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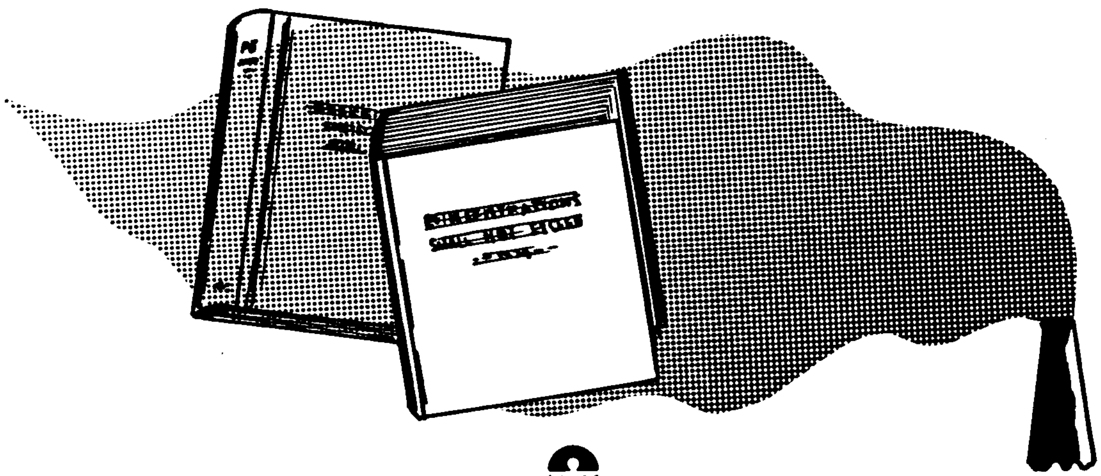
BACKGROUND INFORMATION FOR STANDARDS OF PERFORMANCE: COAL PREPARATION PLANTS

VOLUME 1: PROPOSED STANDARDS



U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

EPA 450/2-74-021a

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Emission Standards and Engineering Division

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PREFACE

A. Purpose of this Report

Standards of performance under section 111 of the Clean Air Act[1/] are proposed only after a very detailed investigation of air pollution control methods available to the affected industry and the impact of their costs on the industry. This report summarizes the information obtained from such a study of coal preparation plants. It is being distributed in connection with formal proposal of standards for that industry in the Federal Register. Its purpose is to explain the background and basis of the proposal in greater detail than could be included in the Federal Register, and to facilitate analysis of the proposal by interested persons, including those who may not be familiar with the many technical aspects of the industry. For additional information, for copies of documents (other than published literature) cited in the Background Information Document, or to comment on the proposed standards, contact Mr. Don R. Goodwin, Director, Emission Standards and Engineering Division, United States Environmental Protection Agency, Research Triangle Park, North Carolina 27711 [(919)688-8146].

B. Authority for the Standards

Standards of performance for new stationary sources are promulgated in accordance with section 111 of the Clean Air Act (42 USC 1857c-6), as amended in 1970. Section 111 requires

1/ Sometimes referred to as "new source performance standards" (NSPS).

the establishment of standards of performance for new stationary sources of air pollution which "... may contribute significantly to air pollution which causes or contributes to the endangerment of public health or welfare." The Act requires that standards of performance for such sources reflect "... the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction) the Administrator determines has been adequately demonstrated." The standards apply only to stationary sources, the construction or modification of which commences after regulations are proposed by publication in the Federal Register.

Section 111 prescribes three steps to follow in establishing standards of performance.

1. The Administrator must identify those categories of stationary sources for which standards of performance will ultimately be promulgated by listing them in the Federal Register.
2. The regulations applicable to a category so listed must be proposed by publication in the Federal Register within 120 days of its listing. This proposal provides interested persons an opportunity for comment.
3. Within 90 days after the proposal, the Administrator must promulgate standards with any alterations he deems appropriate.

