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Second Review of New Source Performance Standards for Coal Preparation Plants

Emission Standards Division

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1. SUMMARY

The objective of this report is to review and determine the need for revision of the NSPS for coal preparation plants. The review includes new developments in emission control technology, coal preparation process technology, projected growth, and other considerations affecting air emissions in the industry.

The new source performance standards (NSPS) for the coal preparation industry were promulgated by the Environmental Protection Agency (EPA) on January 15, 1976. These standards affect thermal dryers, pneumatic coal cleaning equipment, coal processing and conveying equipment, coal storage systems, and coal transfer and loading facilities. Affected facilities are those facilities which commenced construction or modification after October 24, 1974.

The NSPS were reviewed for the first time in 1981. That review concluded that, since best demonstrated control technology had not changed since the regulations were originally promulgated, the standards should remain unchanged. This is the second review of the NSPS. It covers the period from 1980 through 1986.

1.1 BEST DEMONSTRATED CONTROL TECHNOLOGY

The current NSPS specifies emission limits for thermal dryers and pneumatic coal cleaning equipment based on particulate concentration loadings. Emissions from thermal dryers are not to contain particulate matter in excess of 0.31 grains per dry standard cubic foot and shall not exhibit

20 percent or greater opacity. Emissions from pneumatic coal cleaning equipment are not to contain particulate matter in excess of 0.018 grains per dry standard cubic foot and shall not exhibit 10 percent or greater opacity.

No changes have occurred in control technology for thermal dryers and pneumatic cleaning equipment since promulgation of the standards of performance. The best demonstrated technology (BDT) for thermal dryers consists of primary control using centrifugal collectors. Secondary control is accomplished by the use of high-efficiency venturi scrubbers. BDT for pneumatic coal cleaning equipment consists of primary control using centrifugal collectors and secondary control using fabric filtration.

The current NSPS regulates fugitive emissions from coal processing and conveying equipment, coal storage systems, and coal transfer and loading systems. Emissions from these sources shall not exhibit 20 percent or greater opacity. This has historically been accomplished through the use of wet suppression and enclosure of sources of potential fugitive particulate emissions. During this review, however, several coal preparation plants were found to be controlling sources of fugitive emissions by enclosing the source and ducting the emissions to a control device.

1.2 INDUSTRIAL TRENDS

The production of coal in the United States has been growing at an average annual rate of about 3 percent since promulgation of the NSPS. The economics of coal preparation technology is resulting in declining use of thermal drying in favor of mechanical dewatering for Eastern coals. However, the practice of thermally drying coal at preparation plants has been declining. Western coals are not dried either thermally or mechanically.

In 1974, a growth rate of nine thermal dryers per year was estimated. Actual construction of thermal dryers averaged three per year during the period covered by the previous review (1974-1979), and has averaged only two per year during the period covered by the current review (1980-1986). The use of thermal drying of coal is expected to continue to decline. The use of pneumatic coal cleaning equipment has also been declining and no new pneumatic coal cleaning facilities are projected.

1.3 FINDINGS OF THIS REVIEW

1.3.1 Coal Dryers and Pneumatic Cleaning Facilities

There has been general compliance with the current NSPS for thermal dryers and pneumatic coal cleaning equipment with achievability of existing standards adequately demonstrated.

1.3.2 Coal Transfer, Handling, and Storage Systems

Technology being applied to the control of emissions from coal transfer, handling, and storage systems appears to be changing. These sources have historically been controlled by wet suppression or enclosure to prevent excessive fugitive emissions. More recently, however, several well-controlled coal preparation plants have enclosed sources of fugitive emissions and ducted the emissions to a control device. Where this technology is employed, the opacity of emissions from the source and the control device is generally substantially less than the 20 percent required by the NSPS.

1.3.3 Monitoring and Recordkeeping

The NSPS currently requires the owners or operators of coal preparation plants to continuously monitor the pressure of the water supply to the venturi scrubber which controls emissions from thermal coal dryers. This requirement appears to be unnecessary. This review found that venturi scrubber performance can be adequately determined by monitoring the pressure drop across the scrubber, which is also a requirement of the NSPS.

This review also found that there is no current reporting requirement for excess emissions. Further, it was found that the pressure drop across the venturi scrubber is a good indicator of scrubber performance and that this parameter could be used as an indicator of excess emissions.

2. INTRODUCTION

On October 24, 1975 (39 FR 37922), under Section 111 of the Clean Air Act, the Environmental Protection Agency (EPA) proposed standards of performance for new and modified coal preparation plants. In accordance with Section 111 of the Act, as amended, these regulations were promulgated on January 15, 1976, prescribing standards of performance for coal preparation plants.[1] The regulations applied to thermal dryers, pneumatic coal cleaners, coal processing and conveying equipment, coal storage systems, and coal transfer and loading systems, the construction or modification of which commenced after October 24, 1974.

The Clean Air Act Amendments of 1977 require the Administrator of the EPA to review and, if appropriate, revise established standards of performance for new stationary sources at least every 4 years.[2] The standard was previously reviewed in 1980. That review concluded that the regulations should remain unchanged.[3] The purpose of this report is to again review and assess the need for revision of the existing standards for coal preparation plants based on developments that have occurred between 1980 and 1986, or are expected to occur within the coal preparation industry. The information presented in this report was obtained from reference literature, discussions with industry representatives, trade associations, control equipment vendors, EPA Regional Offices, and State agencies.

2.1 BACKGROUND INFORMATION

Coal preparation is a series of processes which has the overall objective of improving the characteristics of mined coal by removing certain contaminants and changing its physical properties to meet market demands of industry. The degree of preparation varies widely, and the processes range from simple mechanical removal of rock and dirt to complex coal beneficiation plants which remove chemical contaminants (e.g., sulfur) which may produce pollution problems (e.g., SO_2) at some point of end use. The type of cleaning process and the extent of cleaning depends on the type of coal, the method of mining, contaminants, and the end use of the coal. Some characteristics of coal which may be altered by coal preparation include the following:

- Size
- Mineral content
- Sulfur content
- Foreign materials
- Surface moisture

The relative amount of contaminants, the manner in which they are part of the coal structure, and the degree to which they can be reduced, vary widely with different coals.

Almost all of the coal mined in the United States is subject to some type of preparation process. Presently, all domestic commercial coal preparation plants handling bituminous coal use physical coal cleaning techniques which are primarily designed to remove mineral matter. Mineral matter forms ash when coal is burned. These physical coal cleaning techniques also increase the energy content of the coal by reducing moisture and other non-combustibles. Run-of-the-mine (ROM) coal is physically cleaned by crushing in several stages to the point at which a portion of the mineral impurities are separated from the coal structure. The mineral and coal fragments are then separated by dry and/or wet techniques which utilize the differences in the specific gravity or surface properties of the particles. Western coal, mainly subbituminous and lignite coals, are strip mined and are not treated by wet techniques. Strip mines commonly contain thick deposits of coal covered by foreign material called overburden (rock and soil), which is removed almost completely. The coal then removed and reduced in size and classified as needed. Though almost all mined coal is crushed and sized in a coal preparation process, only about 35 percent of coal mined in the United States undergoes physical cleaning.[4]

The existence of State and Federal sulfur dioxide (SO_2) emission regulations has created interest in the sulfur reduction potential of the coal preparation process. Sulfur found in coal is normally chemically combined with iron as FeS_2 (pyritic sulfur) which is impregnated in the coal, or as an organic compound which is chemically bound to the coal (organic sulfur). The organic sulfur is part of the coal itself and cannot be removed unless the chemical bonds are broken. The amount of organic sulfur present, therefore, defines the theoretical lowest limit to which the sulfur can be removed by physical methods. In American coals, the organic sulfur ranges from about 20 to 80 percent of the total sulfur, and has a mean value of about 50 percent of the total sulfur.[5]

Several attempts have been made to liberate the pyritic sulfur by the effect of crushing, i.e., reduction in size and subsequent treatment based on the density of the components. One system, known as the Multi-Stream Coal Cleaning System (MCCS), selectively removes the pyritic sulfur from the coal stream, dramatically reducing the sulfur content of the coal. It is designed to provide low-sulfur (2.24 percent sulfur) coal to fuel two existing 600 megawatt steam generation units at the adjacent power plant as well as ultra-low-sulfur (0.88 percent sulfur) coal for a 650 megawatt unit. The selected design utilizes a broad spectrum of conventionally applied coal cleaning equipment, working to its best advantage on a preprocessed feedstock. The MCCS has been operating successfully since 1984.[6]

Chemical coal cleaning processes are also being developed to provide improved techniques for desulfurizing coal employed for steam generation and metallurgical purposes. These processes are intended to remove the organic sulfur. Chemical coal cleaning processes vary substantially due to the different chemical reactions which can be used to remove the sulfur and other contaminants from the coal. Chemical coal processes usually entail grinding the coal into small particles followed by treatment using acid, alkaline, and oxidation reaction methods. The report on the previous (1980) 4-year review estimated that several chemical processes could be ready for commercial demonstration in 5 to 10 years.[7] That estimate proved to be optimistic, and commercial demonstration of chemical coal cleaning still appears to be 5 to 10 years away.[8]

The specific intent of chemical coal cleaning is to produce desulfurized coals for use in complying with SO_2 emission standards. If inexpensive processes can be developed that reduce sulfur content as well as achieve high Btu yields, the vast eastern and midwestern coal reserves would hold greater potential use to industry because compliance with regulations which govern SO_2 emissions could be more readily and economically achieved. Because chemical cleaning is still in the development stage, it is uncertain which processes will prove commercially viable. This report deals exclusively with the available technology of physical coal preparation.

2.2 THE PREPARATION PROCESS[9]

The physical preparation of coal may be categorized into five general processes:

1. Plant feed preparation.
2. Raw coal size reduction and screening.
3. Raw coal cleaning (removal of impurities, including ash and pyrite).
4. Product dewatering and/or drying.
5. Product storage and shipping.

2.2.1 Plant Feed Preparation

The first step in the coal preparation process is the delivery of run-of-the-mine (ROM) coal to the plant site. Coal is transported by railroad cars, trucks, or conveyors from both surface and underground mines. When ROM coal is delivered to the preparation site, it is dumped into a surge bin or surge feeder. The coal is then processed by a ROM scalper to remove large pieces of coal and rock. The ROM scalper is usually a heavy-duty, mechanically vibrated, single deck, inclined screen.

