPM have not been isolated in studies of occupational exposure-response rates of DPM. Instead, the best available studies have examined exposure-response rates of these effects to ambient levels (i.e. 24-hour exposures) of fine (less than 2.5 micron) particulate matter -- $PM_{2.5}$. Applying these results to risks from coal mine exposure to DPM, therefore, requires making several assumptions that are discussed below. These assumptions reveal the uncertainties involved in attempting to estimate benefits of the rule associated with reducing acute effects of DPM exposure.

- **An 8-hour exposure to an extra 3 micrograms/m^3 of $PM_{2.5}$ poses the same risks as a 24-hour exposure to an extra 1 microgram/m^3 of $PM_{2.5}$.** This assumption implies that a 24-hour time-weighted average (TWA_{24}) poses the same risk regardless of how the exposure is distributed over time. That is, a three-fold change in concentration is offset by a an opposite three-fold change in length of exposure. This assumption is probably conservative in the sense that miners are likely to inhale more than one third as much during an 8-hour shift, when they are actively working, as during a 24-hour day, which includes sleeping. However, there is considerable uncertainty about the relative risks of acute effects in the two exposure patterns. It is not well understood whether DPM exposures at higher concentrations for shorter periods of time (with respite periods) or exposures at lower concentrations for longer periods of time (possibly more than 24 hours) pose different risks of acute effects and – if so – which exposure pattern poses the greater risk.

- **Exposure to any level of DPM poses at least as great a risk as exposure to a comparable level of $PM_{2.5}$.** This assumption is plausible in the sense that almost all DPM is also $PM_{2.5}$. Nevertheless, the constituent elements of the $PM_{2.5}$ in the study are not known, and they could include some rather harmful pollutants in addition to DPM. There are clearly substantial uncertainties in assuming that size of particulate matter alone is responsible for specific acute health risks.

- **The population of miners is at the same general level of risk as the population as a whole exposed to $PM_{2.5}$ in the studies.** This assumption is particularly problematic, since acute risks are likely to be exacerbated in populations that are already vulnerable because of health conditions. The population of miners has different demographic and health characteristics than the study populations. Miners who smoke tobacco and/or suffer from various respiratory ailments (which many miners do) fall into groups identified as likely to be especially sensitive to $PM_{2.5}$ and related acute mortality risks. Nevertheless, the general population almost certainly contains persons who are more vulnerable than any working miner. The proportions of miners who are especially sensitive to the acute risks of DPM or $PM_{2.5}$, as well as the degree of their sensitivity, are largely unknown. Thus there are substantial uncertainties in extrapolating from studies of the general population to risks of miners.

While these assumptions allow studies based on ambient $PM_{2.5}$ exposure to be used to estimate risks from occupational DPM exposure, the results are fraught with uncertainties. Moreover, the results of the studies are in the form of relative risk – excess risk as a percent of baseline risk – and they have not been converted to a form that measures numbers of cases avoided. To offset these uncertainties, MSHA has used the lower end of the 95-percent confidence interval as a lower-bound estimate of the risk reduction that may result from the rule.

The methodology used to estimate acute risks is similar to that used for lung cancer. It involves measuring the relative risk at measured DPM concentrations and at DPM concentrations projected under the rule. The reduction in relative risks is attributed to the rule. Because of the uncertainties in interpreting the relative risk functions that are implicit in the assumptions described above, however, MSHA does not consider the results to be reliable quantitative estimates of benefits of the rule to which any great confidence of precision can be ascribed.

Death from Cardiovascular, Cardiopulmonary, or Respiratory Causes. In an analysis of mortality rates associated with $PM_{2.5,}$ Schwartz[36] estimated associations between $PM_{2.5}$ and risks of death from ischemic heart disease[37] (IHD), chronic obstructive pulmonary disease[38] (COPD), and pneumonia.[39] Using the estimated mean reduction in DPM concentration[40] and a 3:1 adjustment factor for the difference in length of exposure[41] with the lower bound values of these relative risks produces estimates of risk reduction equivalent to:

- About one quarter of the baseline mortality rate[42] for IHD;
- About one sixth of the baseline mortality rate[43] for COPD; and
- About one third of the baseline mortality rate[44] for pneumonia.

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[36] Schwartz, et al.

[37] Schwartz found a 2.1 percent increase in mortality from IHD associated with each increment of 10 micrograms/m^3 in the daily concentration of $PM_{2.5}$. The lower 95 percent confidence interval bound was 1.4 percent, yielding an incremental relative risk factor of 1.014.

[38] Schwartz found a 3.3 percent increase in mortality from CPHD associated with each increment of 10 micrograms/m^3 in the daily concentration of $PM_{2.5}$. The lower 95 percent confidence interval bound was 1.0 percent, yielding an incremental relative risk factor of 1.01.

[39] Schwartz found a 4.0 percent increase in mortality from pneumonia associated with each increment of 10 micrograms/m^3 in the daily concentration of $PM_{2.5}$. The lower 95 percent confidence interval bound was 1.8 percent, yielding an incremental relative risk factor of 1.018.

[40] A reduction of 444 micrograms/m^3 in the concentration of DPM. This full reduction in DPM concentration is applicable only to the 5,750 miners who work in mines that use permissible diesel face equipment.

[41] By assumption (since they both result in the same reduction in TWA_{24}), a reduction in an 8-hour exposure of 30 micrograms/m^3 is equivalent to a reduction in a 24-hour exposure of 10 micrograms/m^3.

[42] $0.23 = (1.014)^{(444/30)} - 1$

[43] $0.17 = (1.01)^{(444/30)} - 1$

[44] $0.34 = (1.018)^{(444/30)} - 1$

Sensory Irritation and Respiratory Symptoms. The sensory irritation and respiratory symptoms caused by DPM at concentration levels found in underground mines are clearly documented in the risk assessment in part III of the preamble. The estimated association between $PM_{2.5}$ and acute lower respiratory symptoms varies widely.[45] Using the estimated mean reduction in DPM concentration and a 3:1 adjustment factor for the difference in length of exposure with the lower bound values of these relative risks produces estimates of risk reduction equivalent to nearly two times[46] the baseline rate.

Summary

Benefits of the rule include reductions in lung cancers. In the long run, as the mining population turns over, MSHA estimates that a minimum of 1.8 lung cancer deaths will be avoided per year.[47]

Benefits of the rule will also likely include reductions in the risk of death from cardiovascular, cardiopulmonary, or respiratory causes and reductions in the risk of sensory irritation and respiratory symptoms. However, MSHA has not included these health benefits in its estimates because the Agency cannot currently make reliable or precise quantitative estimates of them. Nevertheless, the expected reductions in the risk of death from cardiovascular, cardiopulmonary, or respiratory causes and the expected reductions in the risk of sensory irritation and respiratory symptoms are likely to be substantial.

[45] An increase of between 15 percent and 82 percent in acute lower respiratory symptoms was associated with each incremental increase of 20 micrograms/m^3 in 24-hour concentration of $PM_{2.5}$ in the ambient air (assumed equivalent to an increase of 60 micrograms/m^3 in 8-hour concentrations in mines). The lower bound of risk yields an incremental relative risk factor of 1.15.

[46] $1.8 = (1.15)^{(444/60)} - 1$

[47] This lower bound figure could significantly underestimate the magnitude of the health benefits. For example, the estimate based on the mean value of all the studies examined is 13 lung cancer deaths avoided per year.

IV. COMPLIANCE COSTS

This chapter analyzes compliance costs for the underground coal mining industry as a whole. Compliance costs for large and small underground coal mines will be addressed in Chapter V.

PERMISSIBLE EQUIPMENT (72.500)

Unit Cost Estimates

Section 72.500(b) requires that DPM emissions of existing permissible equipment be reduced to 2.5 gm/hr within 18 months of publication of the rule. MSHA has verified[48] that the use of a disposable paper filtration system will bring any existing permissible equipment[49] into compliance with this requirement. The use of a paper filtration system is cost-effective for permissible equipment because the engine modifications required to meet permissibility requirements reduce the exhaust gas temperature to a level that will not ignite the filter.

MSHA's estimates of compliance costs for Section 72.500(b) are based on the following data and assumptions:[50]

- **Initial Installation.** MSHA estimates, based on its current knowledge of what manufacturers of aftertreatment devices have charged, that a paper filtration system can be installed on most permissible equipment for an initial cost of $6,000.[51] For some equipment, however, filter kits may not be readily available and/or the installation will be substantially more complicated than usual. For such equipment, MSHA estimates an installation cost of $12,000.[52]

[48] This verification was discussed further in Part II of the Preamble.

[49] Two Isuzu QD100 engines cannot be brought into compliance as currently configured. MSHA has already approved the Isuzu QD100 at a second, lower horsepower, however, and these two engines can be brought into compliance with a paper filter system by derating them to this lower horsepower. (Derating the engines involves making an adjustment—by turning a set screw—to the fuel pump. Given the 18-month period before the requirement becomes effective, this can easily be done during routine maintenance at virtually no cost. Only two engines are involved, and these are, at the higher rating, overpowered for the equipment—so that there would not be productivity losses from the derating. Thus there are not measurable costs associated with derating.)

[50] Except as otherwise noted, costs and other assumptions are the same as in the PREA, for which they were developed using MSHA staff expertise and market data, and were not the subject of significant contrary comments.

[51] These costs represent retrofitting existing equipment. MSHA anticipates that fitting new equipment for filters will cost considerably less. Indeed, some hearing testimony (John Smith, Public Hearing, Beaver, WV, November 19, 1998, pp. 196-197) suggested that equipment manufacturers may consider the cost too small an item to pass it through to mine operators. Even at the full $6,000 price of retrofitting, the initial installation cost is rather small relative to filter replacement costs. Because of these considerations, MSHA has opted not to include initial installation costs on new equipment that replaces existing equipment.

[52] Several commentors estimated that filtration systems on permissible equipment would cost $36,500. This estimate, however, was premised on the assumption that a complete new Dry System Technology DST© would be required to meet the requirement of 95% efficiency. MSHA's verification testing has determined that mine

- **Production Days.** MSHA estimates that underground coal mines operate an average of 250 days per year.[53]

- **Shifts.** Coal mines operate from one to three shifts per day. MSHA estimates that the average underground coal mine operates two shifts per day.[54]

- **Frequency of Filter Replacement.** MSHA's experience, supported by public hearing testimony, is that paper filters will need to be changed every one to three shifts.[55] MSHA therefore estimates that paper filters will need to be replaced every two shifts of operation, for an average of 250 times per year.

- **Cost of Filter Replacement.** MSHA has determined that the price of a replacement disposable paper filter is $30. MSHA estimates that it will take about 15 minutes for a coal miner, whose hourly wage is $26.83,[56] to replace a paper filter. Thus the total unit cost of filter replacement is $36.71.

- **Amortization.** MSHA amortized the cost of a paper filtration system over 10 years (the average estimated equipment life) at a discount rate of 7 percent (the discount rate recommended by OMB).[57]

Table IV-1 summarizes MSHA's estimate of compliance costs per unit of permissible diesel powered equipment, based on these parameters. MSHA estimates that the yearly[58] cost of

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operators will be able to achieve compliance by adding a paper filter at the installation costs used in this analysis. Thus the commentors' assumptions underlying the $36,500 cost estimate are not valid.

[53] In Chapter V, MSHA makes an alternative assumption for underground coal mines with fewer than 20 employees. Since there are only seven affected coal mines in this size class and among them they have only one piece of permissible equipment, however, that assumption will make a negligible difference in the estimate of overall industry costs.

[54] In Chapter V, MSHA makes an alternative assumption for underground coal mines with fewer than 20 employees. Since there are only seven affected coal mines in this size class and among them they have only one piece of permissible equipment, however, that assumption will make a negligible difference in the estimate of overall industry costs.

[55] Replacement of filters is a maintenance activity that results in an annual cost. This activity is mandated by Section 72.503(d), rather than by Section 72.500. Since filter maintenance is directly related to the equipment that must also be retrofitted for filters, however, it is simpler and clearer to combine retrofitting and maintenance costs in one unified analysis.

[56] Data derived from: Schumacher, Otto L., ed. Western Mine Engineering, Mine Cost Services. Spokane, Washington: Western Mine Engineering, 1998.

[57] These parameters result in an annualization factor of: $0.142377503 = 0.07/(1-(1/1.07)^{10})$.

[58] For clarity, MSHA uses the term "annual" to refer to repeated costs that are incurred every year; MSHA uses the term "annualized" to refer to the annual equivalent of initial costs or other costs that are incurred less often than every year; and MSHA uses the term "yearly" to refer to the sum (or other combination) of annual and annualized costs.

compliance is $10,031[59] for equipment that is easy to retrofit with a disposable paper filtration system and $10,885[60] for equipment that is more difficult to retrofit.

[59] $10,031 = {($6,000) x (0.142377503)} + {($36.71) x (250)}.

[60] $10,885 = {($12,000) x (0.142377503)} + {($36.71) x (250)}.

TABLE IV-1: Compliance Costs for Section 72.500 (Permissible Equipment)

Cost Category	Cost Element	Easy to Retrofit	Difficult to Retrofit
UNIT COSTS			
Initial Unit Cost	Capital Outlay	$ 6,000	$12,000
	Annualized Cost[a]	$ 854	$ 1,709
Annual Unit Maintenance Cost	Labor Hours/Change	0.25	0.25
	Wage Rate	$ 26.83	$ 26.83
	Labor Cost/Change	$ 6.71	$ 6.71
	Cost of New Filter	$ 30.00	$ 30.00
	Total Cost/Change	$ 36.71	$ 36.71
	Changes/Year	250	250
	Total Cost/Year	$ 9,177	$ 9,177
Total Yearly Unit Cost		$10,031	$10,885
TOTAL YEARLY INDUSTRY COST			
Section 72.500(b) Yearly Industry Cost as of Date of Requirement	Number of Machines	409	72
	Total Cost	$4,102,736	$ 783,749
		$4,886,485	
Section 72.500(b) Yearly Industry Cost as of Publication Date[a]		$4,414,901	
Section 72.500(a) Additional Yearly Industry Cost[c]		$ 54,064	
Section 72.500 Total Yearly Industry Cost as of Publication Date		$4,468,965	

[a] The annualization factor is 0.142377503. Computed figures may not agree precisely with data in the table because of rounding in the table.

[b] $4,414,901 = $4,886,485 x 0.903492046, where 0.903492046 is the discount factor for 18 months at an annual discount rate of 7.0%.

[c] Based on 10 percent of engines replaced in the first year after the publication date of the rule and 5 percent of engines replaced in months 13-18 after the publication date, with all new engines filtered at the "easy retrofit" cost. $\$54{,}064 = \{[(0.1)x(((1.07)^{1.5})-1]+[(0.05)x(((1.07)^{0.5})-1)]\}x(481)x(\$9{,}063)$

Affected Inventory of Equipment

Not all of the 528 pieces of permissible equipment in the inventory will need to be equipped with a filter. Some permissible equipment already has filters installed on the machine. By MSHA's count, there are 47 such pieces of permissible diesel equipment in underground coal mines.[61] Excluding this equipment, the number of pieces of permissible diesel equipment that must be filtered is reduced to 481. Of this equipment MSHA estimates that 72 pieces[62] will involve a difficult filter installation costing $12,000, and installing a paper filter on the other 409 will cost $6,000 each.