It is important to realize that standards of performance, by themselves, do not guarantee protection of health or welfare; that is, they are not designed to achieve any specific air quality levels. Rather, they are designed to reflect best demonstrated technology (taking into account costs) for the affected sources. The overriding purpose of the collective body of standards is to maintain existing air quality and to prevent new pollution problems from developing.

Previous legal challenges to standards of performance for portland cement plants, steam generators, and sulfuric acid plants have resulted in several court decisions[2/] of importance in developing future standards. In those cases, the principal issues were whether EPA: (1) made reasoned decisions and fully explained the basis of the standards, (2) made available to interested parties the information on which the standards were based, and (3) adequately considered significant comments from interested parties.

Among other things, the court decisions established: (1) that preparation of environmental impact statements is not necessary for standards developed under section 111 of the Clean Air Act because, under that section, EPA must consider any counter-productive environmental effects of a standard in determining what system of control is "best;" (2) in considering costs it is not necessary to provide a cost-benefit analysis;

2/ Portlant Cement Association v Ruckelshaus, 486 F. 2nd 375 (D.C. Cir. 1973); Essex Chemical Corp. v Ruckelshaus, 486 F. 2nd 427 (D.C. Cir. 1973).

(3) EPA is not required to justify standards that require different levels of control in different industries unless such different standards may be unfairly discriminatory; and (4) it is sufficient for EPA to show that a standard can be achieved rather than that it has been achieved by existing sources.

Promulgation of standards of performance does not prevent State or local agencies from adopting more stringent emission limitations for the same sources. On the contrary section 116 of the Act (42 USC 1857-D-1) makes clear that States and other political subdivisions may enact more restrictive standards. Furthermore, for heavily polluted areas, more stringent standards may be required under section 110 of the Act (42 USC 1857c-5) in order to attain or maintain national ambient air quality standards prescribed under section 109 (42 USC 1857c-4). Finally, section 116 makes clear that a State may not adopt or enforce less stringent standards than those adopted by EPA under section 111.

Although it is clear that standards of performance should be in terms of limits on emissions where feasible,[3/] an alternative method of requiring control of air pollution is sometimes necessary. In some cases physical measurement of emissions from a new source may be impractical or exorbitantly expensive.

3/ "'Standards of performance,' ... refers to the degree of emission control which can be achieved through process changes, operation changes, direct emission control, or other methods. The Secretary [Administrator] should not make a technical judgment as to how the standard should be implemented. He should determine the achievable limits and let the owner or operator determine the most economical technique to apply." Senate Report 91-1196.

For example, emissions of hydrocarbons from storage vessels for petroleum liquids are greatest during storage and tank filling. The nature of the emissions (high concentrations for short periods during filling and low concentrations for longer periods during storage) and the configuration of storage tanks make direct emission measurement highly impractical. Therefore, a more practical approach to standards of performance for storage vessels has been equipment specification.

C. Selection of Categories of Stationary Sources

Section 111 directs the Administrator to publish and from time to time revise a list of categories of sources for which standards of performance are to be proposed. A category is to be selected "... if [the Administrator] determines it may contribute significantly to air pollution which causes or contributes to the endangerment of public health or welfare."

Since passage of the Clean Air Amendments of 1970, considerable attention has been given to the development of a system for assigning priorities to various source categories. In brief, the approach that has evolved is as follows.

First, we assess any areas of emphasis by considering the broad EPA strategy for implementing the Clean Air Act. Often, these "areas" are actually pollutants which are primarily emitted by stationary sources. Source categories which emit these pollutants are then evaluated and ranked by a process involving such factors as (1) the level of emission control (if any) already required by State regulations; (2) estimated levels of control that might result from standards of performance for the source category; (3) projections of growth and replacement of existing facilities for the source category; and (4) the estimated incremental amount of air pollution that could be prevented, in a preselected future year, by standards of performance for the source category.