The second step is size reduction, which is done in coal breakers or crushers. There are two fundamental objectives for the reduction of the size of coal: to reduce it to sizes suitable for cleaning or further reduction, and to meet market specifications for certain sizes. Since production of fines is considered undesirable, breakers and crushers are designed to produce minimal amounts of undersize material. ROM coal is broken into increasingly smaller sizes by staged reduction. The first stage, primary breaking, reduces the raw coal to 4 to 8 inches. For metallurgical coal the various sizes are then screened and sent to washing units or to secondary crushers which reduce the product to a top size of 1.75 inches. Subbituminous and lignite coals are not treated in washing units. The final step in the plant feed preparation process is storage of the raw coal.

The storage of raw coal has become an increasingly important operation in new, large coal preparation facilities because it:

- limits interruptions of feedstock to the preparation plant,
- improves efficiency by allowing a controlled feed rate, and
- facilitates in blending various ROM coals to produce the desired properties of the feedstock.

Raw coal can be stored either in open areas, closed bins, or partially or entirely closed slot storage facilities known as barns. Though open outside storage is usually chosen, there are drawbacks to this method. Outside coal storage is a potential environmental problem due to wind and rainfall erosion. Winds remove particulate matter from the storage pile, and rainfall can also leach pollutants from this pile which end up in "run-off" water. The storage of coal in closed bins or slot storage facilities, however, minimizes the potential for airborne pollutants and run-off. Various types of bunkers, silos, and bins are available. Storage bins are usually cylindrical in shape and constructed of steel or concrete.

2.2.2 Raw Coal Size Reduction and Screening

Raw coal sizing generally consists of two stages, primary and secondary, that result in the separation of the coal into three sizes: coarse, intermediate, and fine. Primary sizing is typically accomplished by screens that separate coal into coarse and intermediate fractions. The coarse fraction is reduced in size as necessary and returned to the primary sizing stage. The second sizing stage is generally accomplished by wet (in the case of bituminous coal) or dry vibrating screen. This stage separates the fines from the intermediate fraction and directs the resultant product to the raw coal cleaning operation.

The sizing and screening of coal and its transfer from one operation to the next are sources of fugitive particulate emissions.

2.2.3 Raw Coal Cleaning

The raw coal cleaning operation determines product quality. Although many different coal cleaning techniques exist, most processes are based upon gravity separation methods. The decision concerning which separation process should be used is generally based on the size grouping (fine, intermediate, coarse) of the raw coal. Table 2-1 summarizes the types of equipment used for raw coal cleaning.

TABLE 2-1. SUMMARY OF PHYSICAL COAL CLEANING UNIT OPERATIONS

Unit Operation	Description	Remarks
Hydrocyclones	The separating mechanism is described as taking place in the ascending vortex. The high and low specific gravity particles moving upward in this current are subjected to centrifugal forces effecting separation.	If maximum pyrite reduction and maximum clean coal yield are to be obtained, supplemental processes such as cyclone classifying, fine mesh screening and froth flotation are necessary (on stream process). Hydrocyclones are presently used in the United States to clean flotation-sized coal, but can be used for coarse coal.
Humphrey spiral	Coal-water slurry is fed into a spiral conduit. As it flows downward, stratification of the solids occurs with the heavier particles concentrated in a band along the spiral. An adjustable splitter separates the stream into two products - a clean coal and the middlings.	Has shown significant ash and sulfur reduction on Middle Kittanning coal.
Launder-type coal	Raw coal is fed into the high end of a trough with a stream of water. As the stream of coal and water flows down the incline, particles having the highest settling rate settle into the lower strata of the stream. These are the middling or refuse particles. The clean coal particles gravitate into the upper strata before separation.	Three types of launders are recognized based upon mode of transport. Sizes: 4 mesh to 3 inches.

TABLE 2-1. SUMMARY OF PHYSICAL COAL CLEANING UNIT OPERATIONS (Cont.)

Unit Operation	Description	Remarks
Pneumatic	Coal and refuse particles are stratified by means of pulsating air. The layer of refuse formed travels forward into pickets or wells from which it is withdrawn. The upper layer of coal travels over the refuse and is removed at the opposite end.	Most acceptable preparation method from the standpoint of delivered heating value cost. Sizes: up to 0.25 inches.
Froth flotation	A coal slurry is mixed with a collector to make certain fractions of the mixture hydrophilic. A frother is added and finely disseminated air bubbles are passed through the mix. Air-adhering particles float to the top of the remaining slurry and then are removed as concentrate.	Froth flotation is used to reduce pyrite in English coals; the flotation of coal refuse to obtain salable pyrite is uneconomical in view of today's poor sulfur market; if ethylxanthate is used as the collector, it is absorbed onto coal pyrite in such a manner as to make it ineffective for flotation. Sizes: 14 to 325 mesh.

TABLE 2-1. SUMMARY OF PHYSICAL COAL CLEANING UNIT OPERATIONS (Cont.)

Unit Operation	Description	Remarks
Jigging	A pulsating fluid stratifies coal particles in increasing density from top to bottom. The cleaned coal is overflowed at the top.	Most popular and least expensive coal washer available, but may not produce the desired separation. Sizes: 6 mesh to 3 inches.
Tables	Pulverized coal and water are floated over a table vibrating in a reciprocating motion. The lighter coal particles are separated to the bottom of the table, while the heavier, larger, impure particles move to the sides.	Sizes: 100 mesh to 0.25 inches.
Dense media	Coal is slurried in a medium with a specific gravity close to that at which the separation is to be made. The lighter, purer coal floats to the top and is continuously skimmed off.	Advantages: Ability to make sharp separations at any specific gravity within the range normally required; ability to handle wide range of sizes; relatively low capital and operating costs when considered in terms of high capacity and small space requirements; ability to handle fluctuations in feed quantity and quality. Sizes: 28 mesh to 8 inches.

2.2.4 Product Dewatering and/or Drying

The wet types of coal cleaning operations require some type of product dewatering and/or drying stage. Removal of excess moisture from coal decreases shipping costs, increases the heating value of the coal, and prevents freezing problems in cold climates. Moisture reduction can be accomplished by either mechanical or thermal drying processes. Table 2-2 shows the product coal moisture ranges which can be achieved by various dewatering and drying methods.

The decision of which moisture reduction scheme to utilize is primarily dependent on coal particle size. Coarse particles greater than 0.25 inch offer comparatively small surface areas for moisture adhesion and can be dewatered by mechanical means to 5 percent moisture content or less. Fine coals, 0.5 inch x 28 mesh, have a considerably larger surface area in proportion to weight and require more sophisticated mechanical dewatering techniques to reduce moisture content to below 10 percent. Advanced dewatering techniques include processes such as high performance centrifuges and vacuum filters. Very fine coals, 0.25 inch x 28 mesh, represent the greatest problem, and often may only be adequately dried by the thermal (evaporative) means as a final step. The energy requirements of dewatering and drying are directly related to the size of the feed and the percent moisture reduction desired, and can be very high. Thermal drying is the major air pollutant emission source for thermally dried coal. The emissions consist of particulates, sulfur dioxide, and nitrogen oxides generated during the combustion of coal to provide the hot gases for drying of the coal, as well as entrained small coal particles.

TABLE 2-2. TYPICAL MOISTURE CONTENT OF PRODUCTS BY EQUIPMENT OR PROCESS

Type of Equipment/Process	Discharge of Product
Dewatering screens	8 to 20 percent moisture
Centrifuges	10 to 20 percent moisture
Filters	20 to 50 percent moisture
Hydraulic cyclones	40 to 60 percent solids
Static thickeners	30 to 40 percent solids
Thermal dryers	6 to 7.5 percent moisture
Oil agglomeration processes	8 to 12 percent moisture

2.2.5 Product Storage and Shipping

Coal preparation plants must be capable of providing specific quantities of cleaned coal at specified times. Sometimes it is not feasible to load clean coal at the rate of production of the coal preparation plant. As a result, clean coal storage has become an economic necessity. Several important reasons for storing clean coal are:

- to quickly and economically load unit trains, barges, and other intermittent bulk transport conveyances;
- to facilitate the attainment of maximum product uniformity; and
- to eliminate the dependency on preparation plant production.

Cleaned coal may be stored in open, uncontrolled storage piles or in enclosed silos or bins. In contrast to open storage facilities, enclosed storage facilities eliminate blowing dust and wind losses as well as protect the clean coal from the elements.

2.3 REFERENCES:

1. United States Environmental Protection Agency. Code of Federal Regulations. Title 40, Part 60. Washington, D.C. Office of the Federal Register. January 15, 1976.

2. United States Congress. Clean Air Act, as amended, August 1977. 42 U.S.C. 1857 et. seq. Washington, D.C. U.S. Government Printing Office. November 1977.

3. U.S. Environmental Protection Agency. A Review of Standards of Performance for New Stationary Sources - Coal Preparation Plants. EPA Publication No. EPA-450/3-80-022. December 1980. p. 6-5.

4. Electric Power Research Institute. Report Summary. Coal-Cleaning Plant Refuse Characterization. Report No. EPRI CS-4095s. June 1985.

5. Leonard, J. W., and Mitchell, D. R. Coal Preparation. New York, The American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. 1968, pp. 1-44 through 1-48.

6. Telecon. Beck, Lee, U.S. Environmental Protection Agency, with Harrison, Clark, Electric Power Research Institute, June 27, 1986. Multi-Stream Coal Cleaning System.

7. Reference 3, p. 2-3.

8. Telecon. Beck, Lee, U.S. Environmental Protection Agency, with Kilgroe, J.D., U.S. EPA, October 29, 1986. Coal Cleaning Research.

9. Reference 3, pp. 2-3 through 2-12.

3. CURRENT STANDARDS FOR COAL PREPARATION

3.1 AFFECTED FACILITIES

The existing standards of performance apply to coal preparation plants processing more than 200 tons of coal per day. The specific processes affected by the new source performance standard (NSPS) are thermal dryers, pneumatic coal cleaning equipment (air tables), coal processing and conveying equipment (including breakers and crushers), coal storage systems, and coal transfer and loading facilities. The standards governing thermal dryers and pneumatic coal cleaning equipment apply only to facilities processing bituminous coal. The regulation limiting emissions from coal processing and conveying equipment, coal storage systems and coal transfer and loading facilities, however, applies to the processing of all types of coal. Open coal storage piles are currently excluded from the definition of coal storage systems.[1,2]

3.2 CONTROLLED POLLUTANTS AND EMISSION LEVELS[3]

The coal preparation plant pollutant controlled by the NSPS is particulate matter. The standards are as follows:

- Thermal dryer. Exhaust gases discharged to the atmosphere shall not contain particulate matter in excess of 0.070 grams per dry standard cubic meter (g/dscm) or 0.031 grains per dry standard cubic foot (gr/dscf), and shall not exhibit 20 percent or greater opacity.