Total Industry Costs

Controlling Existing Equipment. In order to estimate total yearly industry costs, two further calculations must be made. First, unit costs must be aggregated over the entire industry. Second, an adjustment needs to be made for the fact that the requirement is deferred until 18 months after the effective date of the rule. Table IV-1 also summarizes these calculations.

Aggregation of costs is straightforward. A total of 409 pieces of equipment will have a yearly unit cost of $4,102,736. An additional 72 pieces of diesel powered equipment will have a yearly unit cost of $783,139. Thus the total yearly industry cost – beginning at the time the equipment is fitted with a filtration system – is $4,886,485.[63]

For purposes of determining the impacts of the rule, the stream of yearly costs should be calculated beginning at the effective date of the rule. Since these costs begin 18 months after the effective date, the yearly costs are discounted to make them equivalent to costs beginning on the effective date. The appropriate discount factor for 18 months at an annual discount rate of 7.0 percent is 0.903.[64] Thus yearly costs of Section 72.500(b), adjusted to the effective date, are $4,414,901.[65]

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[61] During the course of the development of this rule, MSHA had occasion to review information in the diesel inventory. This review indicated that certain mines are using particulate filters on permissible equipment with water scrubbers and with dry exhaust conditioning systems. Four mines (two in District 8 and two in District 9) were found to use water scrubbers and filters on a total of 32 RAMCARS and dry systems on a total of 14 RAMCARS and one shield hauler.

[62] MSHA reviewed the inventory to identify the power packages with which permissible machines in the field are equipped. MSHA identified those power packages that would require testing and more extensive technical review to allow filters to be added. MSHA then referred to the inventory to identify the number of machines that used those power packages. The count of machines so equipped indicated that 72 would be more difficult to install filters on. In the PREA, MSHA estimated that 10 percent of permissible equipment – 49 machines -- would require the more extensive installation. The cost estimate of $12,000 to make such changes, which was used in the PREA and was not the subject of any comments suggesting disagreement, was based on the costs of replacing or modifying the internal parts of an existing scrubber to allow the use of a filter.

[63] $4,886,485 = ((409) x ($10,031)) + ((72) x ($10,885)). Formulas may not match data in tables precisely because of a higher degree of rounding, than was done in the computer computations.

[64] $0.903492046 = 1/(1.07)^{1.5}$

[65] $4,414,901 = $4,886,485 x 0.903492046

Early Replacement of Existing Equipment. The analysis of Section 72.500(b) presented above has assumed that diesel equipment will be controlled 18 months after publication of the rule. Section 72.500(a), however, requires that permissible diesel equipment introduced into an underground coal mine must meet the 2.5 gm/hr standard at the time it is introduced. Thus the newly introduced diesel engines must be controlled sooner than the engines that they replace would need to be controlled. The cost adjustment to reflect this timing can be analyzed by adjustments in the way the costs are discounted. For purposes of this analysis, MSHA makes the following assumptions about replacement (i.e., new) permissible equipment:

- Permissible equipment has a useful life of ten years. Thus (on average) 10 percent of this equipment will be replaced each year.

- Since new engines will predominantly be new equipment, filters will be easy to install (i.e., they will have an installation cost of $6,000).

Because of Section 72.500(a), 10 percent of the engines will actually be filtered in the first year after publication of the rule. For these engines, the discounting should be undone entirely.[66] Similarly 5 percent will be replaced in the first half of the second year, before Section 72.500(b) becomes effective.[67] Combining these two adjustments (one applicable to 10 percent of machines; the other to 5 percent), the yearly cost of Section 72.500(a) that is in addition to the costs of Section 72.500(b) is $54,064.[68] This adjustment is shown in Table IV-1. With this adjustment, the total estimated yearly cost of Section 72.500 is then $4,468,965.

NON-PERMISSIBLE HEAVY DUTY EQUIPMENT (72.501)

Section 72.501(a) requires that DPM emissions of certain non-permissible equipment newly introduced into an underground coal mine after the effective date of the rule not exceed 2.5 gm/hr. This requirement covers generators and air compressors as well as heavy duty equipment.[69] Section 72.501(b) requires that DPM emissions of existing non-permissible heavy duty equipment be reduced to 5.0 gm/hr within 30 months of publication of the rule. Section 72.501(c) requires that controlled DPM emissions of all non-permissible heavy duty equipment be reduced to 2.5 gm/hr within 4 years of publication of the rule.

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[66] The reciprocal operation of "discount" is called "accumulate," and the appropriate annual accumulation factor in this instance is: $1.10681661 = (1.07)^{1.5}$. The factor to calculate the *increase* in the present value of costs due to the accumulation is therefore 0.10681661.

[67] The appropriate factor to accumulate costs in this instance is: $1.03440804 = (1.07)^{0.5}$. The factor to calculate the *increase* in the present value of costs due to the accumulation is thus 0.03440804.

[68] $\$54,064 = \{[(0.1)x(((1.07)^{1.5})-1)]+[(0.05)x(((1.07)^{0.5})-1)]\}$ x (481) x ($9,063)

[69] To avoid extra verbiage, the term "non-permissible heavy duty equipment" will generally be used to include generators and air compressors, even though they are light duty equipment.

Some non-permissible heavy duty equipment, which has low-horsepower, low-emission diesel engines, is already in compliance with Section 72.501(b) without any controls. Other equipment will require one of several types of controls, including an oxidation catalytic converter (OCC), a ceramic[70] filter, or a paper filtration system. The choice of control equipment will depend on cost,[71] the DPM output of each diesel engine, the efficiency of the control,[72] and the paragraph of the rule being complied with.

Unit Cost

MSHA's estimates of compliance costs for Section 72.501 are based on the following data and assumptions:

- **Initial Installation Cost.** MSHA estimates, based on its current knowledge of what manufacturers of aftertreatment devices charge, that the initial cost of installing these three devices will be:
    - $1,000 for an OCC;
    - $5,000 for a ceramic filter for an engine of 150 hp or less;
    - $12,500 for a ceramic filter for an engine of more than 150 hp; [73]
    - $25,000 for installation of a paper filter system, including costs of cooling the exhaust, so as not to burn up the filter.[74]

- **Production Days and Shifts.** As above, MSHA estimates that coal mines will operate an average of 250 production days per year and two shifts per day.

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[70] The term "ceramic" is used generally to indicate a filter capable of operating with high temperature exhaust regardless of the actual filter material utilized.

[71] Replacing engines in heavy duty equipment is not generally a cost-effective way to control DPM emissions to the levels required by the standard. Almost all existing diesel engines can be adequately controlled with a ceramic filter, and most new engines would require a ceramic filter anyway.

[72] MSHA estimates that an OCC can remove 20 percent of DPM. Data from Verminderung der Emissionen von Realmaschinen in Tunnelbau (VERT) show at least one ceramic filter capable of removing 94.5 percent of DPM. Paper filters are slightly more efficient.

[73] These engines include the Caterpillar 3306, the Cummins 5.9-175, the Deutz F10L413FW, the Deutz F12L413FW, and the Navistar A185. This cost estimate was increased from the PREA estimate of $10,000 following comments by Head on the PREA for the proposed metal/non-metal DPM rule. (H. John Head, "Review of Economic and Technical Feasibility of Compliance Issues Related to: Department of Labor – MSHA, 30 CFR Part 57 – Proposed Rule for Diesel Particulate Matter Exposure of Underground Metal and Nonmetal Miners," Report prepared under contract with the National Mining Association, July 21, 1999.)

[74] This cost was based on the cost of a complete DST system ($36,000), but the full cost was reduced by the cost of components that are required for permissible equipment but are not necessary for only a paper filter. Because the PREA assumed extensive use of paper filters on heavy duty equipment, the comments included a great deal of discussion about the costs of DST systems. As noted here, MSHA believes that a full DST system is not required. More importantly, MSHA has obtained more extensive data on the efficiency of ceramic filters, which indicate that paper filters would almost never be needed – and thus the full cost of DST systems is not applicable.

- **Frequency of Filter Replacement.** Based on MSHA's experience and information from filter manufacturers and other sources, MSHA estimates that:
    - An OCC has a useful life of one year and will need to be replaced annually.
    - A ceramic filter has a useful life of at least 8,000 hours of operation[75] and will have to be replaced every two years.[76]
    - Paper filters will have the same replacement cycle as for permissible equipment (replacement daily, or 250 times per year).

- **Cost of Filter Replacement.** For paper filters, replacement will have the same costs as for permissible equipment. Replacement OCCs and ceramic filters will cost the same as initial installation.

- **Amortization.** MSHA amortizes costs at an annual discount rate of 7.0 percent.

- **Regeneration.** Ceramic filters will need to be maintained by being regenerated, so that they do not become clogged. MSHA bases regeneration costs on the following assumptions:
    - The cost of the equipment used for regeneration is included in the costs of the installation package for the filter.
    - Ceramic filters will need to be regenerated daily. This can be done while the equipment is not in use.
    - MSHA estimates that the process of dismounting the filter to regenerate and remounting the filter after regeneration – or alternatively, to attach power cables for on-board regeneration -- will take about 15 minutes for a miner, whose hourly wage is $26.83.
    - Thus the process will cost $1,677 annually for each piece of diesel equipment.[77]

Table IV-2 summarizes MSHA's estimate of yearly compliance costs per unit of non-permissible heavy duty diesel powered equipment, based on these parameters. MSHA estimates that the total yearly unit cost of compliance is

- $1,000 if an OCC is used;

- $4,442 if a ceramic filter is used for an engine of 150 hp or less;

- $8,591 if a ceramic filter is used on any other engine over 150 hp; and

- $12,736 if a paper filter is used.

[75] MSHA's estimate of the life of a ceramic filter is based on the knowledge and expertise of MSHA Approval and Certification Center (ACC) technical staff.

[76] 8,000 hours = (16 hours/day) x (250 days/year) x (2 years).

[77] $1,677/year = (250 replacements/year) x (0.25 hours/replacement) x ($26.83/hour).

TABLE IV-2: Unit Compliance Costs for Section 72.501 (Heavy Duty Equipment)

Cost Category	Cost Element	OCC	Ceramic Filter		Paper Filter
			$\leq$ 150 hp	> 150 hp	
Initial Cost	Capital Outlay for Filter	[a]	$ 5,000	$12,500	$25,000
	Annualized Cost of Filter	[a]	$ 2,765[b]	$ 6,914[b]	$ 3,559[c]
Annual Costs	Labor Hours/ Action[d]	-	0.25	0.25	0.25
	Wage Rate	-	$ 26.83	$ 26.83	$ 26.83
	Labor Cost/ Action[d]	-	$ 6.71	$ 6.71	$ 6.71
	Cost of New OCC or Filter	$ 1,000	-	-	$ 30.00
	Total Cost/ Action[d]	$ 1,000	$ 6.71	$ 6.71	$ 36.71
	Actions/ Year	1	250	250	250
	Total Cost/ Year	$1,000	$ 1,677	$ 1,677	$ 9,177
Total Yearly Cost		$1,000	$ 4,442	$ 8,591	$12,736

[a] All costs for an OCC are included in annual costs.

[b] Amortized over 2 years at an annual discount rate of 7.0%.

[c] Amortized over 10 years at an annual discount rate of 7.0%.

[d] Ceramic filters are regenerated; paper filters are changed.

Controls and Engines

A paper filter is more expensive than a ceramic filter, so that MSHA anticipates that a paper filter will be used only when its slightly greater efficiency is necessary to bring DPM emissions down to the level required by the DPM rule. An OCC is far less expensive than a ceramic filter, so that it will be used whenever possible, but it is also far less effective than either filter. Table VI-3 shows the least expensive control that will bring each engine used in non-permissible heavy duty equipment into compliance with Section 72.501(b) and Section 72.501(c). An OCC will bring an engine with DPM emissions up to 6 grams/hour into compliance with Section 72.501(b) and an engine with DPM emissions up to 3 grams/hour into compliance with Section 72.501(c). A ceramic filter is available that will bring an engine with DPM emissions up to 90 grams/hour into compliance with Section 72.501(b) and an engine with DPM emissions up to 45 grams/hour into compliance with Section 72.501(c).

OCCs need to be replaced every year, and ceramic filters need to be replaced every two years. This fairly short replacement cycle, together with *de minimus* initial installation costs, makes it practical for mine operators to use one control for Section 72.501(b) and then change to another control (if necessary) for Section 72.501(c). MSHA assumes that they will always use the least expensive DPM control. The least-cost control options shown in Table IV-3 can be combined into the following scenarios, which are summarized in Table IV-4:

- One engine model (9 engines) meets the requirements of Section 72.501(b) without controls and will require an OCC to meet the requirements of Section 72.501(c).

- Two engine models less than 150 hp (29 engines) meet the requirements of Section 72.501(b) without controls and will require a ceramic filter to meet the requirements of Section 72.501(c).

- One engine model (with 16 engines) will require an OCC to meet the requirements of Section 72.501(b) and a ceramic filter to meet the requirements of Section 72.501(c).

- Fifteen approved engine models less than or equal to 150 hp (347 engines) and an estimated 124 additional unknown and non-approved engines[78] are 150 hp or less and will require a ceramic filter to meet the requirements of Section 72.501(b) and Section 501(c).

- One approved engine model greater than 150 hp (nine engines) and an estimated 27 additional non approved and unknown engines are greater than 150 hp and will require a ceramic filter to meet the requirements of Section 72.501(b) and Section 72.501(c).

- One engine model greater than 150 hp (with two engines) will require a ceramic filter to meet the requirements of Section 72.501(b) and a paper filter to meet the requirements of Section 72.501(c).

[78] These engines were unknown or non-approved at the time MSHA compiled the diesel inventory. Under MSHA's 1996 diesel equipment rule, however, all heavy duty diesel engines in underground coal mines must be approved. MSHA assumes that all such engines will need ceramic filters for all of Section 72.501 of this rule.

TABLE IV-3: DPM Controls for Heavy Duty Engines

Engine Make	Engine Model	Brake H.P.	DPM gr/hr	Section 72.501(b)	Section 72.501(c)
Kubota	V1200	25.8	2.55	-	OCC
Deutz	F3L 912W	40.0	4.25	-	Ceramic
Deutz	F3L 912W	47.0	4.25	-	Ceramic
Deutz	F4L 912W	54.0	5.95	OCC	Ceramic
Deutz	BF4M1012EC	113.0	6.80	Ceramic	Ceramic
Lister Petter	LPU3 MKII	29.0	7.65	Ceramic	Ceramic
Cummins	5.9-175	175.0	8.50	Ceramic	Ceramic
Deutz	F6L 912W	80.0	8.50	Ceramic	Ceramic
Isuzu	QD60	57.0	9.35	Ceramic	Ceramic
Lister Petter	LPU4 MKII	38.6	10.20	Ceramic	Ceramic
Deutz	F4L 1011F	59.0	11.05	Ceramic	Ceramic
Deutz	F6L 413FW	137.0	11.89	Ceramic	Ceramic
Isuzu	QD100-301	79.0	14.44	Ceramic	Ceramic
Deutz	MWM 916	94.0	19.54	Ceramic	Ceramic
Deutz	F10L 413FW	228.0	20.39	Ceramic	Ceramic
Isuzu	QD145	135.0	20.39	Ceramic	Ceramic
Deutz	F12L 413FW	274.0	23.79	Ceramic	Ceramic
Caterpillar	3304 PCNA	100.0	25.49	Ceramic	Ceramic
Navistar	A185	185.0	25.49	Ceramic	Ceramic
Caterpillar	3306 PCNA	150.0	39.08	Ceramic	Ceramic
Caterpillar	3306 PCTA	215.0	52.68	Ceramic	Paper

Table IV-4: Compliance Strategies and Sources of Compliance Costs for Heavy Duty Equipment

Control Mechanism		Source of Compliance Costs	Number of Engines
Section 72.501(b)	Section 72.501(c)		
None	OCC	Section 72.501(c)	9[a]
None	Ceramic Filter	Section 72.501(c)	29[b]
OCC	Ceramic Filter	Section 72.501(b) & Section 72.501(c)	16[c]
Ceramic Filter ($\leq$150 hp)	Ceramic Filter ($\leq$150 hp)	Section 72.501(b)	471[d]
Ceramic Filter (>150 hp)	Ceramic Filter (>150 hp)	Section 72.501(b)	36[e]
Ceramic Filter	Paper Filter	Section 72.501(b) & Section 72.501(c)	2[f]

[a] Kubota V1200.