After the relative ranking is complete, an estimate must be made of a schedule of activities required to develop a standard. In some cases, it may not be feasible to immediately develop a standard for a source category with a very high priority. This might occur because a program of research and development is needed or because techniques for sampling and measuring emissions may require refinement before study of the industry can be initiated. The schedule of activities must also consider differences in the time required to complete the necessary investigation for different source categores. Substantially more time may be necessary, for example, if a number of pollutants must be investigated in a single source category. Even late in the development process the schedule for completion of a standard may change. For example, inability to obtain emission data from well-controlled sources in time to pursue the development process in a systematic fashion may force a change in scheduling.

Selection of the source category leads to another major decision: determination of the types of sources or facilities to which the standard will apply. A source category often has several facilities that cause air pollution. Emissions from some of these facilities may be insignificant and, at the same time, very expensive to control. An investigation of economics may show that, within the costs that an owner could reasonably afford, air pollution control is better served by applying standards to the more severe pollution problems. For this reason (or perhaps because there may be no adequately demonstrated system for controlling emissions from certain facilities), standards often do not apply to all sources within a category. For similar reasons, the standards may not apply to all air pollutants emitted by such sources. Consequently, although a source category may be selected to be covered by a standard of performance, treatment of some of the pollutants or facilities within that source category may be deferred.

D. Procedure for Development of Standards of Performance

Congress mandated that sources regulated under section 111 of the Clean Air Act be required to utilize the best practicable air pollution control technology that has been adequately demonstrated at the time of their design and construction. In so doing, Congress sought to:

1. maintain existing high-quality air,
2. prevent new air pollution problems, and
3. ensure uniform national standards for new facilities.

The selection of standards of performance to achieve the intent of Congress has been surprisingly difficult. In general, the standards must (1) realistically reflect best demonstrated control practice; (2) adequately consider the cost of such control; (3) be applicable to existing sources that are modified as well as new installations; and (4) meet these conditions for all variations of operating conditions being considered anywhere in the country.

A major portion of the program for development of standards is spent identifying the best system of emission reduction which "has been adequately demonstrated" and quantifying the emission rates achievable with the system. The legislative history of section 111 and the court decisions referred to above make clear that the Administrator's judgment of what is adequately demonstrated is not limited to systems that are in actual routine use. Consequently, the search may include a technical assessment of control systems which have been adequately demonstrated but for which there is limited operational experience. To date, determination of the "degree of emission limitation achievable" has been commonly based on (but not restricted to) results of tests of emissions from existing sources. This has required worldwide investigation and measurement of emissions from control systems. Other countries with heavily populated, industrialized areas have sometimes developed more effective systems of control than those used in the United States.

Because the best demonstrated systems of emission reduction may not be in widespread use, the data base upon which the standards are established will necessarily be somewhat limited. Test data on existing well-controlled sources are an obvious starting point in developing emission limits for new sources. However, since the control of existing sources generally represents retrofit technology or was originally designed to meet an existing State or local regulation, new sources may be able to meet more stringent emission standards. Accordingly, other information must be considered and judgment is necessarily involved in setting proposed standards.

Since passage of the Clean Air Amendments of 1970, a process for the development of a standard has evolved. In general, it follows the guidelines below.

1. Emissions from existing well-controlled sources are measured.
2. Data on emissions from such sources are assessed with consideration of such factors as: (a) the representativeness

of the source tested (feedstock, operation, size, age, etc.); (b) the age and maintenance of the control equipment tested (and possible degradation in the efficiency of control of similar new equipment even with good maintenance procedures); (c) the design uncertainties for the type of control equipment being considered; and (d) the degree of uncertainty affecting the judgment that new sources will be able to achieve similar levels of control.

3. During development of the standards, information from pilot and prototype installations, guarantees by vendors of control equipment, contracted (but not yet constructed) projects, foreign technology, and published literature are considered, especially for sources where "emerging" technology appears significant.