- Pneumatic coal cleaning equipment (air tables). The gases emitted to the atmosphere shall not contain particulate matter in excess of 0.040 grams per dry standard cubic meter (0.018 grains per dry standard cubic foot), and shall not exhibit 10 percent or greater opacity.
- Other facilities. Gases emitted into the atmosphere from any coal processing and conveying equipment, coal storage system, or coal transfer and loading facility shall not exhibit 20 percent or greater opacity.

3.3 STATE REGULATIONS

All of the States surveyed in this study enforce the NSPS for new coal preparation plants. However, most States do not have regulations specific to existing coal preparation plants. These facilities are usually regulated by general process weight regulations which base the allowable emissions on the process throughput, regardless of the material being processed.

3.3.1 Thermal Dryers

State standards governing existing preparation plants are generally less stringent than the Federal NSPS. The only possible exceptions are for plants with very large capacities. In Arizona, for instance, using the allowable emissions formula for existing plants inside the Phoenix/Tucson Region, a 500 tons per hour thermal dryer would have a maximum allowable particulate emission rate of 46.78 pounds per hour. Based on average emission factors for fluid bed dryers with high efficiency venturi-type wet scrubbers for secondary control, the corresponding particulate concentration would be 0.028 grains per dry standard cubic foot.[5] This is slightly less than the thermal dryer NSPS.

3.3.2 Fugitive Sources

As with the regulations for thermal dryers, all States enforce the NSPS for new plants, and most State regulations for existing plants are not as stringent as the NSPS. There are, however, some notable exceptions.

The State of Kentucky requires covering of trucks which transport material, including coal, which may become airborne. The State also requires that roadways inside the plant be paved and "no visible fugitive dust emissions beyond the lot line of the property."[6]

The State of West Virginia requires, in addition to the NSPS, that roads inside the plant and access roads owned by the plant be controlled for fugitive emissions by paving or other suitable measures.[7]

The State of North Dakota applies process-weight regulations to coal preparation plants. Facilities in that State process lignite coal which is not dried, so the regulations apply only to fugitive sources such as crushers and transfer, loading, and storage facilities. Because of the large amount of material handled by these systems, the process-weight regulations are relatively restrictive and the systems are frequently controlled by total enclosure and fabric filtration. The resulting control is far greater than the limitation of 20 percent opacity required by the NSPS.

Pennsylvania requires best available technology (BAT) for fugitive dust sources for any new coal preparation plants or additions to existing ones. Sources such as coal transfer to trucks and roadways associated with surface mines have been delegated to the Bureau of Mining Regulations.

The minimum BAT requirements for fugitive dust emissions from coal preparation plants are a function of plant rated annual coal throughput and proximity to private residences. The Pennsylvania fugitive BAT standards are depicted in Table 3-1.

Probably the most stringent State regulations for fugitive emissions from coal preparation plants are those adopted by the State of California, which are applied primarily to coal shipping terminals in that State. The California regulations require the following control techniques to be used:[9]

- Enclosing all conveyor transfer points and coal receiving hopper areas.
- Providing in-draft air to enclosures (approximately 150 fpm air velocity through opening) and exhausting to a fabric collector.
- Particulate grain loading from each fabric collector may not exceed 0.005 - 0.01 gr/scf.
- Installing water suppression systems and using chemical surfactants to minimize fugitive emissions from unenclosed sources.
- Reducing the falling distance of the coal during loading by using telescopic chutes.
- Enclosing the stacking area.
- Installing wind barriers to reduce dust entrainment caused by strong winds.

TABLE 3-1. STATE OF PENNSYLVANIA REGULATION FOR COAL PREPARATION PLANT FUGITIVE DUST SOURCES

Annual Coal Throughput (T/yr)	Proximity to Residences	Coal Storage	Conveyors	Crushers/ Screens	Loading/ Unloading	Roadways	Misc.
> 500,000	N/A	A+B+C+D	E	G+H+I	J+K	N+O+P	Q
≤ 500,000	≤ 1/4 mile	A+B+C+D	F	G+H+I	L	N+O+P	Q
≤ 500,000	> 1/4 mile	A+B+D	F	G+H	L	N+O+P	Q
≤ 200,000	N/A	D	-	G	L	M+P	Q

KEY TO TABLE 3-1.

Coal Storage
A. Radial or tube stacker with air canon or other device to prevent operational problems in the winter.
B. Use of existing and/or man-made wind barriers.
C. Use of permanent elevated surfactant treated water/oil sprays or water truck with pressurized spray gun for stockpile control.
D. Storage silos with bin vent collector (required for thermally dried coal).

Coal Conveyors
E. Fully enclosed.
F. Partially enclosed.

Crushers and Screens
G. Enclosure of rotary breakers and crushers.
H. Enclosure of screens and transfer points.
I. Use of winterized surfactant treated water/oil sprays at appropriate points.

Loading/Unloading of Coal
J. Underground reclaim tunnels under stockpiles.
K. Elevated rail/barge/truck loadout with telescopic chute.
L. Front end loaders.

Roadways
M. Plant roadways must be delineated by paving or by periodic chipping.
N. Plant entrance roadway must be paved for the first 500 feet and routinely swept; remainder must be delineated by paving or period chipping.
O. Road dust control by road sweeper (if paved) and use of water sprays, oils, or other surfactants including 250 feet of public highway on either side of plant access road.
P. Tarping of all trucks plus posted notice of tarping requirement.

Miscellaneous
Q. Upwind/downwind dustfall monitoring at the request of the State.

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4. STATUS OF CONTROL TECHNOLOGY

4.1 COAL PREPARATION INDUSTRY STATISTICS

4.1.1 Number of Plants and Geographical Distribution

According to data obtained from the Energy Information Adminstration and from States, at least 359 new coal preparation plants were put in operation between 1980 and 1985.[1,2,3,4,5] This does not take into account plants which may have become subject to the NSPS via the modification/reconstruction provisions.

Though the location of these new plants is widely distributed, two-thirds are located in Kentucky, West Virginia, and Pennsylvania. These States supply bituminous coal, which is used as metallurgical coal for coke making and for combustion in utility boilers. The Western States, such as Montana and Wyoming, are sources of subbituminous coal. Texas and North Dakota are sources of lignite coal.

The last review of the NSPS indicated that approximately 488 coal preparation plants were operating in the United States in 1979.[6] This number is believed to be erroneous. The reference for it (1979 Keystone Coal Industry Manual, page 1311) makes no such claim. According to the Energy Information Administration, there were 1017 coal preparation plants operating in the United States in 1980, and 1378 coal preparation plants operating in the United States in 1985.[7] A possible explanation for the mistaken number of coal preparation plants cited in the previous study is a listing of mechanical coal cleaning plants. The manual lists about 500 mechanical coal cleaning plants.[8]

4.1.2 Industrial Trends

During the last review of the NSPS, projections were made that 40 new or modified facilities would be in operation by 1985. As stated above, this estimate was exceeded by a wide margin. In the State of Kentucky alone, permits were issued for the construction of 208 new coal preparation plants.[9] The daily production capacity of each of these plants was in excess of 200 tons. The reason for this gross misprojection of new facilities is unknown. The estimate given in the previous study was based on a projected increase in annual production of domestic coal to about 1 billion tons by 1985. Actual production achieved in 1985 was about 900 million tons or 90 percent of that projected in the previous study. Possibly the earlier study assumed that increased production would be accomplished by fewer plants with very large production capacities. The study may also have neglected or underestimated the impact of plant closures on new plant construction.

The construction of new coal preparation plants is, of course, directly linked to increases in coal production. The Energy Information Administration projects annual coal productions to increase to 1.1 billion tons by 1990 and to 1.2 billion tons by 1995. For the 1985-1995 decade, this translates to an average annual growth rate of 3.1 percent.[10]

Annual coal production in 1985 exceeded 1980 annual production by 128 million tons. Coupling this increase in coal production with the number of coal preparation plants constructed during that time period

(359) produces a factor of 2.8 plants per million tons of increased annual production. Application of this factor to the increase in annual production projected by 1995 (300 million tpy greater than 1985 production),[11] a crude projection can be made of 84 new plants per year for that 10 year period. While this method does not take into account such unknown factors as the current relationship of actual production to production capacity, it does illustrate the potential for substantial growth in the number of new plants over the next decade.

While production and preparation of coal is expected to increase, the practice of thermal drying is declining. When the NSPS became effective in October 1974, EPA projected a growth rate of 9 thermal dryers per year. However, only 17 new dryers were built during the period covered by the previous NSPS review (1974-1980), which amounts to less than 3 new dryers per year. During the period covered by the current review (1980-1985), only 10 new dryers were found to have been constructed. This is only 2 per year. The State of Kentucky, which experienced the greatest amount of new plant construction during the period of 1980-1985 (208 construction permits awarded), reported that no thermal dryers were constructed in that State during the subject 5 year period.[12]

The principle reason behind the general reduction in thermal dryers is that the energy costs associated with thermal drying are substantial. Energy savings associated with the elimination of thermal dryers approach 1 percent of total coal production.[13] For example, for a facility processing 500 tons of coal per hour, the eqivalent of 5 tons of coal is necessary to operate the dryers.

Declining use of thermal drying has led to a greater dependence on mechanical dewatering. Over the past few years, several sophisticated mechanical drying processes have been introduced to the industry. The new processes are able to achieve greater reduction in surface moisture content than previously possible by mechanical methods. This provides a significant advantage because the energy benefits of removing excess moisture, in terms of avoiding transportation and evaporation penalties, are much greater than the energy requirements for mechanical dewatering. The trend towards improving this technology is expected to continue, with emphasis being placed on reducing the surface moisture of fine size coal particles.