[b] Deutz F3L 912W.

[c] Deutz F4L 912W.

[d] Includes Deutz BF4M 1012EC; Lister Petter LPU3 MKII; Deutz F6L 912W; Isuzu QD60; Lister Petter LPU4 MKII; Deutz F4L 1011F; Deutz F6L 413FW; Isuzu QD100-301; Deutz MWM 916; Isuzu QD145; Caterpillar 3304 PCNA; and Caterpillar 3306 PCNA.

[e] Includes Cummins 5.9-175; Deutz F10L 413FW; Deutz F12L 413FW; Navistar A185; and Caterpillar 3306 PCTA.

[f] Caterpillar 3306 PCTA.

Total Industry Costs

Controlling Existing Equipment. The diesel engines used in heavy duty equipment fall into several categories, which are analyzed slightly differently depending on when controls are put on and whether more than one control is used. These categories are reflected in different parts of Table IV-4.

- Most (507) engines will need a ceramic filter to comply with both Section 72.501(b) and Section 72.501(c). Costs for these engines will begin when Section 72.501(b) comes into effect, 30 months after the effective date of the rule. They are found in line 4 and line 5 of Table IV-4. Table IV-5a summarizes costs for these engines.

- A few (38) engines need no controls for Section 72.501(b) but do require controls for Section 72.501(c). These engines are analyzed similarly to the larger group, except that costs do not begin until Section 72.501(c) comes into effect, four years after the effective date of the rule. They are found in line 1 and line 2 of Table IV-4. Table IV-5b summarizes costs for these engines.

- The remaining (18) engines will be controlled one way for Section 72.501(b) and another way for Section 72.501(c). They will be fitted with one control (OCC or ceramic filter) from two years[79] until four years after the effective date, and then be fitted with another control (ceramic or paper filter, respectively). With respect to the second control, costs for these engines will be analyzed similarly to the engines that were first controlled four years after the effective date of the rule. There will be additional costs, however, for the other controls used in the third and fourth year after the effective date of the rule. These engines are found in line 3 and line 6 of Table IV-4. Table IV-5c summarizes costs for these engines.

Table IV-5a multiplies the yearly unit cost (from Table IV-2) times the number of engines (by horsepower class) to obtain the total industry yearly cost of controls. These costs do not begin, however, until 30 months after the effective date of the rule. Thus the yearly cost stream is discounted[80] to the effective date, in order to be made comparable to other cost elements of the rule. These costs are shown on the bottom row of Table IV-5a.

Similarly, Table IV-5b multiplies the yearly unit cost (from Table IV-2) times the number of engines to obtain the total industry yearly cost of controls. These costs do not begin, however, until four years after the effective date of the rule. Thus the yearly cost stream is discounted[81] to the effective date, in order to be made comparable to other cost elements of the rule. These costs are shown on the bottom row of Table IV-5b.

[79] Section 72.401(b) is actually not in force until 2.5 years after the effective date of the rule. Since OCCs have an estimated life of one year and ceramic filters have an estimated life of two years, however, it is simpler (and probably not unreasonable) to assume that most if the controls will be put on earlier than strictly required.

[80] The discount factor is $0.84438509 = 1/(1.07)^{2.5}$.

[81] The discount factor is $0.762895212 = 1/(1.07)^{4}$.

Table IV-5c is a bit more complicated, since it shows the costs of complying with Section 72.501(b) for four years -- and then complying with Section 72.501(c) beginning four years after the effective date. Thus costs associated with Section 72.501(b), which are shown in the upper part of Table IV-5c, are based on the use of controls (two OCCs or one ceramic filter) for two years (year 3 and 4). These yearly costs for two years are discounted to the present and then annualized over ten years.[82] Costs of Section 72.501(c), which are shown in the lower part of Table IV-5c, are computed in the same manner as costs in Table IV-5b. The yearly unit costs (from Table IV-2) are discounted[83] four years for comparability, since this cost stream begins four years after the effective date of the rule. Total yearly industry costs from each provision are computed by multiplying the unit costs by the number of machines, and the results are added together in the bottom row of Table IV-5c.

TABLE IV-5 (a,b,c,d): Compliance Costs for Section 72.501 (Heavy Duty Equipment)

TABLE IV-5a: Annualized Industry Compliance Costs for Machines that Require a Ceramic Filter for Both Section 72.501(b) and Section 72.501(c)

Cost Category	Cost Element	≤ 150 hp	> 150 hp
Yearly Industry Cost as of 30 Months After the Effective Date of the Rule	Yearly Unit Cost[a]	$ 4,442	$ 8,591
	Number of Machines	471	36
	Total Cost	$2,092,182	$ 309,259
Annualized Industry Cost as of Effective Date of Regulation[b]		$1,766,607	$ 261,134

[a] Source: Table IV-2.

[b] The discount factor is $0.84438509 = 1/(1.07)^{2.5}$. Computed figures may not agree precisely with data in the table because of rounding in the table.

[82] The factor is $0.240580478 = ((1/(1.07)^2) + (1/(1.07)^3))*(0.07/(1-(1/1.07)^{10}))$.

[83] The discount factor is $0.762895212 = 1/(1.07)^4$.

TABLE IV-5b: Yearly Industry Costs for Engines that Require No Controls to Comply With Section 72.501(b) But Require A Control to Comply With Section 72.501(c)

Cost Element	OCC	Ceramic Filter
Yearly Cost Over Ten Years[a]	$ 1,000	$ 4,442
Yearly Cost Discounted From Year 4	$ 763	$ 3,389
Number of Machines	9	29
Total Yearly Industry Cost	$ 6,866	$98,282

[a] Source: Table IV-2.

TABLE IV-5c: Yearly Industry Costs for Engines that Can Use One Control to Comply With Section 72.501(b) But Require Another Control to Comply With Section 72.501(c)

Cost Category	Cost Element		
Costs for Section 72.501(b)	Control	OCC	Ceramic Filter
	Yearly Cost From Year 3 to Year 4 [a]	$ 1,000	$ 8,591
	Annualized[b]	$ 241	$ 2,067
	Number of Machines	16	2
	Yearly Industry Cost	$ 3,852	$ 4,133
Costs for Section 72.501(c)	Control	Ceramic Filter	Paper Filter
	Yearly Cost From Year 4 to Year 10 [a]	$ 4,442	$12,736
	Annualized	$ 3,389	$ 9,716
	Number of Machines	16	2
	Yearly Industry Cost	$54,225	$19,433
Combined Yearly Industry Cost		$58,077	$23,566

[a] From Table IV-2.

[b] Two years of annualized cost (two OCCs or one ceramic filter with maintenance) discounted to the present and then annualized over 10 years at a discount rate of 7.0 percent.

TABLE IV-5d: Total Industry Costs For Section 72.501

Control Mechanism		Industry Yearly Cost For Sections 72.501(b)&(c)	Industry Yearly Cost For Section 72.501(a)[a]	Total Industry Yearly Cost
Section 72.501(b)	Section 72.501(c)			
None	OCC	$ 6,866[b]	$ -	$ 6,866
None	Ceramic Filter	$ 98,282[b]	$ -	$ 98,282
OCC	Ceramic Filter	$ 58,077[c]	$ 1,791	$ 59,868
Ceramic Filter ≤ 150 hp	Ceramic Filter ≤ 150 hp	$1,766,607[d]	$ 54,467	$1,821,074
Ceramic Filter > 150 hp	Ceramic Filter > 150 hp	$ 261,134[d]	$ 8,051	$ 269,185
Ceramic Filter	Paper Filter	$ 23,566[c]	-	$ 23,566
Total for All Heavy Duty Engines[e]		$2,214,662	$ 64,308	$2,278,970

[a] Computed by multiplying Industry Yearly Cost For Sections 72.501(b)&(c), shown in the previous column, by 0.03083144.

[b] Source: Table IV-5b.

[c] Source: Table IV-5c.

[d] Source: Table IV-5a.

[e] Computed figures may not agree precisely with data in the table because of rounding in the table.

Early Replacement of Existing Equipment. The analysis of Section 72.501(b) and Section 72.501(c) presented above has assumed that diesel equipment will be controlled when these provisions become effective. Section 72.501(a), however, requires that diesel equipment introduced into an underground coal mine must meet the same DPM emission level set in Section 72.501(b) at the time it is introduced. Thus the newly introduced diesel engines must be controlled sooner than the engines that they replace would need to be controlled. The cost adjustment to reflect this timing can be analyzed by adjustments in the way the costs are discounted. For purposes of this analysis, MSHA makes the following assumptions about replacement equipment:

- Heavy duty equipment has a useful life of ten years. Thus (on average) 10 percent of this equipment will be replaced each year.

- New engines will be in the same horsepower range as the engines they replace.

- Except for the two machines that require a paper filter, which are excluded from the analysis,[84] all newly introduced engines will require the same controls as the engines they replace would require to meet Section 72.501(b). Other than these two engines, there is virtually no scope for reducing compliance costs by changing engines. Only four engine models (the largest being 54 horsepower) comply with Section 72.501(b) – and only one (26 horsepower) complies with Section 72.501(c) – without a ceramic filter (see Table IV-3). The potential saving in control costs is generally not worth the loss of horsepower.

Engines that already comply with Section 72.501(b) do not have to be controlled until four years after the effective date of the rule. For equipment with these engines, no additional costs will be incurred if a new machine is purchased prior to the time that Section 72.501(c) becomes effective. Thus no cost adjustment is necessary.

Other equipment will need to be fitted with the same control equipment used to meet the emission level set in Section 72.501(b). In particular, 10 percent of these costs will be incurred in the first year, and for these, the discounting should be undone[85] entirely. Similarly, 10 percent will be replaced in the second year.[86] Finally, 5 percent will be replaced in the first half of the third year, before Section 72.501(b) becomes effective[87]. When these three adjustments (two applicable to 10 percent of machines; the other to 5 percent) are combined, the yearly cost of Section 72.500(a) that are in addition to the costs of Section 72.501(b) are the costs of Section 72.501(b) times a factor of 0.03083144.[88]

This adjustment factor applies to equipment that uses an OCC or a ceramic filter to comply with Section 72.501(b) and a ceramic filter to comply with Section 72.501(c). The adjustment is shown in Table IV-5d. The total estimated cost that is attributable to Section 72.501(a) – in addition to the Costs of Section 72.501(b) and Section 72.501(c) -- is \$64,309.[89]

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[84] Because paper filtration systems on heavy duty equipment are much more expensive than ceramic filters, MSHA assumes that these engines would be replaced with engines that could comply with Section 72.501(c) using a ceramic filter. This cost saving would far more than offset the cost of controlling an engine slightly earlier than otherwise required. Since there are only two engines in this class and the adjustment would lower costs, MSHA has taken the conservative course of assuming that these cost savings will not be captured by early engine changeout.

[85] The appropriate accumulation factor in this instance is: $1.184293769 = (1.07)^{2.5}$. Thus the factor to calculate the *increase* in the present value of costs due to the accumulation is $0.184293769 = (1.07)^{2.5} - 1$.

[86] The appropriate factor for to accumulate costs is: $1.10681661 = (1.07)^{1.5}$. The factor to calculate the *increase* in the present value of costs due to the accumulation is $0.10681661 = (1.07)^{1.5} - 1$.

[87] The appropriate factor for to accumulate costs is: $1.03440804 = (1.07)^{0.5}$. The factor to calculate the *increase* in the present value of costs due to the accumulation is thus $0.03440804 = (1.07)^{0.5} - 1$.

[88] $0.03083144 = \{[(0.1)x(((1.07)^{2.5})-1)]+[(0.1)x(((1.07)^{1.5})-1)]+[(0.05)x(((1.07)^{0.5})-1)]\}$

[89] \$64,309 = (\$58,077 + \$1,766,607 + \$261,134) x 0.03083144

The estimated total yearly industry cost to control DPM from heavy duty diesel equipment is $2.28 million.

LIGHT DUTY EQUIPMENT (72.502)

Section 72.502 requires light duty diesel powered equipment that is newly introduced into an underground mine to emit no more than 5.0 grams/hour of DPM. Compliance with this requirement can be demonstrated using data obtained from the MSHA engine approval. As an alternative, the rule also permits use of an engine meeting specified EPA engine standards, even if it does not meet the 5.0 grams/hour test. Furthermore, any engine used underground must be approved pursuant to MSHA's diesel equipment rule.

In MSHA's judgment, the variety of MSHA approved engines that meet the specified EPA engine standards is sufficient that mine operators will be able to bring most light duty equipment into compliance without incurring any appreciable costs. MSHA has already approved engines that meet EPA requirements in a wide range of horsepowers. A current list of engines that are approved by MSHA and meet the listed EPA standards is available at: www.MSHA.gov/s&hinfo/deslreg/1909a.htm.

Section 75.502 applies only to newly introduced equipment and engines.[90] That is, engines in light duty equipment are grandfathered in the regulations, so long as they remain in the same mine they were in on the effective date of Section 72.502. Thus there are three circumstances under which compliance costs may be incurred:

- Otherwise grandfathered existing equipment that is shifted to a different mine more than 60 days after the rule is published will need a ceramic filter to comply with Section 72.502 if it has an engine that does not meet the listed EPA standards and emits more DPM than 5.0 grams/hour.
- New equipment brought into a mine, whose engine emits more than 5.0 grams/hour and does not meet the listed EPA standards, will need a ceramic filter to comply with Section 72.502.
- An engine (new or used) that is brought into a mine as a replacement engine for existing equipment, which emits more than 5.0 grams/hour and does not meet the listed EPA standards, will need a ceramic filter to comply with Section 72.502.

[90] The rule defines newly introduced equipment and engines as:

1) Any piece of equipment whose engine is a new addition to the underground inventory of engines of the mine in question, including newly purchased equipment or used equipment; and

2) Equipment having an engine with a new serial number (i.e., not a rebuild) added to the mine's inventory more than 60 days after the rule is published.

The factors that mitigate against the need for a ceramic filter and the circumstances under which costs of a filter might be incurred are discussed further below.