4. Where possible, standards are set at a level that is achievable with more than one control technique or licensed process.

5. Where possible, standards are set to encourage (or at least permit) the use of process modifications or new processes as a method of control rather than "add-on" systems of air pollution control.

6. Where possible, standards are set to permit use of

systems capable of controlling more than one pollutant (for example, a scrubber can remove both gaseous and particulate matter emissions, whereas an electrostatic precipitator is specific to particulate matter).

7. Where appropriate, standards for visible emissions are established in conjunction with mass emission standards. In such cases, the standards are set in such a way that a source meeting the mass emission standard will be able to meet the visible emission standard without additional controls. (In some cases, such as fugitive dust, there is no mass standard).

Finally, when all pertinent data are available, judgment is again required. Numerical tests may not be transposed directly into regulations. The design and operating conditions of those sources from which emissions were actually measured cannot be reproduced exactly by each new source to which the standard of performance will apply.

E. <u>How Costs are Considered</u>

Section 111 of the Clean Air Act requires that cost be considered in setting standards of performance. To do this requires an assessment of the possible economic effects of implementing various levels of control technology in new plants within a given industry. The first step in this analysis requires the generation of estimates of installed capital costs and annual operating costs for various demonstrated control systems, each control system alternative having a different overall control capability. The final step in the analysis is to determine the economic impact of the various control alternatives upon a new plant in the industry. The fundamental question to be addressed in this step is whether or not a new plant would be constructed given that a certain level of control costs would be incurred. Other issues that would be analyzed in this step would be the effects of control costs upon product prices and the effects on product and raw material supplies and producer profitability.

The economic impact upon an industry of a proposed standard is usually addressed both in absolute terms and by comparison with the control costs that would be incurred as a result of compliance with typical existing State control regulations. This incremental approach is taken since a new plant would be required to comply with State regulations in the absence of a Federal standard of performance. This approach requires a detailed analysis of the impact upon the industry resulting from the cost differential that usually exists between the standard of performance and the typical State standard.

It should be noted that the costs for control of air pollutants are not the only control costs considered. Total environmental costs for control of water pollutants as well as air pollutants are analyzed wherever possible.

A thorough study of the profitability and price-setting mechanisms of the industry is essential to the analysis so that an accurate estimate of potential adverse economic impacts can be made. It is also essential to know the capital requirements placed on plants in the absence of Federal standards of performance so that the additional capital requirements necessitated by these standards can be placed in the proper perspective. Finally, it is necessary to recognize any constraints on capital availability within an industry as this factor also influences the ability of new plants to generate the capital required for installation of the additional control equipment needed to meet the standards of performance.

The end result of the analysis is a presentation of costs and potential economic impacts for a series of control alternatives. This information is then a major factor which the Administrator considers in selecting a standard.

F. Impact on Existing Sources

Proposal of standards of performance may affect an existing source in either of two ways. First, if modified after proposal of the standards, with a subsequent increase in air pollution, it is subject to standards of performance as if it were a new source. (Section 111 of the Act defines a new source as "any stationary source, the construction or modification of which is commenced after the regulations are proposed.")4/

Second, promulgation of a standard of performance requires States to establish standards of performance for the same pollutant for existing sources in the same industry under section 111(d) of the Act; unless the pollutant limited by the standard for new sources is one listed under section 108 (requiring promulgation of national ambient air quality standards) or one listed as a hazardous pollutant under section 112. If a State does not act, EPA must establish such standards. Regulations prescribing procedures for control of existing sources under section 111(d) will be proposed as Subpart B of 40 CFR Part 60.