Another significant processing trend has been in the area of chemical cleaning technology. As many processes are still in the pilot plant or development stage, performance and cost comparisons are relatively uncertain at this time. These procesess vary greatly in their approach because of the varied reactions which can be used to effectively remove sulfur and other reactive impurities in the coal. Most chemical processes under development remove over 90 percent of the pyrite sulfur. In addition, several of the processes reportedly remove up to 40 percent of the organic sulfur.[14] These new processes have been developed to maximize the reduction of sulfur (pyrite) in metallurgical coals and boiler fuels which must comply with sulfur dioxide (SO_2) emission regulations.

4.1.3 Preparation of Nonbituminous Coal

Coal drying, pneumatic cleaning (air tables) and beneficiation operations in the United States are applied almost exclusively to bituminous coals. However, the opacity provisions of the NSPS apply to the handling of all kinds of coal, regardless of type, as long as the amount of coal processed exceeds 200 tons per day.

Anthracite production in the United States was less than 6 million tons in 1985. This represents less than 1 percent of the total United States annual coal production. The preparation process for anthracite is comparable to that of bituminous coal preparation. The principle consumer of anthracite is the metallurgical industry.

The production of lignite and other subbituminous coals was 265 million tons in 1985,[15] and production and use of subbituminous coals is expected to increase. The Energy Information Administration projects that annual production of Western Coal (predominently subbituminous) will increase at an average rate of 1.6 percent greater than the growth rate projected for Eastern coal production over the next 10 years.[16]

The largest deposits of subbituminous coals are found in Montana, Wyoming, Colorado, New Mexico, and Arizona. As with lignite, most subbituminous coal seams are relatively free of impurities. Preparation generally consists of crushing to the extent necessary to facilitate transporation and handling. Because the moisture content is mostly inherent, subbituminous coals appear very dry and dusty during handling and transporation.[17] Because of the potential that exists for the utilization of subbituminous coal, fugitive emissions from the preparation of the coal may increase in significance.

4.2 EMISSIONS FROM COAL PREPARATION PLANTS

There are four principle sources of air pollution in the coal preparation process:

1. thermal drying;
2. pneumatic cleaning;
3. crushing and sizing; and
4. coal storage, transportation, and handling.

Air emissions from thermal dryers include particulates from the drying process as well as particulates from the coal-fired furnace that supplies the drying gases.

Uncontrolled particulate emissions from fluid bed thermal dryers have been estimated at 20 pounds per ton of coal dried.[18] Based on this factor, a 500 tons per hour furnace would have an controlled emission rate of 10,000 pounds per hour. For a 3,000 hour operating year, uncontrolled annual particulate emissions would be 15,000 tons per year.

Gaseous emissions from thermal dryers include carbon monoxide (CO), carbon dioxide (CO_2) hydrocarbons (HC), sulfur dioxide (SO_2), and nitrogen oxides (NO_x). All of these are furnace combustion products. Table 4-1 shows typical uncontrolled emission ranges of some of the gaseous emissions.[19]

TABLE 4-1. COMBUSTION PRODUCT EMISSIONS FROM THERMAL DRYERS

Pollutant	Emission rate lb/10^6 Btu	Concentration ppm
NO_x	0.39 to 0.68	40 to 70
CO	<0.30	<50
HC (as methane)	0.07 to 0.35	20 to 100

The emissions of SO_2 from thermal dryers are a function of the sulfur content of the coal burned in the combustion furnace. Figure 4-1 illustrates this relationship for bituminous coal rated at 12,500 Btu per pound.[20] Using this relationship, potential emissions of SO_2 may be calculated for thermal dryer furnaces. For example, a typical furnace using coal with 1 percent sulfur would be estimated to emit 1.6 pounds of SO_2 per million Btu. Based on this estimate, a 100 million Btu per hour furnace has the potential for emitting 160 pounds of SO_2 per hour. Annual emissions of SO_2 (based on a 3,000 hour operating year) would be 240 tons per year.

Actual SO_2 emission levels from thermal dryers may not be as high as those estimated using Figure 4-1. Source tests conducted by EPA have recorded emission rates from thermal dryers in the range of not detectable to 0.09 pound SO_2 per million Btu.[21] Based on the highest measurement, a 100 million Btu per hour furnace would have a maximum SO_2 emission rate

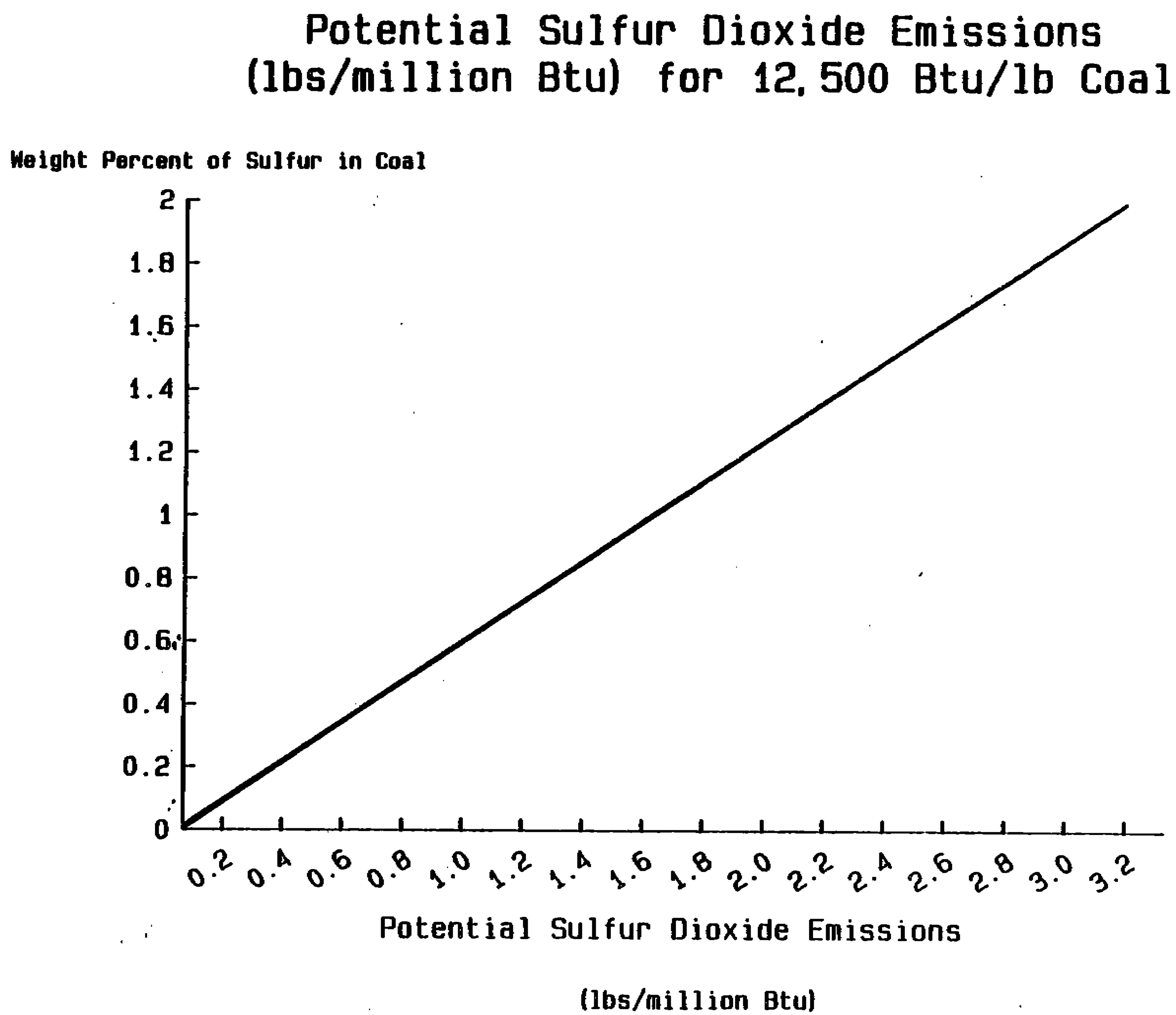

FIGURE 4-1. SO_2 Emissions Compared to Coal Sulfur

of 9 pounds per hour. Corresponding maximum annual emissions (based on a 3,000 hour operating year) would be 13.5 ton per year or less than 6 percent of the annual value calculated using Figure 4-1.

The reason for the disparity between measured and estimated SO_2 emission levels is unclear. It appears that SO_2 is somehow being removed from the thermal dryer off-gas, possibly as a result of secondary wet scrubbing. In the case of fluid bed thermal dryers, a percentage of SO_2 may be adsorbed by the coal due to the reaction of SO_2 with flue gas oxygen and water which forms sulfuric acid in the coal pores.[22] Incomplete combustion of coal in the dryer furnace may also account for the difference between measured and estimated SO_2 emission levels.

Of the coal cleaning (separation) processes, only pneumatic cleaning operations contribute to air pollution. Emissions from pneumatic cleaning consist of particulate matter only, because ambient air is used to separate coal from refuse. The quantity and pressure of the air used depends on the size of coal to be cleaned. For pneumatic cleaning of coal less than 0.375 inch, an average exhaust air volume is 14,200 cubic feet per ton of feed coal. The exhaust air usually entrains 70 percent of the less than 48 mesh material in the feed coal. Typically, the less than 48 mesh material accounts for about 20 percent of the total feed. Therefore, the uncontrolled exhaust air could contain 280 pounds of dust per ton of coal feed treated or 138 grains of dust per dry cubic foot. For a representative air table having a design capacity of 50 tons per hour, uncontrolled particulate emissions could be as high as 14,000 pounds per hour. Annual uncontrolled particulate emissions (based on a 3,000 hour operating year) would be 21,000 tons per year.