Moving Existing Light Duty Equipment

The rule provides 60 days between publication and the effective date of the requirements of Section 72.502. MSHA believes that this is sufficient time for mine operators to reallocate light duty equipment among mines if they choose to do so. Accordingly, MSHA is not attributing any cost for controlling emissions from such equipment.

Availability of Compliant Engines for New Light Duty Equipment

Many of the engines used in light duty equipment already meet the listed EPA standards. MSHA's inventory of diesel powered equipment in coal mines indicates that engines in most light duty equipment fall into the 25 to 100 horsepower range. Of 39 engine models for light duty equipment and portable equipment other than generators and compressors, 26 engine models are below 100 hp. Of the MSHA-approved engines in the 25 to 100 horsepower range, 66 percent meet the listed EPA standards.

MSHA approved engines that do not meet the EPA standards listed in the rule often have substitutes that do. By far the most widely used engine model in light duty equipment is the 59-horsepower Isuzu QD60(C240). It does not meet the EPA standards listed in the rule or the Section 72.502 standard of 5.0 DPM grams/hour. The Deutz 1011, which does meet the listed EPA standards, can be substituted for the QD60. Another widely used engine model, the 79-horsepower Isuzu QD100-301, is now out of production. Thus equipment manufacturers will need to find a substitute, even if this takes some re-engineering of equipment. These costs of re-engineering are being attributed to the equipment manufacturers instead of the mine operators.

A great deal of light duty equipment is purchased in the commercial market, where engines that meet the listed EPA standards are prevalent, rather than being designed specifically for mines.

- Portable equipment (welders, pumps, and water sprayers) is purchased in the open commercial market. At least one such welder with an engine that meets the listed EPA standards is already on the market, and MSHA anticipates that such availability will spread rapidly.

- There are currently 7 MSHA approved engines meeting the listed EPA standards available for pick-up trucks. Manufacturers that use such engines include Chevrolet, Dodge, Ford, and Hummer. The Hummer is also available configured as mechanic's trucks and utility trucks.

- Personnel carriers and mantrips are, for the most part, similar to pick-ups in terms of availability of engines that meet the EPA standards listed in the rule. Numerous pick-ups and Hummers also appear in this category.

There has been a pronounced shift in light duty equipment away from specialized equipment built specifically for mining toward more generic commercial equipment. This shift puts more reliance on engines that meet current EPA standards and less on engines traditionally used in mines that are MSHA approved but do not meet EPA standards. For example:

- Pick-up trucks and other commercially available vehicles are reportedly more comfortable and cost effective than many existing personnel carriers built for mine use, and they are gaining market share among personnel carriers.

- The only light duty rock dusters with large engines are over 10 years old.

- The inventory's only large crane trucks manufactured by mining equipment companies are at least 13 years old. Newer crane trucks resemble over-the-road trucks and can be expected to have engines that meet the EPA standards listed in the rule.

Because of these factors, clean MSHA approved engines and/or engines that meet the listed EPA standards are available (or are expected to be available in the very near future) for almost all light duty equipment. Only a small amount of replacement mine-specific light duty equipment can be expected to require DPM controls to comply with Section 72.502. The engines currently used in such equipment are the CAT 3304 PCNA, CAT 3306 PCNA, Deutz MWM 916, and Isuzu QD145.

Availability of Compliant Replacement Engines for Existing Light Duty Equipment

For several reasons, very few pieces of existing light duty equipment will need to be filtered because a replacement engine is introduced into the mine. A considerable amount of light duty equipment will not have an engine replaced, since it is not cost-effective to do so:

- For portable equipment such as welders, pumps, and water sprayers, the engine itself is the most expensive component, so that mine operators are expected to replace the entire piece of equipment rather than just replace the engine.

- Forklifts (and similar equipment) used in mines are generally built specifically for that application. These forklifts have extensive hydraulic systems. Although the machines are much more substantial than portable equipment, the wear and tear on the machine and its hydraulic systems in mine use typically means that the whole machine is ready for scrapping by the time the engine needs replacement.

Other light duty equipment – including a good deal of the light duty equipment with large engines – is likely not to have another engine installed. Several factors account for this outcome:

- Since light duty equipment is typically subject to less wear and tear than heavy duty equipment, it may be cost-effective to rebuild engines in the more durable mining equipment almost indefinitely. Engines in this type of equipment are themselves more durable and are designed for rebuilding by inclusion of design features such as replaceable cylinder liners.

- Some light duty equipment – particularly equipment with large engines built specifically for mining – is more than ten years old. Indeed, most equipment that is more than 10 years old is actually more than 15 years old. MSHA estimates that the useful life of an engine is 10 years, even if light duty equipment is used for longer periods. Thus MSHA projects that equipment that is 10 years old or older will be on its last engine; it will be scrapped[91] rather than have a new engine installed.[92]

Even if an engine is introduced into a mine as a replacement engine in light duty equipment, there are several reasons why it may not have to be filtered.

- As with engines in new equipment, most engines of under 100 horsepower that would be used as replacement engines in existing light duty equipment already have MSHA approval and meet the listed EPA standards.

- Since the applicable EPA standard is the one in force at the time an engine was manufactured, many used engines (as well as new ones) will meet this test.

- Some types of light duty equipment have engines that drive hydrostatic transmission systems (e.g., forklifts), which allows a good deal of flexibility in configuration for substituting an approved engine that meets EPA standards for one that does not.

- Some engines (particularly the Isuzu QD60 and Isuzu QD100) are so widely used by mining equipment manufacturers that the manufacturers will re-engineer equipment to use engines that meet the listed EPA standards. MSHA expects that they will share the revised designs with customers, thus minimizing engineering costs of changing engines for mine operators.

- Diesel powered equipment in Pennsylvania mines will not require DPM controls as a result of Section 72.502 because Pennsylvania regulations already require DPM filter systems.

These considerations indicate that most existing light duty equipment either will not need to have an engine replaced or will have a replacement engine that complies with the requirements of Section 72.502 without needing a filter. The exceptions (again) are a small amount of durable light duty equipment with powerful engines that was typically made by mining equipment companies. The engines currently used in such equipment again are the CAT 3304 PCNA, CAT 3306 PCNA, Deutz MWM 916, and Isuzu QD145.

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[91] Scrapping includes the possibility of selling the equipment, which makes it even less economic to put in a new engine.

[92] As noted above, many of these older machines are being replaced with different equipment for which EPA approved engines are available.

Light Duty Equipment Requiring Filters

As discussed above, most light duty equipment will comply with Section 72.502 without a filter, even when a new engine is introduced into an underground coal mine – either to replace an existing engine or as part of a new machine. There remains a small amount of light duty equipment, however, that MSHA believes will require controls when a new engine (or machine) is needed. MSHA reviewed light duty equipment in the diesel inventory, by equipment type and model, to determine how many such pieces of equipment exist. For analytical purposes, this equipment falls into three categories:

- Large, durable machines built specifically for mining that need powerful engines will need comparable replacement engines and eventually will be replaced by comparable equipment containing comparable engines. Thus, whether the engine is replaced or the entire machine is replaced, MSHA assumes that Section 72.502 will necessitate DPM emission controls when the existing engine is replaced. This category includes of 26 pieces of light duty equipment[93]

- Some equipment classified as light duty is a heavy duty equipment type or has a model number indicating that it was originally heavy duty equipment (most often LHDs). When heavy duty equipment becomes marginally serviceable, mine operators may decide to convert it to uses that fall into the light duty category. MSHA assumes that when this equipment reaches the end of its useful light duty life, it will be replaced by converting other older heavy duty equipment. For purposes of cost estimation, MSHA assumes that half of these converted machines will require filters.[94] There are six such pieces of light duty equipment.[95]

- Some large, durable light duty equipment would probably require filters if an engine were replaced. The inventory does not include the manufacturing date for this equipment, so that it is not possible to know whether this equipment is more than 10 years old. In addition, some of this equipment may be converted heavy duty equipment. Because of these data uncertainties, MSHA assumes that half of this equipment will require replacement engines that must be filtered, and half will not involve compliance costs. There are 14 large pieces of light duty equipment without a manufacturing date.[96]

[93] This equipment includes 15 tractors, 3 supply tractors, and 8 utility (and other) trucks.

[94] Heavy duty equipment in the mine whose engines are installed at the effective date of this regulation will be grandfathered when converted to light duty use, and the mine operators will incur no Section 72.502 costs upon conversion of this equipment. Heavy duty equipment in the mine that has a newly introduced engine after the effective date (possibly upon conversion to light duty use) will continue to need to have DPM emission controls under Section 72.502, even though the conversion exempts it from the requirements of Section 72.501. MSHA assumes that half of these engines will fall into each of these groups.

[95] This equipment includes 2 locomotives, 2 LHDs, 1 personnel carrier, and 1 utility truck.

[96] This equipment includes 3 tractors, 7 personnel carriers, and 4 utility trucks.

Industry Costs

Unit costs of installing ceramic filters were presented in Table IV-2. The yearly cost of a ceramic filter system, as of the time the filter is first installed (in this case, when a new engine is introduced into the mine) is $4,442 for engines of 150 horsepower or less. All of the engines that may be filtered fall into that size category.

For comparability with other costs, the yearly cost stream needs to be discounted from the year that the filter is first installed to the effective date of the regulation. For computational purposes, MSHA makes the following assumptions with respect to timing:

- Engines that MSHA expects to require filters with certainty are estimated to be replaced 10 years after the equipment was manufactured. The yearly cost stream for each engine is then discounted to the effective date of the regulation (2001). The estimated yearly industry cost for the engines in these 26 pieces of light duty equipment is $87,367.[97]

- Engines that MSHA expects to require filters with a 50 percent probability, because they are in converted heavy duty equipment, are estimated to be replaced 10 years after the piece of equipment was manufactured. Half of the yearly cost stream for each engine is then discounted to the effective date. The estimated yearly industry cost for the engines in these 6 pieces of equipment is $10,085.[98]

- Costs for the 14 engines that MSHA expects to require filters with a 50 percent probability, but for which no manufacturing date is known, are estimated by assuming that two engines will be replaced and filtered in each of the first seven years after the effective date. Half of the yearly cost stream for each of these engines is then discounted to the effective date. The estimated yearly industry cost for the engines in this light duty equipment is $23,939.[99]

Thus the total estimated yearly cost of Section 72.502 for the underground coal mining industry is $121,391.

MAINTENANCE TRAINING (72.503)

Section 72.503(d) requires that any aftertreatment device be maintained according to manufacturer specifications.[100] Existing Section 75.1915 requires that mechanics be trained in maintenance of diesel engines. The training must also be recorded. In the long run, training about paper and ceramic filtration systems used on permissible and non-permissible heavy duty

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[97] $\$87,367 = \$4,442 * [(3/(1.07)) + (1/(1.07)^2) + (5/(1.07)^3) + (4/(1.07)^4) + (7/(1.07)^5) + (3/(1.07)^6) + (3/(1.07)^7)]$

[98] $\$10,085 = 0.5 * \$4,442 * [(2/(1.07)) + (2/(1.07)^5) + (2/(1.07)^7)]$

[99] $\$23,939 = 0.5 * \$4,442 * [(2/(1.07)) + (2/(1.07)^2) + (2/(1.07)^3) + (2/(1.07)^4) + (2/(1.07)^5) + (2/(1.07)^6) + (2/(1.07)^7)]$

[100] Costs of filter maintenance itself were included under Section 72.500 and Section 72.501, above.

equipment will become part of Section 75.1915 training. The immediate impact of this rule, however, is that mechanics who have already been trained under Section 75.1915 must receive additional training on aftertreatment devices.

MSHA assumes that mine operators will also provide training in certain basic activities to operators of permissible and non-permissible heavy duty equipment. This training will cover primarily monitoring and actions to take if gauges indicate that filters are beginning to clog. Since this training is not the type of maintenance training required under Section 75.1915, this training will not need to be recorded.

Unit Cost Estimates

Mechanic Training

MSHA's estimate of mechanic training costs derived from Section 75.503(d) is based on the following assumptions:

- **Paper and Ceramic Filters.** Both the media and the maintenance activities differ greatly between paper and ceramic filters. Thus entirely separate training will be necessary for the two types of filters. MSHA assumes, however, that training in maintenance of both types of filters will have the same duration and cost.[101]

- **Mode of Training.** Mine operators will contract out the training, which will entail either a manufacturer's seminar (on the purchase of new equipment) or classroom training in a vocational or lecture type of setting. Instructional costs are estimated to be $75 per hour for each person trained.

- **Number of Trainees.** The number of trainees for each mine will be determined by the number of pieces of permissible equipment and the number of pieces of heavy duty equipment,[102] as follows:
  - One person will be trained in maintenance of paper filtration systems in mines with 1 to 6 pieces of permissible equipment.
  - An additional person will be trained in maintenance of paper filtration systems for every 12 pieces of permissible equipment (rounded up to the next higher dozen) above the initial six pieces.
  - One person will be trained in maintenance of ceramic filters in mines with 1 to 6 pieces of non-permissible heavy duty equipment.

[101] This assumption replaces the PREA assumption that trainees would attend one training course for all filters.

[102] For purposes of estimating these training costs, MSHA assumed that equipment that the inventory listed as being in mines that were closed was nevertheless operated and maintained. (See Chapter II for a discussion of closed mines.) That is, MSHA assumed that all permissible and heavy duty equipment taken out a given mine that was closed was put into another mine that previously had had no such equipment. This assumption was a simple one for the purposes of estimating the number of mechanics to be trained, and – although arbitrary – it appears on the whole to be reasonably conservative in terms of its effects on training costs.

- An additional person will be trained in maintenance of ceramic filters for every 12 pieces of non-permissible heavy duty equipment (rounded up to the next higher dozen) above the initial six pieces.[103]

- **Duration of Training.** The training course will take one hour of the trainees' time.[104]

- **Recording.** The training will be recorded by having each trainee sign a sign-in sheet, which was prepared by a clerical worker and will be entered into a computer. MSHA estimates that this process will entail the following actions:[105]
  - The supervisor will brief the clerical worker, which will require an estimated five minutes of both persons' time.
  - The clerical worker will prepare a registration sheet with the trainees' names on a clipboard and will subsequently record the attendees in a computer file, which will require an estimated 10 minutes plus one minute for each trainee.
  - Attendees will sign the registration sheet. This will require an estimated 20 seconds each, which will occur during training rather than in addition to it.[106]

Machine Operator Training

MSHA's estimate of costs of machine operator training related to filters is based on the following assumptions:

- **Paper and Ceramic Filters.** Because the instrumentation and monitoring will be similar for paper and ceramic filters, operators can be trained together, regardless of the type of equipment operated.

- **Number of Trainees.** Each mine will train one operator per machine per shift.[107]

- **Mode of Training.** Supervisors will conduct the operator training on location in the mine, utilizing a piece of diesel powered equipment for demonstration purposes.

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[103] These assumptions replace the PREA assumptions that each mine with 20 or more employees would train 3 qualified people and each smaller mine would train 1 qualified person. The current assumptions better represent the relationship between the number of pieces of equipment and the number of people to be trained.

[104] This assumption replaces the PREA assumption of a three-hour course, but separate one-hour courses would be required for paper and ceramic filters. The current assumption better represents the fact that some mines will not need to provide training for maintenance of both paper and ceramic filters.

[105] This process replaces the PREA assumption that recording of attendance would require five minutes of a supervisor's time.