G. Revision of Standards of Performance

Congress was aware that the level of air pollution control achievable by any industry may improve with technological advances. Accordingly, section 111 of the Act provides that the Administrator may revise such standards from time to time. Although standards proposed and promulgated by EPA under section 111 are designed to require installation of the "... best system of emission reduction ... (taking into account the cost)..." the standards will be reviewed periodically. Revisions will be proposed and promulgated as necessary to assure that the standards

4/ Specific provisions dealing with modifications to existing facilities are being proposed by the Administrator under the General Provisions of 40 CFR Part 60.

continue to reflect the best systems that become available in the future. Such revisions will not be retroactive but will apply to stationary sources constructed or modified after proposal of the revised standards.

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INTRODUCTION

"Coal preparation" is one segment of the coal industry. Coal preparation encompasses operations between the mining of raw coal and the distribution of product coal.

The extent of preparation and type of processing depend upon the physical character and chemical composition of the raw coal and the customer specifications on product coal. Coal preparation is therefore a function of the demand for an improved quality product.

Coal preparation plants were specifically named as major sources of air pollution in 40 CFR Part 52 "Prevention of Significant Air Quality Deterioration," published as proposed in the Federal Register, July 16, 1973. One study on emissions from coal preparation estimated that particulate emissions from thermal dryers alone exceeded 150,000 tons in 1968.[1]

SUMMARY OF PROPOSED STANDARDS

Standards of performance are being proposed for new coal preparation plants. The proposed standards would limit emissions of particulates (including visible emissions) from the following sources, which are the affected facilities: thermal driers, pneumatic coal-cleaning equipment (air tables), coal processing and conveying equipment (including breakers and crushers), screening (classifying) equipment, coal storage, coal transfer points, and coal loading facilities.

The standards apply at the point(s) where undiluted gases are discharged from the air pollution control system or from the affected facility if no air pollution control system is utilized. If air or other dilution gases are added prior to the measurement point(s), the owner or operator must provide a means of accurately determining the amount of dilution and correcting the pollutant concentration to the undiluted basis.

The proposed standards for these sources would limit particulate emissions to the atmosphere as follows:

Particulate Matter from Thermal Driers

1. No more than 0.070 gram per dry standard cubic meter (0.031 grain per dry standard cubic foot).
2. Less than 30 percent opacity.

Particulate Matter from Pneumatic Coal-Cleaning Equipment

1. No more than 0.040 gram per dry standard cubic meter (0.018 grain per dry standard cubic foot).

2. Less than 20 percent opacity.

Particulate Matter from Other Affected Facilities

Less than 20 percent opacity.

DESCRIPTION OF PROCESS

Coal in its natural state contains impurities such as sulfur, clay, rock, shale and other inorganic materials, generally called ash. Coal mining also adds more impurities in the form of mine rock, dirt, tramp iron and wood. To remove these impurities, coal preparation plants utilize the difference in specific gravities to separate coal from the heavier contaminants.

Since this separation depends on the coal and impurities already being separate entities, the larger coal lumps must be broken up to free entrapped impurities. Thus impurities which occur as finely divided mixtures in coal are more difficult to remove than the coarser materials, e.g., pyritic sulfur is much more difficult to remove than rock or shale. Scalpers and magnets remove wood and iron prior to size reduction.

Coal preparation plants prepare various types of coal in response to market demand. Three types of preparation plants are common: (1) "complete preparation," those that clean both coarse and fine coal; (2) "partial preparation," those that clean only coarse coal; and (3) "coal crushing," where the coal is merely crushed to a specified maximum size. Since all features of the two other types are incorporated into the complete preparation plant, only it will be described.

Figure 1 is a schematic diagram of a complete coal preparation facility. Coal from the mine is broken and screened to remove oversize material, then stored until the batch processing in the plant is begun. Secondary breaking or crushing is sometimes necessary to ensure good separation of coal from impurities in the cleaning plant. Classifying screens separate coal particles by size and route them to various cleaning processes represented by the "cleaning process" portion of the diagram. In general this cleaning process may be wet, dry, or a combination of both.