Crushing and sizing operations produce dry, small particles (0.5 to 6.0 microns) at ambient temperatures. The quantity of particulate matter generated depends on the coal type, moisture level, and type of sizing and screening operations.[23]

Particulate matter in the form of fugitive coal dust is emitted from storage, transporation, and handling operations. The amount of particulate matter generated varies widely, depending on such factors as climate, topography, and coal characteristics including moisture content. For example, the handling of thermally dried coal results in more particulate emissions than undried coal because the moisture content has been lowered. It has been estimated that 80 pounds of coal per ton are lost as fugitive particulate emissions during transporation and handling operations. A particulate emission factor from coal storage piles has been estimated at 0.0018 pounds per ton per year.[24]

4.2.1 NSPS Control Techniques

Several types of air pollution control devices can be applied to emissions from cleaning facilities. The choice of control device is dependent upon the pollutant, the properties of the pollutant, and the properties of the conveying medium. Particulate control devices are broadly classified as dry inertial collectors, filters, and wet scrubbers. Dry inertial collectors (cyclones) are characterized by moderate removal efficiencies, low energy requirements, low capital and operating costs, and an ability to accommodate high inlet particulate loadings. They can also operate at high temperatures. The major disadvantage of using cyclones for emissions control is their low collection efficiency for particles smaller than 10 microns. Consequently, they are generally considered part of the operating process rather than part of the emissions control system. Fabric filters are regarded as one of the simplest and most reliable high efficiency dry collection devices, capable of 99.9 percent removal of submicron size particles. Fabric filters are suitable for a wide variety of dry particulate removal applications. Limitations are excessive moisture, which tends to blind the fabric, and gas stream temperature, which must be relatively cool. The advantages of wet scrubbers are high removal efficiency, ability to remove gaseous pollutants, tolerance of moisture in the gas stream treated, and relatively low capital costs. The major disadvantage of wet scrubbers is their high energy requirements.

4.2.1.1 Thermal drying. Exhaust air from thermal dryers is characterized by high moisture content and low temperature (about 200°F). Particulate levels are characteristically high due to the entrainment of fine coal particles during the drying process.[25] Fabric filters are not generally applied on thermal dryers due to the high moisture content and low temperature of the exhaust air. High moisture content combined with too low an operating temperature results in the condensation of moisture that produces blinding of the fabric (i.e., particulate matter is retained within the fabric interstices or pores making resistance to gas flow prohibitively high).

The principle control device applied to thermal dryers is a wet scrubber. Venturi type wet scrubbers associated with thermal dryers normally operate at pressure differentials of 15 to 40 inches water gauge. The equipment requires 3 to 10 gallons of water per 1,000 cubic feet per minute of gas cleaned. Water entrained by exhaust gases from the scrubbers is removed using mist eliminators.

An average uncontrolled emission rate for fluid-bed dryers is 3.0 grains per dry standard cubic foot. Well-controlled thermal dryers with high efficiency venturi type wet scrubbers reduce particulate emissions to less than or equal to the standard of performance, which is 0.031 grains per dry standard cubic foot. This is equivalent to 99 percent control efficiency.

4.2.1.2 Pneumatic cleaning. Emissions from pneumatic coal cleaning equipment consist entirely of particulate matter. Typically, emission control is achieved by a fabric filter. In tests conducted by EPA, particulate emissions measured from representative pneumatic cleaning operations equipped with fabric filter control ranged from 0.004 to 0.011 grains per dry standard cubic foot. The existing standard of performance for pneumatic coal cleaning equipment is 0.018 grains per dry standard cubic foot.[26]

4.2.1.3 Storage, transporation and handling. Coal processing and conveying equipment, storage systems, and transfer and loading facilities are subject to the general opacity provisions of the NSPS. Fugitive emissions from these sources may not exhibit 20 percent or greater opacity. Historically, these sources have been controlled by applying wet suppression techniques and/or by completely enclosing the source. This is still generally true for most plants processing Eastern (bituminous) coal. However, some of the best controlled Eastern plants are now applying engineering controls consisting of local hooding and ventilation systems for emissions capture and control devices for collection. The EPA visited two such facilities. One plant has two very similar production lines for processing bituminous coal.[27] The major difference in the two lines, from an emissions control perspective, is that one uses low-energy scrubbers (Rotoclones) to control fugitive sources and the other line uses fabric filters to control fugitive sources. Sources which are hooded and ducted to the control devices include conveyor transfer points upstream and downstream of the dryer and the coal crusher. A fabric filter collects coal dust on one line upstream of the dryer, evidence to the fact that fabric filters can tolerate some ambient moisture without blinding. Emissions from the control devices have never been measured; however, no visible emissions were detected in the control device exhaust.[28]

The other Eastern plant visited by EPA controls two dry-coal conveyor transfer points by enclosure and venting to a fabric filter. The fabric filter, which has a gas handling capacity of 3,000 ACFM, has never been tested for emissions control performance.[29]

Some plants processing Western (lignite and subbituminous) coal are also beginning to use engineering controls on sources of fugitive emissions. Three such plants were visited by EPA as part of this review.

luding high operating costs and limited capacity.[34] No domestic, mercial, indirect thermal dryers were found presently in operation, is operating characteristics could not be quantified.

Operating wet scrubbers at higher pressure drops could provide a rther reduction in particulate emissions from thermal dryers. The ghest pressure drop recorded on a scrubber demonstrated to be achieving he NSPS for thermal dryers is 40 inches water gauge. Basing a revised tandard on the application of venturi scrubbers operated at substantially igher pressure drops could result in a lower emission limit for the tandard. However, the resulting increase in energy consumption and consequent impact on costs appear to be disproportionate to any benefits derived. Energy requirements for venturi scrubbers are exponentially related to the level of control achieved.

As mentioned in Section 4.2, gaseous emissions from thermal dryers include sulfur dioxide (SO_2). These emissions are not regulated by the NSPS. Removal of SO_2 can be accomplished by a process of wet absorption, such as with a lime/limestone based scrubbing system. Removal efficiencies range from 70 to 90 percent SO_2 in inlet gas.[35] Although these operations have achieved commercial status in flue gas desulfurization for utility and industrial boilers, installation and operating costs are high.[36]

Probably the most significant potential for additional control of particulate emissions from coal preparation plants is in the area of fugitive emissions from coal processing, conveying, transfer, loading, and storage facilities. The current NSPS requires control of emissions from these operations only to the extent that they do not exceed 20 percent opacity. As noted in Section 4.2.1.3, each of these sources is currently being controlled at one or more plants by ventilation followed by fabric filtration. Additional investigation is necessary to determine if more stringent fugitive emission controls should be applied across the industry.

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5. ENFORCEMENT AND COMPLIANCE

EPA Regional Offices, State agencies, and operating facilities were contacted to obtain comments on enforcement aspects of the NSPS and compliance testing results for new, modified, or reconstructed coal preparation plants. Test data for thermal dryers, air tables, dust suppression, wet dust collectors and fabric filters were also requested.

The information obtained supported information found in the literature concerning process trends. Many coal preparation plants handling bituminous coal are removing the surface moisture of the coal by means of centrifuging. This is one of the reasons for the small number of thermal dryers put in operation since the standards of performance were reviewed in 1980. No new air tables were installed during this period of time.

5.1 ENFORCEMENT APPLICABILITY

The NSPS for coal preparation plants clearly states that the regulation applies to any plant which processes more than 200 tons per day and includes any of the following operations: "Thermal dryers, pneumatic coal-cleaning and conveying equipment (including breakers and crushers), coal storage systems, and coal transfer and loading systems." The scope of applicability, therefore, includes many facilities at stationary sources not commonly referred to as "coal preparation plants." These include large power plants, coke oven batteries, and large loading facilities.

5.2 ANALYSIS OF NSPS TEST RESULTS

The results of compliance tests obtained from new, modified, or reconstructed coal preparation plants with thermal dryers are summarized in Table 5-1. All dryers were of the fluid bed design and emissions from all were controlled using venturi scrubbers.

From the test data it can be seen that all plants are in compliance with existing NSPS, with particulate emissions ranging from 0.005 to 0.024 grains per dry standard cubic foot. The pressure drops for the venturi scrubbers listed in Table 5-1 range from 32 to 40 inches H_2O. Generally, the units with the higher pressure drop produced lower particulate emissions.

5.3 MONITORING AND RECORDKEEPING

Review of the monitoring and recordkeeping provisions of the regulation indicate that only one of the requirements may be questionable. This is the requirement to continuously monitor the pressure of the water supply to the scrubber. An increase in the water supply pressure could indicate a beneficial situation (e.g., more water being supplied to the scrubber) or a condition which would have a detrimental effect on scrubber performance (e.g., plugged spray nozzles). Also, the effect of some sets of conditions may offset each other with a decrease in scrubber performance yet no net change in water supply pressure. An example of offsetting conditions would be a combination of broken spray nozzles and plugged spray nozzles.

TABLE 5-1. COAL PREPARATION COMPLIANCE TEST RESULTS FOR THERMAL DRYERS

Plant Name	Location	Date of Test	Particulate Emissions gr/dscf	Process Rate ton/hr	Venturi Pressure Drop in H_2O	Reference
Consol Pennsylvania Coal Company	Bailey preparation plant Enon, PA	11/85	0.024	688	32 to 35	1
Consolid. Coal Co.	Nailler Mine Mannington, WV	4/84	0.024	678	30 to 32	1
Consolid. Coal Co.	Blacksville No. 2 dryer Wana, WV	5/86	0.018	810	28 to 30	1
Consolid. Coal Co.	Amonate plant Amonate, WV	11/78	0.022	380	32	1
Consolid. Coal Co.	Buchanan preparation plant Oakwood, VA	11/85	0.014	413	34 to 37	1
Pittston	Moss III Met Dryer Dante, VA	7-8/81	0.007	400	35	2
Pittston	Moss III Midds Dryer	7-8/81	0.006	300	35	2
Pittston	McClure River	6/83	0.009	1275	39.5	3
Island Creek Coal Co.	VP5 Mine Oakwood, VA	5/85	0.014	425	35	4
Island Creek Coal Co.	VP6 Mine Oakwood, VA	11/82	0.024	425	35	5,6

After concluding that water supply pressure is not a good indicator of scrubber performance, we considered a revision to require the monitoring of water flow to the scrubber. Such a requirement would eliminate the concern about increased water supply pressure being the result of plugged nozzles, but again, offsetting conditions such as a combination of plugged and broken spray nozzles could result in no net change in water flow.

As a result of discussions with EPA's Air and Energy Engineering Research Laboratory (AEERL), this review determined that one good indicator of water flow through the scrubber is the pressure drop measured across the throat of the venturi.[7] Since the NSPS currently requires continuous monitoring of the pressure drop, this review concluded that the requirement for continuous monitoring of water supply pressure may be redundant.