[106] Because this cost is included in the training time, it is not explicitly estimated in this section. For purposes of estimating paperwork burden, however, the time is a distinct burden that is estimated separately.

[107] MSHA has assumed that all underground coal mines operate two shifts. Holding training when shifts change will make it possible to train operators from different shifts at the same time.

- **Size of Training Session.** MSHA assumes that (due to the hands-on nature of the training) no more than 12 operators will be trained in one session.

- **Duration of Training.** The training will take fifteen minutes.

Assumptions made by MSHA that are common to both types of training include the following:

- **Wage Rates.** Estimated hourly wage rates are:
  - $49.79 for a supervisor,
  - $26.83 for a trainee, and
  - $18.56 for a clerical worker.

- **Amortization.** MSHA amortizes the one-time cost of training over 10 years at an annual discount rate of 7.0 percent.

The estimated unit costs are summarized in Table IV-6. In an illustrative situation, a coal mine with one piece of permissible equipment and one piece of heavy duty equipment would train two mechanics – one for each type of filter -- and would train 4 operators in one session. This situation represents the unit cost in most aspects of training and recording. In this example, for each mechanic[108] training costs would be $101.85[109] and cost of recording the training would be $9.10.[110] Additional operator training would cost $39.28[111] Thus total costs for the one mine would be $261.18. Since this training is a one-time cost, the annualized cost would be $37.18.

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[108] MSHA assumes separate recording costs, as well as training, for paper filter and ceramic filter systems.

[109] $101.83 = $75.00 + $26.38.

[110] $9.10 = $4.15 + $4.64 + $0.31 = ($49.79 x 0.0833) + ($18.56 x 0.25) + ($18.56 x 0.01667)

[111] $ 39.28 = (0.25) x [(49.79 + 4*(26.83)]

TABLE IV-6: Unit Costs of Filter Maintenance Training

Cost Category		Cost Element	(Wage) Rate	Hours	Cost
Mechanic Training					
Cost per Mechanic	Training	Instruction	$75.00	1	$ 75.00
		Employee	$26.83	1	$ 26.83
		Subtotal			$101.83
	Recording	Clerical	$18.56	0.0167	$ .31
	Total Unit Cost per Mechanic				$102.14
Cost per Mine	Recording	Supervisor	$49.79	0.0833	$ 4.15
		Clerical	$18.56	0.25	$ 4.64
	Total Unit Cost per Mine				$ 8.79
Operator Training					
Cost per Operator	Training	Operator	$26.83	0.25	$ 6.71
Cost per Session	Training	Supervisor	$49.79	0.25	$12.45

Total Industry Costs

Table IV-7a classifies underground coal mines by the numbers of pieces of diesel powered permissible equipment and by the numbers of pieces of non-permissible heavy duty equipment, that they have. These amounts of equipment determine the estimated number of mechanics that mines will train. MSHA estimates that 223 mechanics will be trained in filter maintenance.

Table IV-7b classifies underground coal mines by the total numbers of pieces of permissible and heavy duty diesel equipment they have. Table IV-7b shows the number of machine operators in these mines who will be trained. Table IV-7b (using an approach similar to Table IV-7a) also indicates the numbers of sessions that will be needed to train these operators.

Table IV-8 then computes industry costs by multiplying each unit cost by the number of units (trainees, mines, or training sessions) derived in Table IV-6. Since this training is a one-time cost, it is annualized using an annualization factor of 0.07.[112] The total estimated annualized industry cost for filter maintenance training is $2,971.

[112] For a one-time cost that is never repeated, it is appropriate to use the annual discount rate as an annualization factor, thereby amortizing the cost over an indefinitely long (infinite) time period.

TABLE IV-7 (a,b): Trainees for Filter Maintenance

TABLE IV-7a: Number of Mechanics Trained

Number of Pieces of Equipment in a Mine		**Trainees per Mine**	**Number of Mines**	Total Trainees
Permissible	1 to 6	1	38	38
	7 to 18	2	17	34
	19 to 30	3	2	6
	31 to 42	4	1	4
	43 to 54	5	1	5
	55 to 66	6	-	-
	67 to 78	7	-	-
	79 to 90	8	1	8
	Industry Subtotal		60	95
Heavy Duty[a]	1 to 6	1	68	68
	7 to 18	2	19	38
	19 to 30	3	6	18
	31 to 42	4	1	4
	Industry Subtotal		94	128
Industry Total of Trainees			154	223

[a] Includes generators, compressors, and other pieces of light duty equipment that MSHA estimates will need to be fitted with ceramic filters under Section 72.502.

TABLE IV-7b: Number of Operators Trained and Number of Training Sessions

Number of Permissible & Heavy Duty Machines[a]		Number of Operators Trained	Training Sessions		
In a Mine	Industry Total		Sessions per Mine	Number of Mines	Industry Total
1 to 6	166	332	1	68	68
7 to 12	87	174	2	8	16
13 to 18	157	314	3	10	30
19 to 24	105	210	4	5	20
25 to 30	134	268	5	5	25
31 to 36	99	198	6	3	18
37 to 42	154	308	7	4	28
42 to 48	-	-	8	-	-
49 to 54	51	102	9	1	9
55 to 60	-	-	10	-	-
61 to 66	61	122	11	1	11
121 to 126	122	244	21	1	21
Total Operators		2,272	Total Sessions		246

[a] Includes generators and compressors, which will need ceramic filters under Section 72.501, and other pieces of light duty equipment that MSHA estimates will need to be fitted with ceramic filters under Section 72.502.

Table IV-8: First Year Industry Cost of Filter Maintenance Training

Type of Training	Cost Element	Unit Cost	Number	Industry Cost
Mechanic Training	Cost per Mechanic	$102.14	223	$ 22,777
	Cost per Mine	$ 8.79	154[a]	$ 1,354
	Subtotal Industry Cost			$ 24,131
Operator Training	Cost per Operator	$ 6.71	2,272	$ 15,245
	Cost per Session	$12.45	246	$ 3,063
	Subtotal Industry Cost			$ 18,308
Total Industry Cost	Total Cost at Time of Training			$ 42,439
	Total Annualized Cost[b]			$ 2,971

[a] This number counts twice underground coal mines with both permissible and non-permissible heavy duty equipment, and it omits mines that have neither.

[b] The annualization factor is 0.07, which is equal to the annual discount rate. Computed figures may not agree precisely with data in the table because of rounding in the table.

After the first year, MSHA estimates a turnover rate of 7 percent for mechanics who work on diesel machines and for machine operators of diesel powered equipment. Therefore, annually, of the 223 mechanics being trained in the first year, 16 new mechanics would each need 1 hour of training. MSHA assumes that each new mechanic trained would be in a different mine. With respect to machine operators, MSHA estimates that of the 2,272 machine operators receiving training in the first year, 159 new machine operators would need training annually. MSHA estimates that 62 sessions would be needed to train the 159 new machine operators. Table IV-8a below shows annual costs to train new mechanics that work on diesel machines and new machine operators of diesel powered equipment.

Table IV-8a: Annual Industry Cost of Filter Maintenance Training

Type of Training	Cost Element	Unit Cost	Number	Industry Cost
Mechanic Training	Cost per Mechanic	$102.14	16	$ 1,634
	Cost per Mine	$ 8.79	16[a]	$ 141
	Subtotal Industry Cost			$ 1,775
Operator Training	Cost per Operator	$ 6.71	159	$ 1,067
	Cost per Session	$12.45	62	$ 772
	Subtotal Industry Cost			$ 1,839
Total Industry Cost	Total Annual Cost at Time of Training			$ 3,614

[a] This number counts twice underground coal mines with both permissible and non-permissible heavy duty equipment, and it omits mines that have neither.

MINER HEALTH TRAINING (72.510)

Section 72.510 requires that coal miners covered by the rule who can reasonably be expected to be exposed to DPM be trained in DPM health risks (72.510(a)(1)), DPM control methods (72.510(a)(2)), personnel responsible for controls (72.510(a)(3)), and actions required by miners to ensure that controls operate as intended (72.510(a)(4)). In addition, the mine operator is required to maintain records of the training for one year (72.510(b)(1)) and to provide access to the training records on demand (72.510(b)(2)).

Unit Cost Estimates

MSHA's estimate of miner training and recording costs under Section 72.510(a) is based on the following assumptions:

- **Instruction.** Training will be performed by a mine supervisor.

- **Size of Training Session.** Up to 34 miners will be trained at each session.[113]

- **Trainees.** Miners to be trained (i.e. those in underground coal mines using diesel powered equipment) constitute 95 percent of employees in those mines.

- **Wage Rates.** Hourly wage rates of the personnel involved are:
  - $49.79 for a mine supervisor,
  - $26.83 for a miner, and
  - $18.56 for a clerical worker.

- **Duration of Training Session.** Training sessions of two durations[114] will be held:
  - Underground mines with diesel equipment subject to Section 72.500 or Section 72.501 will hold training sessions that last for 30 minutes, and
  - Underground mines with only diesel equipment subject to Section 72.502 will hold abbreviated training sessions that cover only DPM health hazards (72.510(a)(1)) and last for 15 minutes.

- **Recording.** The training will be recorded by having each trainee sign a sign-in sheet, which was prepared by a clerical worker and will be entered into a computer. MSHA estimates that this process will entail the following actions:[115]
  - The supervisor will brief the clerical worker, which will require an estimated five minutes of both persons' time. This will occur once at each mine.
  - For each training session, the clerical worker will prepare a registration sheet with the trainees' names on a clipboard and will subsequently record the attendees in a computer file, which will require an estimated 10 minutes plus one minute for each trainee, and
  - Attendees will sign the registration sheet. This will require an estimated 20 seconds each, which will occur during training rather than in addition to it.[116]

Training costs of a single training session are thus calculated as:

Session Cost = [(Session Length) x (Supervisor's Wage)]
+ [(Session Length) x (Miner's Wage) x (Number of Miners in Session)]

[113] Thus, for example, a mine with 100 miners would hold three training sessions, while a mine with 40 miners would hold two training sessions. This assumption replaces the PREA assumption that all mines with 20 or more employees would hold an average of 3 training sessions and all smaller mines would hold one training session.

[114] This assumption represents a change from the PREA, which assumed that all miners in mines with 20 or more employees would receive 30-minute training and all miners in smaller mines would receive 15-minute training. It is a more refined assumption to make the length of training session depend on the type of diesel powered equipment rather than merely on the size of mine.

[115] This process replaces the PREA assumption that recording would consist only of each miner taking 30 seconds to sign a list. The current assumption accounts for setting up and processing the attendance list.

[116] Because this cost is included in the training time, it is not explicitly estimated in this section. For purposes of estimating paperwork burden, however, the time is a distinct burden that is estimated separately.

Total costs of training for a mine are:

Total Cost = [(Number of Training Sessions) x (Session Length) x (Supervisor's Wage)]
+ [(Session Length) x (Miner's Wage) x (Number of Miners in Mine)]

In addition to training costs, each mine will have the following recordkeeping costs:

Recordkeeping Costs = [{(Supervisor's Hourly Wage)+(Clerical worker's Hourly Wage)}/12]
+ [(Number of Sessions) x (Clerical worker's Hourly Wage)/6]
+ [(Number of Miners) x (Clerical worker's Hourly Wage)/60]

Thus, for example, an underground coal mine with 120 miners and permissible and/or heavy duty equipment would incur training and recordkeeping costs of $1,765.[117] while a mine with 40 miners and only light duty diesel equipment would incur training and recordkeeping costs of $317.[118]

Total Industry Cost

Table IV-9 and Table IV-10 summarize the computation of industry costs of miner training. Table IV-9 is based on a classification of underground coal mines by whether they have permissible equipment, heavy duty equipment, or generators or compressors (in which case they require 30-minute training sessions) or not (in which case they require 15-minute training sessions). Table IV-9 also groups mines by how many training sessions each mine will hold, based on the number of employees. The result of these computations is that 87 underground coal mines will hold 408 30-minute training sessions, and 58 underground coal mines will hold 120 15-minute training sessions.

Table IV-10 computes the unit labor costs of each 30-minute and each 15-minute session for instructing supervisors and attending miners. The unit costs are then multiplied by the number of training sessions (for instructors) or by the number of miners, respectively, to produce an estimate of industry costs. Total annual industry miner training costs are estimated to be $189,203, of which 89 percent are for mines with filtered equipment.

Table IV-11 shows the derivation of MSHA's estimate of recordkeeping costs. The five-minute briefing of a clerical worker by a supervisor occurs once for each mine. Thus this unit cost is computed and then multiplied by the number of mines. The time it takes for the clerical worker to produce a sign-up sheet depends both on the number of sessions and on the number of miners. Each of these unit cost elements is computed separately, multiplied by the number of units (sessions and miners, respectively), and then added together. Since MSHA anticipates that

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[117] $1,765 = [(4 Sessions) x (0.5 hours) x ($49.79/hour)] + [(0.5 hours) x ($26.83/hour) x 120)] + [{($49.79/hour)+($18.56/hour)} x (0.0833 hours)] + [4 Sessions) x (0.1667 hour) x ($18.56/hour)] + [($18.56/hour) x (0.0167 hour) x (120)].

[118] $317 = [(2 Sessions) x (0.25 Hours) x ($49.79/hour)] + [(0.25 Hours) x ($26.83/hour) x (40)] + [{($49.79/hour)+($18.56/hour)} x (0.0833 hour)] + [2 Sessions) x (0.1667 hour) x ($18.56/hour)] + [($18.56/hour) x (0.0167 hour) x (40)].

the miners will pass around and sign the registration sheet during the training session, that cost was already included in the estimated time of the sessions themselves. The total estimated cost of recording miner health training is $7,006, of which 88 percent is for preparing and processing the list of attendees.

Total estimated annual industry costs for Section 72.510, including training and recordkeeping, is $196,209.

TABLE IV-9: Miner Health Training Sessions

Sessions per Mine	30-Minute Training Sessions		15-Minute Training Sessions	
	Number of Mines	Total Sessions	Number of Mines	Total Sessions
1	10	10	21	21
2	21	42	23	46
3	13	39	10	30
4	9	36	2	8
5	9	45	-	-
6	5	30	1	6
7	7	49	-	-
8	1	8	-	-
9	1	9	1	9
10	1	10	-	-
11	3	33	-	-
12	4	48	-	-
13	2	26	-	-
23	1	23	-	-
TOTAL	87	408	58	120

TABLE IV-10: Costs of Miner Health Training Under Section 72.510

Cost Category	Cost Element	30-Minute Sessions	15-Minute Sessions
Instruction Costs (Supervisor)	Wage Rate	$ 49.79	$ 49.79
	Length of Session	0.5 hour	0.25 hour
	Cost per Session	$ 24.90	$ 12.45
	Number of Sessions	408	120
	Total Cost[a]	$ 10,159	$ 1,494
Miner Costs	Wage Rate	$ 26.83	$ 26.83
	Length of Session	0.5 hour	0.25 hour
	Cost per Session	$ 13.42	$ 6.71
	Number of Miners	11,764	2,934
	Total Cost[a]	$157,873	$ 19,687
Total Industry Costs		$168,032	$ 21,171
		$189,203	

[a] Computed figures may not agree precisely with data in the table because of rounding in the table.