This review also found that, unlike most other NSPS, the regulation for coal preparation plants has no provisions for the reporting of excess emissions. In searching for a meaningful indicator of excess emissions, it was found that the pressure drop across the throat of the venturi scrubber has a direct effect on scrubber performance. In fact, a decrease of only 10 percent in the pressure drop across the scrubber can result in a 75 percent increase in particulate emissions.[8] Since the NSPS requires continuous monitoring of the pressure drop across the scrubber, a requirement to report pressure drop decreases in excess of 10 percent of the pressure drop measured during the performance test would be a good indicator of possible excess emissions.

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6. COST ANALYSIS

6.1 INTRODUCTION

The estimated and reported costs of particulate emission control systems for new and modified coal preparation plants are presented in this chapter. Eastern preparation plants, for the most part, utilize thermal dryers and control them by venturi scrubbers. Venturi scrubbers are used because the residual moisture remaining after thermal drying is sufficient to cause fabric filters to blind, if the gas temperature should fall below the moisture dew point. Western plants, which primarily process subbituminous and lignite coals, generally from surface mines, rely on fabric filters. The capital costs estimated by EPA are based on standard references or on vendor quotes for major equipment, escalated to January 1986, via the Fabricated Equipment component of the Chemical Engineering magazine "CE plant cost index". The capital costs reported by industry were not listed by individual pieces of equipment, but were reported for entire control systems. To escalate the industry costs, the Mining and Milling industry segment of the Marshall and Swift ("M&S") equipment cost index for the first Quarter of 1986, also taken from Chemical Engineering, was used.

Investment and annualized costs of emission control for eastern plants are presented in Section 6.2. The costs for controlling western plants and fugitive sources are shown in Sections 6.3 and 6.4, respectively. Lastly, cost-effectiveness data for these control measures are presented in Section 6.5.

6.2 COSTS FOR CONTROLLING EASTERN PLANTS

6.2.1 Reported Costs

Four plants supplied cost information on their NSPS units.[1] All utilized venturi scrubbers following cyclones to control thermal dryers. In the case of coal preparation plants, the manufacturing process requires cyclones to maintain acceptable product yields. Thus, their costs should not be charged against particulate emissions control. A static pressure drop of approximately 5 inches of water is required to operate the cyclones.[2] The energy costs for operating the cyclones have been deducted from the industry-reported annualized costs, to keep from distorting the control costs per ton of coal processed and per ton of particulate captured (cost-effectiveness). One other adjustment was made to the reported costs. Because the industry figures did not allow for recovery of capital, a capital recovery factor of 11.75 percent of investment was added to their annual costs. This factor represents a 20-year equipment life at a 10 percent annual interest rate. (Note: this is a "real" interest rate that does not consider either income taxes or inflation.) Table 6-1 gives the industry-reported investment and annualized costs for the four eastern coal preparation plants.

6.2.2 Estimated Costs and Cost Comparison

The investment and annualized costs for three model plants were calculated by EPA for comparison with the industry data.[3] The industry information showed that the installation cost averaged 33 percent of the cost of the control devices and auxiliaries.[4] The EPA used the same factor. Table 6-2 presents the EPA costs. (The factors used to calculate the various annualized costs are listed after each item in the table.)

TABLE 6-1

CONTROL COSTS FOR EXISTING EASTERN

COAL PREPARATION PLANTS[a,b]

	Loveridge	Blacksville #2	Bailey	Buchanan
Air Volume, acfm	245,000	145,000	145,000	175,000
Investment, $				
Control Device	$189,400	$133,700	$109,000	$160,800
Auxiliaries	238,300	188,900	205,400	209,900
Instruments & Controls	13,400	9,000	9,500	9,500
Installation	139,100	107,700	112,300	148,200
Total (unescalated)	$580,200	$439,300	$436,200	$528,400
Total (1st Q 1986)[c,d]	$586,000	$444,000	$450,000	$534,000
Annualized Costs, $/yr				
Labor	$ 16,900	$ 11,500	$ 11,500	$ 11,500
Utilities	168,000	92,000	99,900	117,400
Caustic		134,100		
Overhead	16,900	11,500	11,500	11,500
Taxes & Insurance	1,000	1,000	1,000	1,000
Capital Recovery (10%, 20 yr)	68,800	52,100	52,900	62,700
Total[d]	$272,000	$302,000	$177,000	$204,000

[a]Reference 5.

[b]These costs pertain to venturi scrubbers installed to control particulate emissions from existing thermal dryers. The costs of product recovery equipment (e.g., cyclones) are not included in the above numbers.

[c]Industry total was escalated to first quarter 1986 dollars via the Marshall and Swift (M&S) cost index.

[d]Total costs have been rounded to three places.

TABLE 6-2

CONTROL COSTS FOR MODEL EASTERN

COAL PREPARATION PLANTS[a,b]

Air Volume, acfm	90,000	160,000	240,000
Investment, $			
Cyclone/Scrubber	$120,000	$185,000	$260,000
Fan & Motor	131,700	168,100	181,500
Circulating Pump & Motor	3,200	7,000	7,900
Make-up Pump & Motor	1,900	2,200	2,700
Thickener Pump & Motor	2,200	2,500	2,700
Transfer Point Baghouse	–	24,500	27,200
Fan & Motor		1,600	2,100
Total Major Equipment	$259,000	$390,900	$484,100
Insallation	86,300	130,300	161,400
Total[c]	$345,000	$521,000	$646,000
Annualized Costs, $/yr			
Labor (1.5 mhr/shift @ $14.37/hr)	$ 12,900	$ 12,900	$ 12,900
Utilities, @ $0.04/kwh	146,800	261,000	391,400
Overhead, @ 80% of Labor	10,300	10,300	10,300
Taxes & Insurance, @ 4% of Investment	13,400	20,800	25,800
Capital Recovery (10%, 20yr)	39,400	61,200	75,800
Total[c]	$223,000	$366,000	$516,000

[a]References 6-10.

[b]These costs pertain to venturi scrubbers for control of thermal dryers in the model plants.

[c]Total costs have been rounded to three places.

Figure 6-1 compares the industry-reported and the EPA-estimated investment costs. A reasonably good agreement is evident. Figure 6-2 compares the reported and estimated annualized costs. The EPA annualized costs are somewhat higher than the industry-reported costs. One of the largest components of the annualized costs is the cost of power, which varies in proportion to the capacity utilization (operating hours). The EPA estimates assume full capacity utilization during the reported hours of operation. It is evident from the reported costs that the industry capacity utilization is well below the maximum. If the industry costs were adjusted to reflect full capacity utilization, the differences between them and the EPA estimates would likely be smaller than those shown in Figure 6.2.

6.3 COSTS FOR CONTROLLING WESTERN PLANTS

6.3.1 Reported Costs

The reports from western plants did not furnish detailed costs for individual pieces of equipment, only costs for total investment and annual maintenance. Therefore, no itemized industry costs can be shown.

6.3.2 Estimated Costs and Cost Comparison

EPA estimated costs for fabric filters to control emissions from a western coal preparation plant (Freedom, ND). These costs are based upon the engineering parameters reported by industry sources. Table 6-3 shows both the capital cost totals reported by industry and the costs estimated by EPA. Generally, the reported and estimated costs differ by less than ± 30 percent. The control devices to control Sources 18 and 19 are identical, yet the cost for Source 19 exceeds Source 18 cost by fifty percent. Presumably, additional equipment was charged to the Source 19 project, so that the lower cost for Source 18 is probably the correct one for both sources.