TABLE IV-11: Costs of Recording Miner Health Training

Activity	Cost Element	Supervisor	Clerical Worker
Briefing	**Wage Rate**	**$49.79**	**$18.56**
	Hours per Mine	**0.08333**	**0.08333**
	Cost per Mine	**$ 4.15**	**$ 1.55**
	Number of Mines	**145**	**145**
	Industry Cost	$ 602	$ 225
		$ 827	
Prepare List/ **Record Names**	Wage Rate		$18.56
	Hours per Session		0.16667
	Cost per Training Sessions		$ 3.09
	Number of Training Sessions		528
	Industry Subtotal		$1,633
	Hours per Miner		0.01667
	Cost per Miner		$ .31
	Number of Miners		14,697[a]
	Industry Subtotal		$4,546
	Industry Cost		$6,179
Total Industry Annual Cost			$7,006

[a] 95 percent of all employees in underground coal mines using diesel equipment.

DIESEL EQUIPMENT INVENTORY (72.520)

Section 72.500 requires underground coal mine operators to maintain an inventory of diesel powered equipment units, together with information about any unit's emission control or filtration system. The rule requires mine operators to update the inventory when equipment or emission control systems are changed. It also requires mine operators to submit the inventory to the District Manager whenever it is modified and to provide a copy to the representative of the miners upon request.

Unit Cost Estimates

Initial Costs

MSHA bases its estimate of costs of Section 72.520, the diesel equipment inventory, on the following assumptions:[119]

- Mine operators will obtain general information on approved engines from manufacturers or MSHA (via MSHA's website). This task will take a mine supervisor earning $49.79 per hour an average of one hour per mine.

- Mine operators will obtain machine-specific information (e.g. serial numbers) from maintenance files or similar records. Collection and recording of this information will take a miner earning $26.83 per hour an average of 2 minutes per machine.

- Production and distribution of the inventory will be done by a clerical worker. MSHA assumes that the inventory will average two pages in length. MSHA also assumes the mine operator will make and a copy for the representative of the miners whenever a copy is made for the District Manager, as this will require less effort and cost than responding to requests of the representative of the miners. Production and distribution costs of the initial inventory will entail:
    - One quarter hour[120] per mine of a clerical worker earning $18.56 per hour,
    - Copying costs of $ .15 per page (equivalent to $ .30 per plan copy or $ .60 for two plan copies), and
    - Postage (for submission to MSHA at $ .33 per plan.

Some costs can readily be estimated by mine and added up for all mines. It is much simpler computationally, however, to estimate machine-specific costs for the industry as a whole than mine by mine. Table IV-12a, which summarizes the estimated costs of the initial diesel equipment inventory, uses this hybrid computation. As Table IV-12 indicates, estimated costs of

[119] These assumptions replace the PREA assumption that revisions to the ventilation plan would take one hour of a supervisor's time in mines with 20 or more employees and one half hour of a supervisor's time in smaller mines. The current assumption better reflects the relationship between costs and the number of pieces of diesel powered equipment to be listed.

[120] This assumption is the same as the PREA assumption that it would take 15 minutes for compliance with proposed Section 75.370(f).

initial preparation of the diesel equipment inventory are $49.79 per mine for general information collection by a supervisor; $ .89 per machine for machine-specific information collection by a mine worker; and $5.57 per mine for copying and distribution of the inventory.

TABLE IV-12 (a,b): Compliance Costs of Section 72.520 (Diesel Equipment Inventory)

TABLE IV-12a: Compliance Cost of Initial Diesel Equipment Inventory

		Diesel Equipment Inventory Activity		
Cost Category	Cost Element	General Information (Supervisor)	Machine Information (Miner)	Process Documents (Secretary)
Unit Cost	Wage Rate	$ 49.79	$ 26.83	$ 18.56
	Hours	1	0.03333	0.25
	Labor Cost	$ 49.79	$ 0.89	$ 4.64
	Copying	$ -	$ -	$ 0.60[a]
	Postage	$ -	$ -	$ .33
	Unit Cost Subtotal	$ 49.79	$ .89	$ 5.57
Industry Cost	Mines	145	-	145
	Machines	-	3,121	-
	Activity Subtotal	$ 7,220	$ 2,791	$ 808
	Total Cost	$ 10,818		
Annualized Cost[b]		$ 757		

[a] $0.60 = ($ .15/page) x (2 pages/copy) x (2 copies/mine)

[b] The annualization factor is 0.07, which is equal to the annual discount rate. Computed figures may not agree precisely with data in the table because of rounding in the table.

Updating Costs

MSHA assumes that, once the plan is in place, it will be updated whenever diesel equipment is replaced. Updating an inventory will be much less costly than setting up an inventory in the first place, since updating involves machinery that is being logged into a mine's records in other respects. MSHA bases its estimate of costs of updating the diesel equipment inventory on the following assumptions:

- Retrieving general information on approved engines will take a mine supervisor earning $49.79 per hour an average of two minutes per machine.

- Collection and recording of machine-specific information will take a miner earning $26.83 per hour an average of 2 minutes per machine.

- Production and distribution of a modified inventory will entail:
    - Five minutes per mine of a clerical worker earning $18.56 per hour,
    - Copying costs of $ .15 per page (equivalent to $ .30 per plan copy or $ .60 for two plan copies), and
    - Postage (for submission to MSHA at $ .33 per plan.

Table IV-12b, which summarizes the estimated costs of the updating a diesel equipment inventory, indicates estimated costs of $1.66 per machine for general information collection by a supervisor; $ .89 per machine for machine-specific information collection by a mine worker; and $2.48 per machine for copying and distribution of the inventory.

Industry Costs

Table IV-12a shows total estimated industry costs, as well as unit costs. These costs are computed by multiplying general information costs and copying/distribution costs by the number of underground coal mines (145) and multiplying the machine-specific unit costs by the number of diesel powered machines in these mines (3,121). Total estimated costs of the initial diesel equipment inventory are $10,824.

Initial creation of the diesel equipment inventory is a one-time cost. Costs of subsequent updating are estimated separately. In order to annualize this one-time cost, MSHA amortized the cost using an accumulation factor of 0.07. The resulting annualized total industry cost for this provision is $757.

Table IV-12b similarly shows total estimated industry costs of updating the inventories, as well as unit costs. Since the expected life of an engine is 10 years, MSHA assumes that in any given year an average 10 percent of the fleet will have equipment replacements that necessitate updating of the inventory. The industry costs of updating are computed by multiplying information costs and copying/distribution costs by the average number of replacements (312). Total estimated annual costs of the updating the diesel equipment inventory are $1,570.

Combining the annualized initial costs and the annual updating costs of the diesel equipment inventory, the total estimated yearly cost to the underground coal mine industry of Section 72.520 is $2,327.

TABLE IV-12b: Compliance Cost of Updating Diesel Equipment Inventory

		Diesel Equipment Inventory Activity		
Cost Category	Cost Element	General Information (Supervisor)	Machine Information (Miner)	Process Documents (Secretary)
Unit Cost	Wage Rate	$ 49.79	$ 26.83	$ 18.56
	Hours	0.03333	0.03333	0.08333
	Labor Cost	$ 49.79	$ 0.89	$ 4.64
	Copying	$ -	$ -	$ 0.60[a]
	Postage	$ -	$ -	$ .33
	Unit Cost Subtotal	$ 49.79	$ .89	$ 5.57
Industry Cost	Machines	312	312	312
	Activity Subtotal	$ 518	$ 279	$ 773
	Total Annual Cost	$ 1,570		

[a] $0.60 = ($ .15/page) x (2 pages/copy) x (2 copies/mine)

TOTAL MINE OPERATOR COSTS

Yearly Costs

Table IV-13 aggregates costs to underground coal mine operators of the individual sections of the rule. The estimated total yearly cost to the industry is $7.07 million.

TABLE IV-13: Total Yearly Compliance Costs for Mine Operators

Requirement	Total Yearly Industry Cost
Section 72.500 (Permissible Equipment)[a]	$ 4,468,965
Section 72.501 (Heavy Duty Equipment)[b]	$ 2,278,970
Section 72.502 (Light Duty Equipment)[c]	$ 121,391
Section 72.504 (Filter Maintenance Training)[d]	$ 2,971
Section 72.510 (Miner Health Training)[e]	$ 196,209
Section 72.520 (Diesel Equipment Inventory)[f]	$ 2,327
TOTAL	$ 7,070,833

[a] Source: Table IV-1.

[b] Source: Table IV-5d.

[c] Source: Footnotes 50, 51, and 52.

[d] Source: Table IV-8.

[e] Source: Table IV-9 and Table IV-10.

[f] Source: Table IV-12.

Initial Costs

Where heavy capital investment is required by a regulation, the size of these initial capital costs, which are typically concentrated in the first year of the regulation, is of concern. This rule is unusual, however, since the large investment costs are phased to occur in the second year (paper filters on permissible equipment) and the third year (ceramic filters on heavy duty equipment). Moreover, most of the annual O&M costs do not begin until corresponding equipment costs have been incurred, so that the first-year costs are relatively small. The costs actually incurred in the first year include filters for engines in new equipment, related maintenance costs, and one-time training and ventilation plan revision costs.

Table IV-14 shows the actual costs to mine operators of the first three years of the rule in the year that they will be incurred.

- Actual estimated industry costs in the first year will be $1.38 million, including:
  - $0.65 million in equipment costs and other one-time costs, and
  - $0.73 million in annual O&M costs.

- Actual estimated industry costs in the second year will be $8.12 million, including:
    - $3.33 million in equipment costs and other one-time costs, and
    - $4.79 million in annual O&M costs.

- Actual estimated industry costs in the third year will be $8.10 million, including:
    - $2.60 million in equipment costs and other one-time costs, and
    - $5.50 million in annual O&M costs.

Thus actual costs peak in the second and third years at a level about $1 million (15 percent) above the average yearly costs.

MANUFACTURER'S COSTS

As a result of Section 72.500, which requires all permissible equipment to have filtration devices, manufacturers will need to amend many of the existing permissible machine approvals. In most cases, the application and evaluation will be a relatively simple process. Some power packages, however, will require considerably more effort, some redesign, and retesting.

As a result of Section 72.502, manufacturers will need to reconfigure some of their light duty equipment models in order to accommodate engines that comply with EPA standards listed in the rule. The engineering will create cost impacts when an option with an EPA compliant engine is not available. Mining equipment manufacturers will need to bear these costs in order to remain competitive.

Unit Cost Estimate for Power Package Approval

MSHA's estimates of the costs to equipment manufacturers of getting approval for power packages are based on the following assumptions:

- **Level of Effort.** MSHA estimates that the manufacturers' redesign of the power package and preparation of the application will require:
    - 20 hours in the case of power packages with easy evaluations, and
    - 40 hours in the case of power packages requiring hard evaluations and testing.

- **Hourly Cost.** MSHA estimates that manufacturers' costs will be $50 per hour.[121]

- **MSHA Evaluation Cost.** The cost to the manufacturer for MSHA evaluation of the revised power packages will be:
    - $2,000 for power packages with easy evaluations, and
    - $25,000 for power packages requiring testing.

- **Number of Approvals.** MSHA estimates[122] that there will be applications for:

[121] This estimate replaces the PREA assumption of $75 per hour.

- 27 power packages with easy evaluations, and
- 4 power packages with hard evaluations and testing.[123]

Table IV-14 summarizes the unit costs for amending permissible power package approvals. The approval cost is $3,000 for an approval with easy evaluation and $27,000 for a power package with a difficult evaluation and testing.

[122] This updated estimate replaces the PREA estimate of 16 easy evaluations and 5 difficult applications.

[123] MSHA reviewed the inventory information to identify the power packages with which diesel powered equipment in the field is equipped. After discussions with Division personnel, MSHA identified those power packages that would require testing and more extensive technical review to allow filters to be added.

TABLE IV-14: Initial Costs for Mine Operators

Type of Cost	Specific Cost	Years After Publication of Rule		
		Year 1	Year 2	Year 3
Filter Costs	Install Paper Filter Systems[a]	$ 288,000	$3,030,000	$ 0
	Install Ceramic Filters[b,c]	$ 305,000	$ 295,000	$2,595,000
Other One-Time Costs	Maintenance Training and Recordkeeping	$ 42,439	$ 0	$ 0
	Ventilation Plan Revision	$ 12,172	$ 0	$ 0
Total Equipment Costs and Other One-Time Costs		$ 647,611	$3,325,000	$2,595,000
Annual O&M Costs	Change[d] Paper Filters	$ 440,496	$4,414,137	$4,414,137
	Regenerate[d] Ceramic Filters	$ 92,235	$ 181,116	$ 873,717
	OCCs[c]	$ 1,000	$ 3,000	$ 16,000
	Miner Health Training and Recordkeeping	$ 196,209	$ 196,209	$ 196,209
	Total	$ 729,940	$4,794,462	$5,500,063
Total Cost for Year		$1,377,551	$8,119,462	$8,095,063

[a] Year 1 includes 48 "easy" filters on replacement equipment; Year 2 includes 24 "easy" filters on replacement equipment and 409 filters (337 "easy" and 72 "difficult") on remaining equipment.

[b] Year 1 includes 51 ceramic filters on new engines $\leq$150 hp (47 heavy duty; 4 light duty) and 4 ceramic filters on new engines >150 hp (heavy duty). Year 2 includes 49 ceramic filters on engines $\leq$150 hp (47 heavy duty; 2 light duty) and 4 ceramic filters on new engines >150 hp (heavy duty). Year 3 includes 434 ceramic filters on engines $\leq$150 hp (424 heavy duty; 10 light duty) and 34 ceramic filters on engines >150 hp (heavy duty).

[c] Ceramic filters are designated as capital expenses because they are replaced every two years. OCCs are designated as annual O&M because they are replaced every year.

[d] Costs reflect all filters installed during year or earlier.

Unit Cost Estimate for Engineering Reconfigurations for EPA Compliant Engines

MSHA's estimates of the engineering costs to equipment manufacturers to reconfigure light duty equipment for engines that meet the listed EPA standards are based on the following assumptions:

- **Level of Effort.** MSHA estimates that the average engineering redesign will require 80 hours.[124]

- **Hourly Cost.** MSHA estimates that manufacturers' costs will be $50 per hour.

- **Number of Reconfigurations.** MSHA estimates[125] that a total of 12 mining equipment manufacturers will need to engineer reconfigurations of a total of 60 models of mining equipment.

Table IV-14 summarizes the computation of engineering costs. The unit engineering cost to the manufacturer to reconfigure light duty equipment models is estimated to be $4,000.

Industry Costs

Total estimated costs to manufacturers, which are shown in Table IV-14, are:

- $189,000 for amended approval of power packages; and

- $240,000 for engineering to accommodate EPA approved engines.

Costs of amended approvals and engineering are one-time costs. MSHA has therefore annualized these costs using an annualization factor of 0.07.[126] As shown in Table IV-15, the annualized cost to manufacturers is $30,030.

[124] Most estimates were in the range of 40 to 80 hours, with the remainder being lower.

[125] This estimate is based on a review of the inventory of light duty diesel powered equipment to assess the number of fundamentally distinct equipment models and the engines used in that equipment.

[126] For a one-time cost that is never repeated, it is appropriate to use the annual discount rate as an annualization factor, thereby amortizing the cost over an indefinitely long (infinite) time period.

TABLE IV-15: Equipment Manufacturers' Costs

Cost Category	Cost Element	Engine Approval by Difficulty of Evaluation		Engineering for Engine Meeting Listed EPA Standard
		Easy	Hard, With Testing	
Application Or Engineering	Hours for Preparation	20	40	80
	Cost/Hour	$ 50	$ 50	$ 50
	Subtotal	$ 1,000	$ 2,000	$ 4,000
MSHA Evaluation		$ 2,000	$ 25,000	-
Total Unit Cost		$ 3,000	$ 27,000	$ 4,000
Number of Power Packages		27	4	60
Total Industry Cost to Manufacturers		$81,000	$108,000	$240,000
		$189,000		
		$429,000		
Annualized Industry Cost		$ 30,030		

[a] The annualization factor is 0.07, which is equal to the annual discount rate.

FEASIBILITY

The Agency has considered the technological and economic feasibility of the rule for the segment of underground coal mines that use diesel-powered equipment. As discussed in more detail in Part V of the preamble, MSHA has concluded that the requirements of the final rule are technologically and economically feasible for underground coal mines that use diesel-powered equipment.

The final rule requires underground coal mines that use diesel-powered equipment to limit the emissions of DPM emitted by various categories of equipment – permissible, heavy duty, and light duty. Although, the final rule does not immediately apply to light-duty equipment (with the exception of compressors and generators), it is covered (over time) by the rule's requirements concerning equipment added to a mine's inventory more than 60 days after the rule is promulgated, and equipment already in the inventory but equipped with a new engine.

There are available emission controls that can bring all existing and contemplated future diesel-powered equipment into compliance with the final rule's requirements. Paper filters have now been verified to reduce emissions from the dirtiest permissible engines to the rule's required limit of 2.5 grams per hour. Ceramic filters have been certified by VERT to have the efficiency required to reduce emissions from the dirtiest heavy duty engines to the rule's interim required limit of 5.0 grams per hour, and for all but one engine to the rule's final required limit of 2.5 grams per hour.[127] Approved engines that meet the emissions limit for newly introduced light duty equipment are available for all categories.

In addition, sufficient time is provided for mine operators to comply with the rule's requirements. Even though emission controls are readily available to meet the rule's requirements, the existing permissible fleet has 18 months to comply, while implementation for the existing heavy duty fleet (and compressors and generators) extends 4 years from the date of promulgation. The delay in the rule's promulgation allows operators adequate time to familiarize themselves with the compliance technology and to train mine personnel in the maintenance and use of such technology.

With respect to economic feasibility, as previously estimated in this chapter, the affected underground coal mines will incur costs of approximately $7 million yearly to comply with the final rule. That the total $7 million borne yearly by the 145 underground coal mines using diesel-powered equipment as a result of the final rule is less well less than 1 percent (about 0.23 percent) of those mines' yearly revenues of about $3.03 billion provides convincing evidence that the final rule is economically feasible.[128]

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[127] VERT is an acronym for Verminderung der Emissionen von Realmaschinen in Tunnelbau, a consortium of several European agencies conducting diesel emission research in connection with major planned tunneling projects in Austria, Switzerland, and Germany. VERT was established to advance hot gas filter technology due to concerns in Europe about DPM levels.

[128] For the coal mining industry as a whole, the economic impact is even smaller, with compliance costs equal to only 0.035 percent of yearly industry revenues of about $19.7 billion. Therefore, the Agency concludes that the final rule is economically feasible for the coal mining industry as a whole.

V. REGULATORY FLEXIBILITY CERTIFICATION

INTRODUCTION

In accordance with § 605 of the Regulatory Flexibility Act of 1980 as amended, MSHA has analyzed the impact of the final rule on small businesses and certifies that this final rule will not have a significant economic impact on a substantial number of small entities that are affected by this rulemaking. Under the Small Business Regulatory Enforcement Fairness Act (SBREFA) amendments to the Regulatory Flexibility Act (RFA), MSHA must include a factual basis for this certification. The Agency must also publish the regulatory flexibility certification statement in the Federal Register, along with the factual basis, followed by an opportunity for the public to comment. If the final rule has a significant economic impact on a substantial number of small entities, then the Agency must develop a regulatory flexibility analysis.

DEFINITION OF A SMALL MINE

Under the RFA, in analyzing the impact of a rule on small entities, MSHA must use the Small Business Administration (SBA) definition for a small entity or, after consultation with the SBA Office of Advocacy, establish an alternative definition for the mining industry by publishing that definition in the Federal Register for notice and comment. MSHA has not taken such an action, and hence is required to use the SBA definition.

The SBA defines a small entity in the mining industry as an establishment with 500 or fewer employees (13 CFR 121.201). All but one underground coal mine affected by this rulemaking falls into this category and hence can be viewed as sharing the special regulatory concerns that the RFA was designed to address.

Traditionally, the Agency has also looked at the impacts of its rules on a subset of mines with 500 or fewer employees -- those with fewer than 20 employees, which the mining community refers to as "small mines.” The way these small mines perform mining operations is generally recognized as being different from the way larger mines operate. These small mines differ from larger mines not only in the number of employees, but also, among other things, in economies of scale in material produced, in the type and amount of production equipment, and in supply inventory. Therefore, their costs of complying with MSHA rules and the impact of MSHA rules on them will also tend to be different. It is for this reason that “small mines,” as traditionally defined by the mining community, are of special concern to MSHA.

This analysis complies with the legal requirements of the RFA for an analysis of the impacts on "small entities" while continuing MSHA's traditional look at "small mines." MSHA concludes that it can certify that the final rule will not have a significant economic impact on a substantial number of small entities that are affected by this rulemaking. The Agency has determined that this is the case both for underground coal mines affected by this rulemaking with fewer than 20 employees and for underground coal mines affected by this rulemaking with 500 or fewer employees.

FACTUAL BASIS FOR CERTIFICATION

General Approach

The Agency's analysis of impacts on "small entities" begins with a "screening" analysis. The screening compares the estimated compliance costs of a rule for small entities in the sector affected by the rule to the estimated revenues for those small entities. When estimated compliance costs are less than 1 percent of the estimated revenues (for the size categories considered), the Agency believes it is generally appropriate to conclude that there is no significant economic impact on a substantial number of small entities. When estimated compliance costs exceed 1 percent of revenues, it tends to indicate that further analysis may be warranted.

Derivation of Costs and Revenues

In Chapter IV, MSHA used the same assumptions for estimating the costs of all mines, regardless of size. For most assumptions this procedure was appropriate. For some costs (e.g., filter installation), there is no reason to believe that costs will differ by mine size. For other costs (e.g., training costs), the costs were estimated on the basis of fixed costs plus variable costs that implicitly adjusted for mine size. For analysis of costs or impacts by mine size, however, MSHA used a different estimate of production hours for a small underground coal mine:

- In Chapter IV, MSHA assumed that all underground coal mines operate two shifts per day and operate 250 days a year.

- In the analysis of mines with fewer than 20 employees, by contrast, MSHA estimates that these small mines operate one shift per day and operate 160 days per year.

The implication of this estimate is that small mines replace and regenerate paper and/or ceramic filters less frequently than larger mines do. Thus small mines have correspondingly lower costs for filters and for the labor required to replace or regenerate them, and also for operator training.

In addition, the per mine compliance costs of the final rule get proportionally larger as the size of the mine increases. The highest compliance costs of the rule are associated with installation of emission control equipment on diesel machines, and the larger the mine the more pieces of diesel-powered equipment it is likely to own. For example, cost impacts on mines employing fewer than 20 workers will be less because these mines have a total of only 20 diesel machine (see Table II-4).

In determining revenues for underground coal mines that use diesel powered equipment, MSHA multiplied their production data (in tons) by the estimated price per ton of the commodity

($17.58 per ton in 1998). The production data were obtained from MSHA's Denver Office,[129] and the price estimates were obtained from the Department of Energy. [130]

Results of Screening Analysis

The final rule applies to underground coal mines that use diesel-powered equipment. Table V-1 shows that the estimated yearly cost of the final rule as a percentage of yearly revenues is about 0.08 percent for the affected underground coal mines employing fewer than 20 employees. The estimated yearly cost of the final rule as a percentage of yearly revenues is about 0.21 percent for the affected underground coal mines employing 500 or fewer employees.

Table V-1
Estimated Yearly Costs of Final Rule Relative to Yearly Revenues
For Underground Coal Mines That Use Diesel-Powered Equipment

Mine Size	Final Rule Yearly Costs	Revenues[a]	Costs as Percentage Of Revenues
< 20 emp.	$7,411	$9,138,770	0.08%
≤ 500 emp.	$6,089,991	$2,945,289,121	0.21%

[a] Source: Mine Safety and Health Administration, Office of Injury and Employment Information, Denver, Colorado. 1999, and U.S. Department of Energy, Energy Information Agency, Annual Energy Review 1998, DOE/EIA0384(98), July 1999, p.203.

Whether a small mine is defined as one with fewer than 20 employees or one with 500 or fewer employees, the estimated compliance costs are substantially less than 1 percent of estimated coal revenues, well below the level suggesting that they might have a significant economic impact on a substantial number of small entities. Accordingly, MSHA has certified that there is no significant economic impact on a substantial number of small entities in the coal mining industry that are affected by this final rule.

As required under the law, MSHA complied with its obligation to consult with the Chief Counsel for Advocacy on this final rule, and on the Agency's certification of no significant economic impact on a substantial number of small entities covered by this final rule.

[129] Mine Safety and Health Administration, Office of Injury and Employment Information, Denver, Colorado, 1999.

[130] U.S. Department of Energy, Energy Information Agency, Annual Energy Review 1998, DOE/EIA-0384(98), July 1999, p.203.

VI. OTHER REGULATORY CONSIDERATIONS

THE UNFUNDED MANDATES REFORM ACT

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

NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) of 1969 requires each Federal agency to consider the environmental effects of proposed actions and to prepare an Environmental Impact Statement on major actions significantly affecting the quality of the environment. MSHA has reviewed the final rule in accordance with NEPA requirements (42 U.S.C. 4321 *et. seq.*), the regulations of the Council of Environmental Quality (40 CFR Part 1500), and the Department of Labor's NEPA procedures (29 CFR Part 11). As a result of this review, MSHA has determined that this rule will have no significant environmental impact.

EXECUTIVE ORDER 12630: GOVERNMENT ACTIONS AND INTERFERENCE WITH CONSTITUTIONALLY PROTECTED PROPERTY RIGHTS

This 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.

EXECUTIVE ORDER 12988: CIVIL JUSTICE REFORM

The Agency has reviewed Executive Order 12988, Civil Justice Reform, and determined that the final rule will not unduly burden the Federal court system. The 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.

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 final rule on children. The Agency has determined that the rule will not have an adverse impact on children.

EXECUTIVE ORDER 13084: CONSULTATION AND COORDINATION WITH INDIAN TRIBAL GOVERNMENTS

MSHA certifies that the final rule will not impose substantial direct compliance costs on Indian tribal governments.

EXECUTIVE ORDER 13132: FEDERALISM

MSHA has reviewed the final rule in accordance with Executive Order 13132 regarding federalism and has determined that it does not have "federalism implications." The final rule does 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."

VII. THE PAPERWORK REDUCTION ACT OF 1995

INTRODUCTION

The purpose of this chapter is to show the burden hours and related costs of the final rule that are borne by affected: (1) underground coal mine operators that use diesel powered equipment, and (2) manufacturers of diesel powered equipment. The compliance costs derived in Chapter IV included both paperwork and non-paperwork costs. This chapter, however, shows only costs which relate to burden hours resulting from the final rule.

SUMMARY OF PAPERWORK BURDEN HOURS AND RELATED COSTS

The following hourly wage rates were used to determine burden hour costs: supervisor wage rate of $49.79, coal miner wage rate of $26.83, and clerical worker wage rate of $18.56. All first year costs borne by mine operators are annualized using an annualization factor of 0.07. First year costs borne by manufacturers are annualized using an annualization factor of 0.142, which reflects that these costs are spread over a 10 year life.

For mine operators that use diesel powered equipment, the final rule imposes two types of burden hours. First, there are burden hours that will occur only in the first year the rule is in effect (hereafter referred to as "first year" burden hours). Second, there are burden hours that will occur every year that the rule is in effect, starting with the first year (hereafter referred to as "annual" burden hours).

Manufacturers of diesel equipment that are affected by this rule will incur only first year burden hours.

Mine Operators

First Year Burden Hours

In the first year after the rule takes effect, mine operators will incur 997 burden hours, which is composed of 349 first year burden hours (from Table VII-1) and 648 annual burden hours (from Table VII-1(a)). The related costs to mine operators will be $33,049, of which $12,627 is related to first year burden hours (from Table VII-1) and $20,422 is related to annual burden hours (from Table VII-1(a)).

Burden Hours After the First Year

Beginning in the second year the rule takes effect and continuing every year thereafter, mine operators will incur 648 burden hours and related costs of $20,422 (from Table VII-1(a)).

Manufacturers

First Year Burden Hours

In the first year that the rule is in effect manufacturers will incur 700 burden hours and related costs of $35,000 (from Table VII-2). After the first year, manufacturers will not incur any burden hours or related costs.

Table VII-1
Mine Operators - First Year Burden Hours

	< 20		20 to 500		> 500		Total	
Provision	Hrs.	Costs	Hrs.	Costs	Hrs.	Costs	Hrs.	Costs
75.1915/72.503	1	$28	50	$1,299	1	$14	52	$1,341
72.510	0.6	$29	11	$568	0.1	$4	12	$602
72.520	9	$399	267	$10,027	9	$257	285	$10,684
Total	11	$456	329	$11,895	10	$276	349	$12,627

Table VII-1(a)
Mine Operators - Annual Burden Hours

	< 20		20 to 500		> 500		Total	
Provision	Hrs.	Costs	Hrs.	Costs	Hrs.	Costs	Hrs.	Costs
72.510	5	$167	563	$17,971	28	$922	597	$19,061
75.1915/72.503	0	$0	4	$76	0.3	$5	4	$82
72.520	0.3	$8	43	$1,177	3.5	$94	47	$1,279
Total	5	$176	610	$19,225	32	$1,021	648	$20,422

Table VII-2
Manufacturers' - Annual Burden Hours

Detail	Hrs.	Costs
Amend Applications	700	$35,000

Paperwork Burden for Mine Operators

Section 72.503 Determination of Emissions; Filter Maintenance

Section 72.503(d) requires that aftertreatment devices installed on diesel powered equipment be maintained according to manufacturer specifications. Since such devices are not usually on diesel machinery, maintenance personnel will need to be trained concerning the maintenance of such devices. Existing §75.1915 (training and qualifications of persons working on diesel powered equipment) requires training in the maintenance of diesel powered equipment.

The training will be contracted out, which will entail either a manufacturer's seminar (on the purchase of new equipment) or classroom training in a vocational or college setting. Since the training will be contracted out there is no related burden hours to mine operators. Therefore, the cost of training does not appear in this chapter.

Three persons will receive training in the 3 small mines employing fewer than 20 workers; 208 persons will receive training in the 137 mines employing 20 to 500 workers; and 12 persons will receive training in the 1 mine that employs over 500 workers.

A supervisor will take 5 minutes (0.0833 hours) to instruct a clerical worker concerning the training. Table VII-3 shows burden hours and costs related to the supervisor's instructions.