FIGURE 6-1
EASTERN COAL PREPARATION PLANTS
Investment Cost vs Air Volume

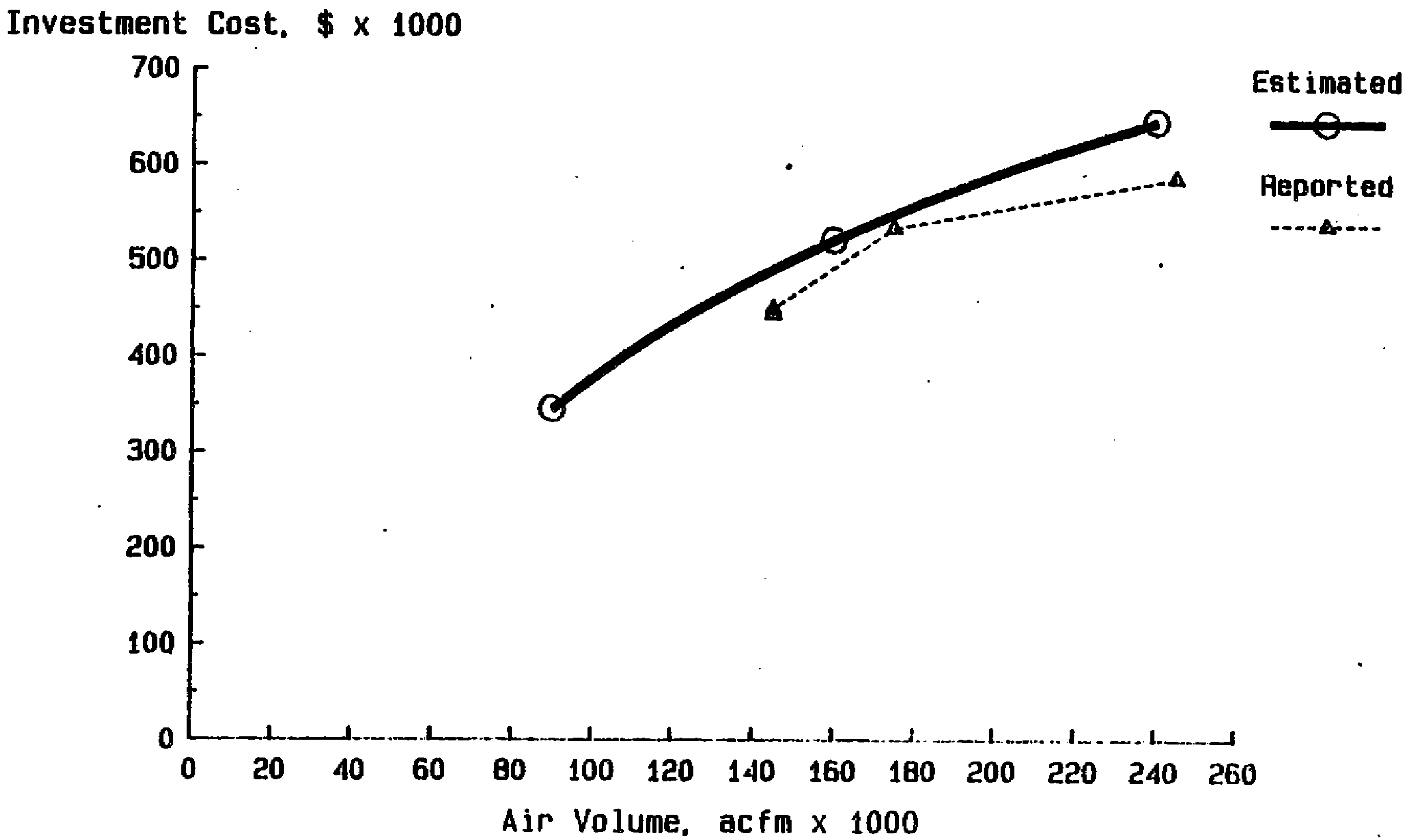

FIGURE 6-2
EASTERN COAL PREPARATION PLANTS
Annualized Cost vs Air Volume

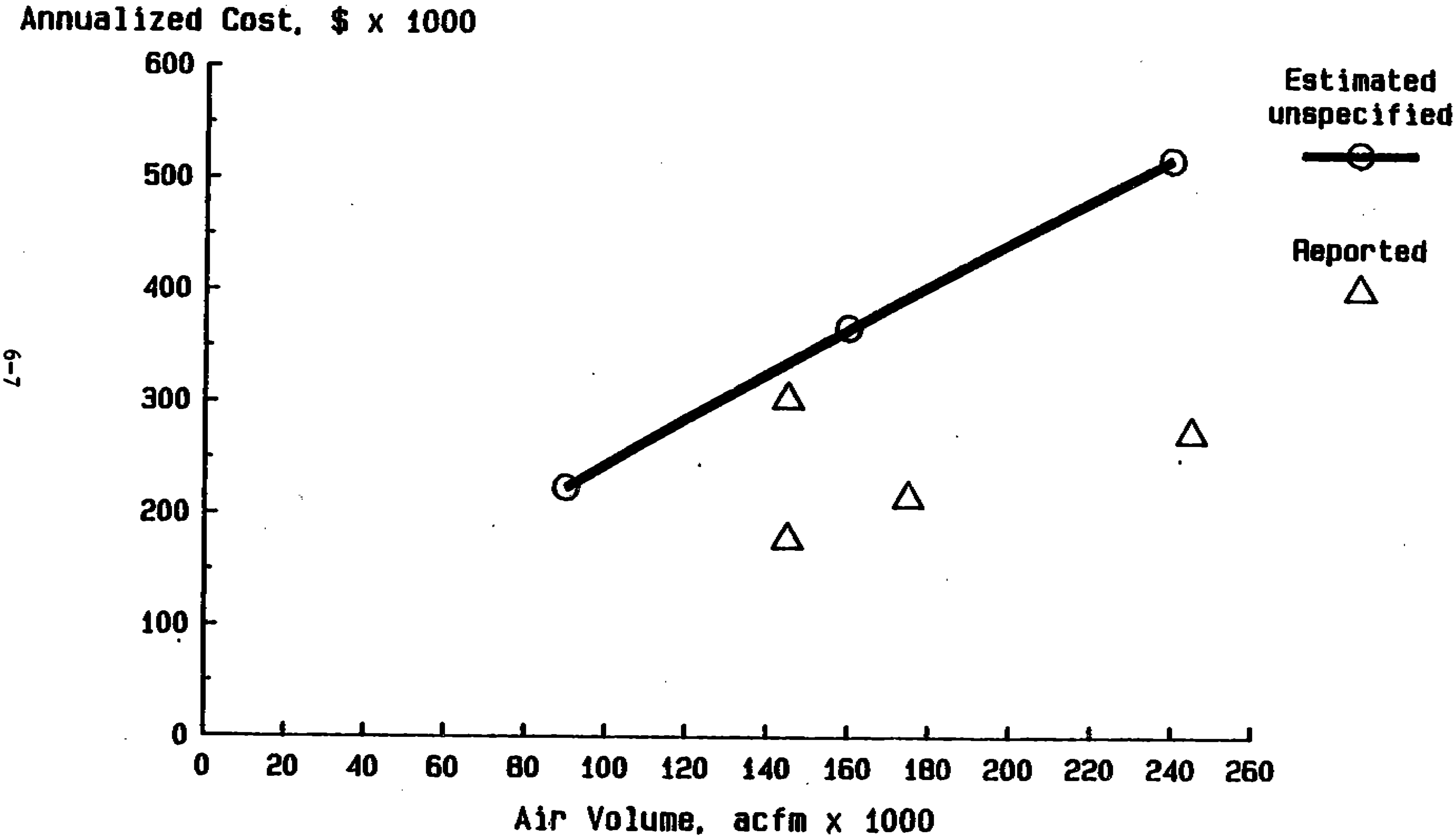

TABLE 6-3

CONTROL COSTS FOR SOURCES AT A WESTERN COAL PREPARATION PLANT (FREEDOM MINE, ND)[a,b]

Emission Source Number	17	18	19	20
Air Volume, acfm	10,100	15,000	15,000	9,800
Baghouse Cloth Area, sq. ft.	1,155	1,732	1,732	1,367
Pressure Drop, in. of H_2O	6	6	6	6
Installed Capital (Reported):	$64,875	$70,439	$106,707	NR[c]
Date of Installation	12-83	12-83	8-84	7-83
Installed Capital (Escalated to 1st Qtr. 1986)[d]:	$65,400	$71,000	$106,000	–
Investment Cost (Estimated)				
Baghouse	$10,700	$13,400	$13,400	$11,700
Insulation add on	10,300	11,500	11,500	10,700
Bags	700	1,000	1,000	900
Motor	800	1,300	1,300	800
Fan	1,100	1,400	1,400	1,100
Major Equipment Total MET	$23,600	$28,600	$28,600	$25,200
Installation, @ 72% of MET	17,000	20,600	20,600	18,100
Indirect Cost, @ 45% of MET	10,600	12,900	12,900	11,300
Total[d]	$51,200	$62,100	$62,100	$54,600
Annualized Cost				
Labor	$3,520	$5,120	$5,990	$2,060
Materials	430	1,960	1,010	1,560
Utilities	2,280	3,380	3,380	2,210
Overhead, @ 80% of Labor	2,820	4,100	4,790	1,640
Taxes and Insurance, @ 4% of Investment	2,050	2,480	2,480	2,190
Capital Recovery (10%, 20 yrs)	6,020	7,280	7,280	6,440
Total[d]	$17,100	$24,300	$24,900	$16,100

[a]References 11-15.

[b]Costs are for a fabric filter (baghouse) to control each of the above sources.

[c]Indicates that no cost was reported for this source.

[d]Total costs have been rounded to three places.

6.4 COSTS FOR CONTROLLING FUGITIVE EMISSION SOURCES

There are several sources of fugitive emissions in a coal preparation plant, such as truck dumps, conveyor transfer points, and crusher discharges. For the control of these fugitive emissions, three sizes of control systems have been costed: a 1,000-, a 5,000- and a 10,000-acfm unit, which can handle the gas volumes captured by a 5-, a 25-, and a 50-square foot hood, respectively. Costs for both venturi scrubber and fabric filter systems have been estimated by EPA for each of these three flowrates.

Table 6-4 sets forth the investment costs for the three venturi scrubber systems; Table 6-5 details their annualized costs. Investment and annualized costs for the three fabric filter systems are shown in Tables 6-6 and 6-7, respectively.

6.5 COST-EFFECTIVENESS OF THE PRESENT NSPS CONTROLS

The cost-effectiveness of controlling particulate emissions at existing coal preparation plants to meet the present NSPS has also been calculated, based on data supplied by coal preparation plants.

Table 6-8 shows the cost effectiveness calculations for coal dryers operated by the Consolidation Coal Company mines in the eastern U.S. The cost of pollution control ranges from $0.06 to $0.10 per ton of coal cleaned, and the cost-effectiveness ranges from $10 to $15 per ton of particulate captured.

Table 6-9 shows the cost-effectiveness calculations for four sources of fugitive emissions at the Freedom Mine of North American Coal Corporation (NACC) in Beulah County, North Dakota. Based on information submitted by NACC, the control cost per ton of coal approximates $0.01, and the cost-effectiveness is $3.18 per ton of particulate matter collected.

TABLE 6-4

VENTURI SCRUBBER INVESTMENT COSTS FOR

FUGITIVE EMISSIONS CONTROL

	Air Volume, acfm		
	1,000	5,000	10,000
Venturi Scrubber[a]	$4,050	$6,250	$8,270
Fan (15" Static Pressure)[b]	675	1,640	1,640
Motor[c] and Starter	1,351	2,101	4,923
Water Pump[d] and Motor	1,741	1,741	1,741
Ductwork & Hoods	2,323	3,518	5,442
Major Equipment Total (MET)	$7,822	$15,250	$22,016
Sales Tax, Freight, Instrumentation, @ 18% of MET	1,480	2,745	3,302
Installation Direct Costs, @ 56% of MET[e]	5,209	10,077	14,178
Installation Indirect Costs, @ 35% of MET[e]	3,256	6,298	8,861
Total Investment Cost[f]	$17,800	$34,400	$48,400

[a]Reference 16.
[b]Reference 17.
[c]Reference 18.
[d]Reference 19.
[e]Reference 20.
[f]Total costs have been rounded to three places.

TABLE 6-5

VENTURI SCRUBBER ANNUALIZED COSTS FOR

FUGITIVE EMISSIONS CONTROL

	Air Volume, acfm		
	1,000	5,000	10,000
Labor, 2hr/shift @ \$12/hr[a]	\$13,200	\$13,200	\$13,200
Supervision, @ 15% of Labor	1,980	1,980	1,980
Overhead, @ 80% of Lab. + Supv.	12,144	12,144	12,144
Utilities	1,600	8,000	16,000
Taxes, Insurance, & G&A, @ 4% of Investment	710	1,374	1,934
Capital Recovery (10 years, 10%)	2,891	5,592	7,868
Maintenance, @ 5% of Investment	888	1,719	2,417
Total Annualized Cost[b]	\$33,400	\$44,000	\$55,600
Particulate Captured, tons/yr.[c]	67.9	338	676
Cost Effectiveness, \$/ton	492	130	82

[a]Reference 21.
[b]Total costs have been rounded to three places.
[c]Inlet particulate loading of 4 gr./dscf, 90% removal efficiency, 4,400-hr/yr operating factor.