A clerical worker will take 15 minutes (0.25 hours) in each mine to make arrangements concerning the required training. In addition, the clerical worker will take 1 minute (0.0167 hours) to record each trainee in a computer file. Table VII-4 shows burden hours and costs related to the preparation by the clerical worker.

Each trainee will take 20 seconds (0.0056) to sign a registration sheet, which will also act as a record that the miner has received the required training. Table VII-5 shows burden hours and costs related to trainee registration.

Table VII-3: Existing 75.1915 and Sections 72.503(d)
Maintenance Training - Supervisor Instruction to Clerical Worker
First Year Burden Hours and Costs

Mine Size	No. of Mines	Time to Instruct (hrs.)	First Year Burden Hours	Superv. Wage (per hr.)	First Year Burden Costs	Annualized Burden Costs
<20	3	0.0833	0.3	$49.79	$12	$1
≥ 20 & ≤500	137	0.0833	11	$49.79	$568	$40
>500	1	0.0833	0.1	$49.79	$4	$0
Total	141		12		$585	$41

Table VII-4: Existing 75.1915 and Sections 72.503(d)
Maintenance Training - Clerical Worker Preparation
First Year Burden Hours and Costs

Mine Size	No. of Mines	Time to Prepare (hrs.)	Time Spent on Each Miner (hrs.)	No. of Miners to Train	First Year Burden Hours[a]	Clercial Wage (per hr.)	First Year Burden Costs	Annualized Burden Costs
<20	3	0.25	0.0167	3	1	$18.56	$15	$1
≥ 20 & ≤500	137	0.25	0.0167	208	38	$18.56	$700	$49
>500	1	0.25	0.0167	12	0.45	$18.56	$8	$1
Total	141			223	39		$723	$51

[a] First Year Burden Hours = (No. of Mines x Time to Prepare)+(Time Spent on Each Miner x No. of Miners to Train).

Table VII-5: Existing 75.1915 and Sections 72.503(d)
Maintenance Training - Miner Registration and Record
First Year Burden Hours and Costs

Mine Size	No. of Miners to Train	Time to Register per Miner (hrs.)	First Year Burden Hours	Miner Wage (per hr.)	First Year Burden Costs	Annualized Burden Costs
<20	3	0.0056	0.02	$26.83	$0.45	$0.03
≥ 20 & ≤500	208	0.0056	1	$26.83	$31	$2.17
>500	12	0.0056	0.07	$26.83	$2	$0.13
Total	223		1		$33	$2

After the first year, for mines employing 20 or more workers, MSHA estimates a turnover rate of 7 percent for mechanics who work on diesel powered equipment. Therefore, annually, of the 223 mechanics being trained in the first year, 16 new mechanics would each need to be trained. MSHA assumes that each new mechanic trained would be in a different mine. Table VII-4a shows annual burden hours and costs related to the preparation by the clerical worker. Table VII-5a shows annual burden hours and costs related to trainee registration.

Table VII-4a: Existing 75.1915 and Sections 72.503(d)
Annual Maintenance Training - Clerical Worker Preparation
First Year Burden Hours and Costs

Mine Size	No. of Mines	Time to Prepare (hrs.)	Time Spent on Each Miner (hrs.)	No. of Miners to Train	Annual Year Burden Hours[a]	Clercial Wage (per hr.)	Annual Year Burden Costs
≥ 20 & ≤500	15	0.25	0.0167	15	4	$18.56	$74
>500	1	0.25	0.0167	1	0.27	$18.56	$5
Total	16			16	4		$79

[a] First Year Burden Hours = (No. of Mines x Time to Prepare)+(Time Spent on Each Miner x No. of Miners to Train).

Table VII-5a: Existing 75.1915 and Sections 72.503(d)
Annual Maintenance Training - Miner Registration and Record
First Year Burden Hours and Costs

Mine Size	No. of Miners to Train	Time to Register per Miner (hrs.)	Annual Year Burden Hours	Miner Wage (per hr.)	Annual Year Burden Costs
≥ 20 & ≤500	15	0.0056	0.08	$26.83	$2
>500	1	0.0056	0.01	$26.83	$0.15
Total	16		0.09		$2

Section 72.510 Miner Health Training

This section requires that all miners who can reasonably be expected to be exposed to diesel emissions on mine property be trained annually in accordance with §72.510(a). A mine supervisor will perform the training. The length of the training session will vary depending on the type of diesel equipment in the mine. Mines with diesel equipment subject to §72.500 or §72.501 will hold 30 minute (0.5 hours) training sessions. Mines with diesel equipment subject to §72.502 will hold 15 minute (0.25 hours) training sessions.

With respect to the 30 minute sessions, 2 sessions would be needed in the mines employing fewer than 20 workers, 383 sessions would be needed in mines employing between 20 to 500 workers, and 23 sessions would be needed in mines employing more than 500 workers. With respect to the 15 minute sessions, 5 sessions would be needed in the mines employing fewer than 20 workers, 115 sessions would be needed in mines employing between 20 to 500 workers, and no sessions are needed in mines employing more than 500 workers. Table VII-6 shows burden hours and costs related to supervisor providing training.

A supervisor will take 5 minutes (0.0833 hours) to instruct a clerical worker concerning the training. Table VII-7 shows burden hours and costs related to the supervisor's instructions.

A clerical worker will take 15 minutes (0.25 hours) in each mine (includes listening to supervisor's instructions) to make arrangements concerning the required training. In addition, the clerical worker will take 1 minute (0.0167 hours) to record each trainee in a computer file. Table VII-8 shows burden hours and costs related to the preparation by the clerical worker. Each trainee will take 20 seconds (0.0056) to sign a registration sheet, which will also act as a record that the miner has received the required training. Table VII-9 shows burden hours and costs related to trainee registration.

Table VII-6: Section 72.510
Miner Health Training - Supervisor Providing Training
Annual Burden Hours and Costs

Mine Size	No. of 30 Minute Sessions	Time for Each 30 Minute Session (hrs.)	No. of 15 Minute Sessions	Time for Each 30 Minute Session (hrs.)	Annual Burden Hours	Superv. Wage (per hr.)	Annual Burden Costs
<20	2	0.5	5	0.25	2	$49.79	$112
≥ 20 & ≤500	383	0.5	115	0.25	220	$49.79	$10,966
>500	23	0.5	0	0	12	$49.79	$573
Total	408		120		234		$11,651

Table VII-7: Section 72.510
Miner Health Training - Supervisor Instruction to Clerical Worker
First Year Burden Hours and Costs

Mine Size	No. of Mines	Time to Instruct (hrs.)	First Year Burden Hours	Superv. Wage (per hr.)	First Year Burden Costs	Annualized Burden Costs
<20	7	0.0833	0.6	$49.79	$29	$2
≥ 20 & ≤500	137	0.0833	11	$49.79	$568	$40
>500	1	0.0833	0.1	$49.79	$4	$0
Total	145		12		$602	$42

Table VII-8: Section 72.510
Miner Health Training - Clerical Worker Preparation
Annual Burden Hours and Costs

Mine Size	No. of Mines	Time to Prepare (hrs.)	Time Spent on Each Miner (hrs.)	No. of Miners to Train	Annual Burden Hours[a]	Clercial Wage (per hr.)	Annual Burden Costs
<20	7	0.25	0.0167	50	3	$18.56	$48
≥ 20 & ≤500	137	0.25	0.0167	13,895	266	$18.56	$4,934
>500	1	0.25	0.0167	752	12.78	$18.56	$237
Total	145			14,697	281		$5,219

[a] First Year Burden Hours = (No. of Mines x Time to Prepare)+(Time Spent on Each Miner x No. of Miners to Train).

Table VII-9: Section 72.510
Miner Health Training - Miner Registration and Record
Annual Burden Hours and Costs

Mine Size	No. of Miners to Train	Time to Register per Miner (hrs.)	First Year Burden Hours	Miner Wage (per hr.)	Annual Burden Costs
<20	50	0.0056	0.28	$26.83	$7
≥ 20 & ≤500	13,895	0.0056	77	$26.83	$2,071
>500	752	0.0056	4.2	$26.83	$112
Total	14,697		82		$2,191

Section 72.520 Diesel Equipment Inventory
First Year Burden

Section 72.520 requires underground coal mine operators to maintain a list of diesel powered equipment units, together with information about any unit's emission control or filtration system.

Mine operators can obtain general information on approved engines from manufacturers or MSHA (via MSHA's website). Initially, this task will take a mine supervisor about 1 hour per mine. Table VII-10 shows burden hours and costs related to information collection by the supervisor.

Table VII-10: Section 72.520
Diesel Inventory List - Data Collection by Supervisor
First Year Burden Hours and Costs

Mine Size	No. of Mines	Time for Superv. to Collect Data (hr.)	First Year Burden Hours	Superv. Wage (per hr.)	First Year Burden Costs	Annualized Burden Costs
<20	7	1	7	$49.79	$349	$24
≥ 20 & ≤500	137	1	137	$49.79	$6,821	$477
>500	1	1	1	$49.79	$50	$3
Total	145		145		$7,220	$505

In addition, mine operators can obtain machine-specific information (e.g. serial numbers) from maintenance files or similar records. Collection and recording of this information will take a miner an average of 2 minutes (0.0333 hours) per machine. Table VII-11 shows burden hours and costs related to information collection and recording by the miner.

Table VII-11: Section 72.500
Diesel Inventory List
Data Collection and Recording by Miner
First Year Burden Hours and Costs

Mine Size	No. of Diesel Machines	Time for Miner to Collect Data (per machine)	First Year Burden Hours	Miner Wage (per hr.)	First Year Burden Costs	Annualized Burden Costs
<20	20	0.0333	1	\$26.83	\$18	\$1
≥ 20 & ≤500	2,874	0.0333	96	\$26.83	\$2,570	\$180
>500	227	0.0333	8	\$26.83	\$203	\$14
Total	3,121		104		\$2,791	\$195

Section 72.520 Diesel Equipment Inventory - Continued
First Year Burden

The operator must send a copy of the diesel inventory list to the appropriate MSHA District Manager and provide a copy to the miner representative. It will take a secretary 15 minutes (0.25 hours) to copy the list, send the list to the District Manager, and provide a copy to the miner representative.

Table VII-12 shows burden hours and costs associated with the tasks performed by the clerical worker.

Table VII-12: Section 72.520
Diesel Inventory List - Clerical Worker Duties
First Year Burden Hours and Costs

Mine Size	No. of Mines	Clerical Time[a] (hrs.)	First Year Burden Hours	Clerical Wage (hr.)	First Year Burden Costs	Annualized Burden Costs
≤20	7	0.25	2	$18.56	$32	$2
≥ 20 & <500	137	0.25	34	$18.56	$636	$44
≥500	1	0.25	0.3	$18.56	$5	$0
Total	145		36		$673	$47

[a] relates to time for clerical person to make copies, mail copy to MSHA, and provide copy to miner representative.

Section 72.520 Diesel Equipment Inventory
Annual Burden

Section 72.520 requires underground coal mine operators to maintain a list of diesel powered equipment units, together with information about any unit's emission control or filtration system. This List must be updated annually.

Mine operators can obtain general information on approved engines from manufacturers or MSHA (via MSHA's website). Annually, this task will take a mine supervisor about 2 minutes to perform for each change that is required. Each year, it is estimated that there will be: 2 diesel machine changes in the 7 mines that employ fewer than 20 workers (or 0.2857 machines per mine); 287 diesel machine changes in 137 mines that employ 20 to 500 workers (or 2.0948 machines per mine); and 23 diesel machine changes in 1 mine that employs more than 500 workers. Table VII-13 shows burden hours and costs related to information collection by the supervisor.

Table VII-13: Section 72.520
Diesel Inventory List - Data Collection by Supervisor
Annual Burden Hours and Costs

Mine Size	No. of Mines	Annual No. of Machine Changes per mine	Time for Superv. to Collect Data (hr.)	Annual Burden Hours	Superv. Wage (per hr.)	Annual Burden Costs
<20	7	0.2857	0.0333	0.1	$49.79	$3
≥ 20 & ≤500	137	2.0949	0.0333	9.6	$49.79	$476
>500	1	23	0.0333	0.8	$49.79	$38
Total	145			10		$518

Section 72.520 Diesel Equipment Inventory - Continued
Annual Burden

In addition, mine operators can obtain machine-specific information (e.g. serial numbers) from maintenance files or similar records. Collection and recording of this information will take a miner an average of 2 minutes (0.0333 hours) per machine. Annually, the number of diesel machine changes will be: 2 in mines employing fewer than 20 workers; 287 in mines employing 20 to 500 workers; and 23 in mines employing more than 500 workers. Table VII-14 shows burden hours and costs related to information collection and recording by the miner.

Table VII-14: Section 72.500
Diesel Inventory List
Data Collection and Recording by Miner
Annual Burden Hours and Costs

Mine Size	No. of Diesel Machine Changes per year	Time for Miner to Collect Data (per machine)	First Year Burden Hours	Miner Wage (per hr.)	Annual Burden Costs
<20	2	0.0333	0.1	$26.83	$2
≥ 20 & ≤500	287	0.0333	10	$26.83	$257
>500	23	0.0333	1	$26.83	$21
Total	312		10		$279

Section 72.520 Diesel Equipment Inventory - Continued
Annual Burden

The operator must send a copy of the diesel inventory list to the appropriate MSHA District Manager and provide a copy to the miner representative. This list that must be sent must be updated annually.

For each change a clerical worker must copy the list, send the list to the District Manager, and provide a copy to the miner representative. It will take a secretary 5 minutes (0.0833 hours) to perform these functions. Table VII-15 shows burden hours and costs associated with the tasks performed by the clerical worker.

Table VII-15: Section 72.520
Diesel Inventory List - Clerical Worker Duties
Annual Burden Hours and Costs

Mine Size	No. of Diesel Machine Changes per year	Clerical Time[a] (hrs.)	First Year Burden Hours	Clerical Wage (hr.)	Annual Burden Costs
<20	2	0.0833	0.2	$18.56	$3
≥ 20 & ≤500	287	0.0833	24	$18.56	$444
>500	23	0.0833	1.9	$18.56	$36
Total	312		26		$483

[a] relates to time for clerical person to make copies, mail copy to MSHA and provide copy to miner representative.

As a result of §72.500, which requires all permissible equipment to have filtration devices, manufacturers will need to amend some existing permissible machine approvals. In most cases, the application and evaluation will be a simple process. However, some power packages will require more effort and some redesign and retesting.

The number of approvals affected will be 31, of which 27 will be easy evaluations and 4 will be harder evaluations. MSHA estimates that will take 20 hours to prepare an easy evaluation and 40 hours for a harder evaluation. Manufacturers' costs to amend an existing application are estimated at $50 per hour.

Table VII-16 shows burden hours and costs related to manufacturers' amending existing applications.

Table VII-16
Manufacturers Costs to Amend Existing Applications
First Year Burden Hours and Costs

Machine Approvals	No. of Existing Machine Approvals to Amend	Time to Amend (in hrs.)	First Year Burden Hours	Cost to Amend (per hr.)	First Year Burden Costs	Annualized Burden Costs
Easy Install	27	20	540	$50	$27,000	$3,834
Difficult Install	4	40	160	$50	$8,000	$1,136
Total	31		700		$35,000	$4,970

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