TABLE 6-6

FABRIC FILTER INVESTMENT COSTS FOR

FUGITIVE EMISSIONS CONTROL

	Air Volume, acfm		
	1,000	5,000	10,000
Fabric Filter Cost w/o Bags[a]	$10,000	$28,667	$52,000
Polypropylene bags[b]	488	2,440	4,880
Fan[c] Motor[d] and Starter	2,286	2,400	6,000
Ducting & Hood	1,751	2,400	6,000
Major Equipment Total (MET)	$14,525	$35,392	$71,535
Sales Tax, Freight, Instrumentation, @ 18% of MET	2,615	6,370	12,876
Installation Direct Costs, @ 72% of MET[e]	10,458	25,482	60,776
Installation Indirect Costs, @ 45% of MET[e]	6,536	15,926	37,985
Total Investment Cost[f]	$31,500	$76,800	$183,000

[a]Reference 12.
[b]Reference 13.
[c]Reference 17.
[d]Reference 18.
[e]Reference 21.
[f]Total costs have been rounded to three places.

TABLE 6-7

FABRIC FILTER ANNUALIZED COSTS FOR

FUGITIVE EMISSIONS CONTROL

	Air Volume, acfm		
	1,000	5,000	10,000
Labor, 2hr/shift @ $12/hr[a]	$13,200	$13,200	$13,200
Supervision, @ 15% of Labor	1,980	1,980	1,980
Overhead, @ 80% of Lab. + Supv.	12,144	12,144	12,144
Utilities	392	1,960	3,921
Bag replacement (2-year life)	244	1,220	2,440
Taxes, Insurance, & G&A, @ 4% of Investment	1,261	3,072	7,327
Capital Recovery (10 years 10%)	5,128	12,495	29,802
Maintenance	1,576	3,840	9,159
Total Annualized Cost[a]	$35,900	$49,900	$80,000
Particulate Captured, tons/yr.[b]	74.7	372	743
Cost Effectiveness, $/ton	481	134	108

[a]Total costs have been rounded to three places.
[b]Inlet particulate loading of 4 gr./dscf, 99% removal efficiency, 4,400-hr/yr operating factor.

TABLE 6-8

COST EFFECTIVENESS CALCULATIONS FOR PARTICULATE CONTROL FROM DRYERS AT EXISTING EASTERN COAL PREPARATION PLANTS

	Loveridge WV	Blacksville #2 WV	Bailey PA	Buchanan VA
Coal Cleaned, tons/hr	935	810	688	413
Operating Time, hrs/yr	3,625	6,000	4,500	4,830
Production, 10^3 tons/yr	3,389	4,860	3,096	1,995
Annualized Control Cost, $\$10^3$/yr[a]	272	302	177	204
Control Cost, $/ton of coal cleaned	0.080	0.062	0.057	0.102
Average 1984 Coal Price, $/ton[b]	36.74	36.74	34.56	37.10
Control Cost as Percent of Coal Price	0.22	0.17	0.16	0.27
Particulate Captured, tons/yr	21,300	20,900	15,700	20,300
Cost-Effectiveness, $/ton of Particulate	$12.80	$14.40	$11.30	$10.00

[a]From Table 6-1.

[b]Reference 22.

TABLE 6-9

COST EFFECTIVENESS CALCULATIONS FOR
EXISTING WESTERN COAL PREPARATION
(BEULAH COUNTY, ND)

Capacity, tons/yr	8,320,000
Annualized Cost, $/yr	82,445
Control Cost, $/ton of capacity	0.0099
Control Cost as percent of coal price ($9.69/ton)	0.10
Total particulate matter captured, tons/yr	10,079
Cost effectiveness, $/ton of particulate	8.18

6.6 REFERENCES

1. Letter from Brady, Spencer J., Consolidation Coal Co., to Farmer, J.R., EPA. February 20, 1986. (§114 response.)

2. Letter from Werle, Don, Flex-Kleen Corporation, to Georgieff Naum T., EPA. November 12, 1985. (Scrubber costs.)

3. Memo from Georgieff, Naum T., EPA, to Jenkins, R.E., EPA. March 21, 1986. (Model plant parameters.)

4. Reference 1.

5. Reference 1.

6. Reference 3.

7. Telcon. Jenkins, R.E., EPA, to Rich Bohinc, Westinghouse Corporation. April 4, 1986. (Electric motor costs.)

8. Letter from Almon, Duke, PNUCOR, to Jenkins, R.E., EPA. April 8, 1986. (Pump quote.)

9. Quote from Robinson Industries to Georgieff, Naum T., EPA. January 16, 1986. (Fan quote.)

10. Reference 1.

11. Letter from Stromberg, Andrea L., The North American Coal Corporation, to Farmer, J.R., EPA, March 18, 1986. (§114 response.)

12. Memo from Buck, Ken, Fuller Company, to Neveril, Robert, G.A.R.D. January 15, 1986. (Baghouse costs.)

13. Letter from Kintsch, John J., National Filter Media Corporation, to Jenkins, R.E., EPA. March 11, 1985. (Filter media costs.)

14. Reference 7.

15. Richardson Engineering Services, Inc., Process Plant Construction Estimating Standards Volume 4, Solano Beach, CA, 1978-79, §100-110 p.8.

16. Reference 15, §100-115, pp.11-12.

17. Reference 15, §100-110, p.4.

18. Reference 15, §100-650, p.6.

19. Reference 15, §100-282, p.4.

20. Neveril, R.B., Capital and Operating Costs of Selected Air Pollution Control Systems, U.S. Environmental Protection Agency, EPA 450/5-80-002, December 1978, p.3-11.

21. Survey of Current Business, U.S. Department of Commerce, August 1986, p.5-12.

22. Coal Production 1984, Energy Information Administration, DOE/EIA-01118 (84), p. 112.

7. CONCLUSIONS

The current NSPS for coal preparation plants has remained unchanged since it was proposed in 1974 and reviewed in 1979. The primary purpose of the NSPS was to control particulate emissions from thermal coal dryers. These emissions, from an estimated 200 coal dryers operating with existing controls in 1968, exceeded 150,000 tons nationwide.

The production of coal in the United States has been growing at an average annual rate of about 3 percent since promulgation of the NSPS. However, the U.S. Department of Energy forecasts that growth will decline to an average annual rate of 2.3 percent between 1985 and 1995. Furthermore, the average annual rate of growth in production of Western coal (mostly lignite and subbituminous) is projected to exceed the annual growth rate in Eastern coal production over the next 10 years (3.6 percent versus 1.6 percent). Western coals are predominantly removed by surface (strip) mining techniques in relatively arid portions of the country, whereas Eastern coals are predominantly removed via underground (shaft) mines and the coal is wet because of water sprayed on the coal during the mining process. Consequently, the handling of Western coal, where more of the growth is expected to occur, is more conducive to generating fugitive particulate emissions than handling undried Eastern coal. The economics of coal preparation technology is resulting in declining use of thermal drying in favor of mechanical dewatering for Eastern coals. Western coals are not dried either thermally or mechanically.

7.1 COAL DRYERS AND PNEUMATIC CLEANING FACILITIES

Of the 84 coal preparation plants per year expected to be built during the next decade, probably fewer than two per year will use thermal dryers. This is primarily the result of the industry's selection of mechanical dewatering technology. Mechanical dewatering, which is not a significant source of air emissions, offers the advantage of being less energy intensive, and consequently less costly, than thermal drying. The use of thermal drying of coal is expected to continue to decline. The use of pneumatic coal cleaning equipment has also been declining and no new pneumatic coal cleaning facilities are projected.

With the exception of a total ban on the use of thermal drying, no new technology was found to be capable of reducing emissions significantly below what is currently required by the NSPS.

7.2 COAL TRANSFER, HANDLING, AND STORAGE SYSTEMS

Technology is available to control the transfer, handling, and storage of both Eastern and Western coals more effectively than the requirements of the current NSPS. As indicated in Section 4.2.1.3, particulate grain loadings range from 0.001 gr/ dscf to 0.005 gr/dscf. While no EPA Method 9 opacity data are available for these facilities, unofficial observations by State and EPA personnel indicate that the opacities at the processes being controlled and at the exhausts of the control devices are generally zero.

A wide range of coal types and processing methods used by the approximately 1400 coal preparation plants operating in the United States. Controls which are appropriate and cost-effective at one plant, however, may be inappropriate for another. For example, coal crusher and conveyor transfer points are being controlled by fabric filtration at some Western plants with an estimated cost effectiveness of less than $500/ton of particulate captured. However, Eastern coal at some processing locations is so wet as it comes from the mine that uncontrolled processing operations upstream of the dryer present no significant potential for particulate emissions. Those Eastern plants which process dryer, dustier coals frequently control sources of fugitive particulate emissions by using water sprays. Spraying water on some of the Western coals would be totally inappropriate since it would add unwanted moisture and create a freezing problem at some plants located in severe winter climates.

The coal preparation industry has been growing since proposal of the NSPS, and all new or modified coal preparation plants have potential sources of fugitive emissions which are subject to the existing 20 percent limit on opacity. Also, this review found that many of the newer plants are controlling sources of fugitive emissions to a degree beyond that which is required by the existing NSPS.

7.3 MONITORING AND RECORDKEEPING

During our review of the monitoring and recordkeeping provisions of the regulation, only one requirement was found to be questionable. This is the requirement to continuously monitor the pressure of the water supply to the scrubber.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-450/3-88-001	2.	3. RECIPIENT'S ACCESSION NO.
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7. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Office of Air Quality Planning and Standards U.S. EPA, Research Triangle Park, NC 27711		10. PROGRAM ELEMENT NO.
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15. SUPPLEMENTARY NOTES

16. ABSTRACT

The new source performance standards (NSPS) for coal preparation plants (Subpart Y of 40 CFR Part 60) were reviewed by the U. S. Environmental Protection Agency for the second time. The industry and other government agencies were contacted to obtain data. The review found that the use of coal dryers and pneumatic coal cleaning equipment is declining, and that no new technology exists for these facilities. Technology exists for more stringent control than required by the NSPS for sources of fugitive emissions from coal transfer, handling, and storage facilities because of recent application of high efficiency control equipment for particulate emissions.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Pollution Control Standards of Performance Coal Cleaning Particulates	Air Pollution Control Stationary Sources	13B

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