Wet Cleaning Systems[2]

Wet cleaning systems utilize centrifugal or gravity separation of heavier rejects from coal (see Figure 2). None of the variety of wet cleaning methods emit pollutants. However, the auxiliary processes of handling and drying can be major sources. After the coal is wetted by the cleaning process, it is dried mechanically by dewatering screens followed by centrifugal driers. Removing excess moisture from coal decreases shipping costs, increases the higher heating value of coal, and prevents freezing in very cold climates.

Where customer demand is for low surface moisture (3 to 6 percent) of finer coal sizes, secondary drying is required. Such low moisture levels can best be accomplished by thermal drying. It appears that new coal preparation plants that install thermal driers will use a fluid-bed type.

In the fluid-bed drier, hot combustion gases from a coal-fired furnace are passed upward through a moving bed of wet coal of fine

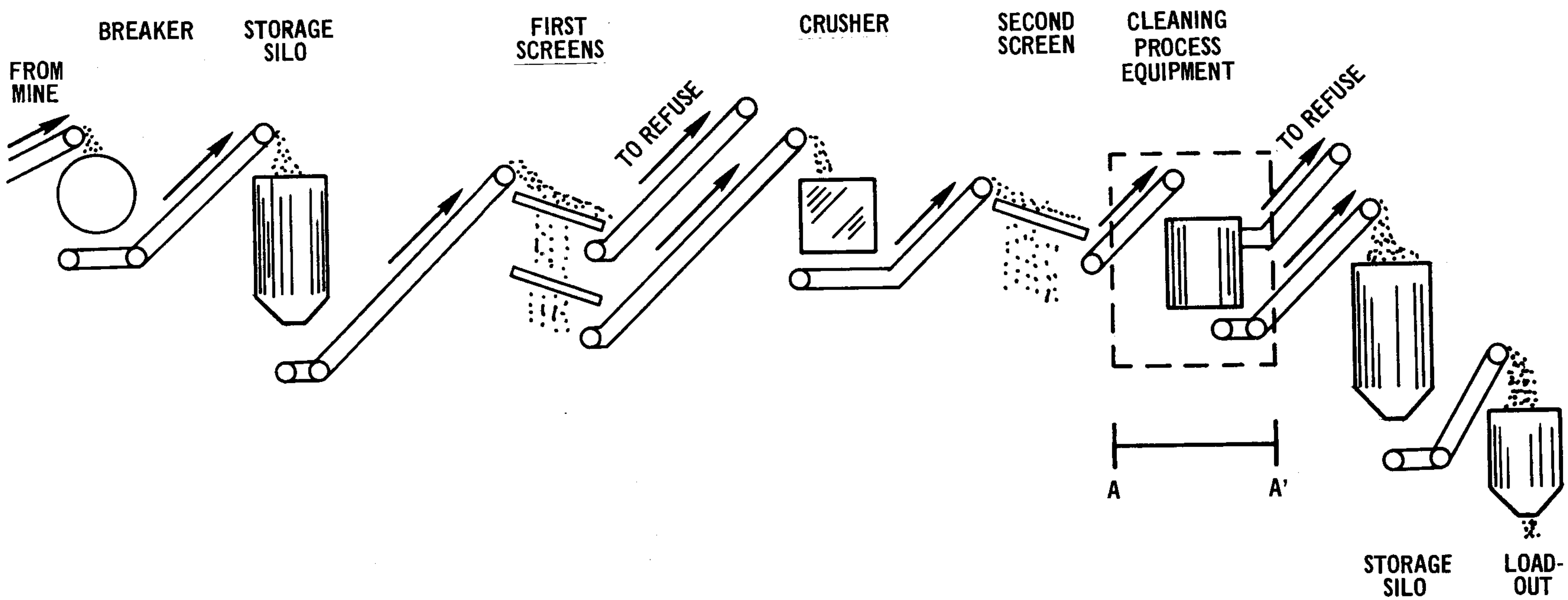


Figure 1. Flow diagram for coal cleaning plant (for section A - A', see Figures 2 and 3).

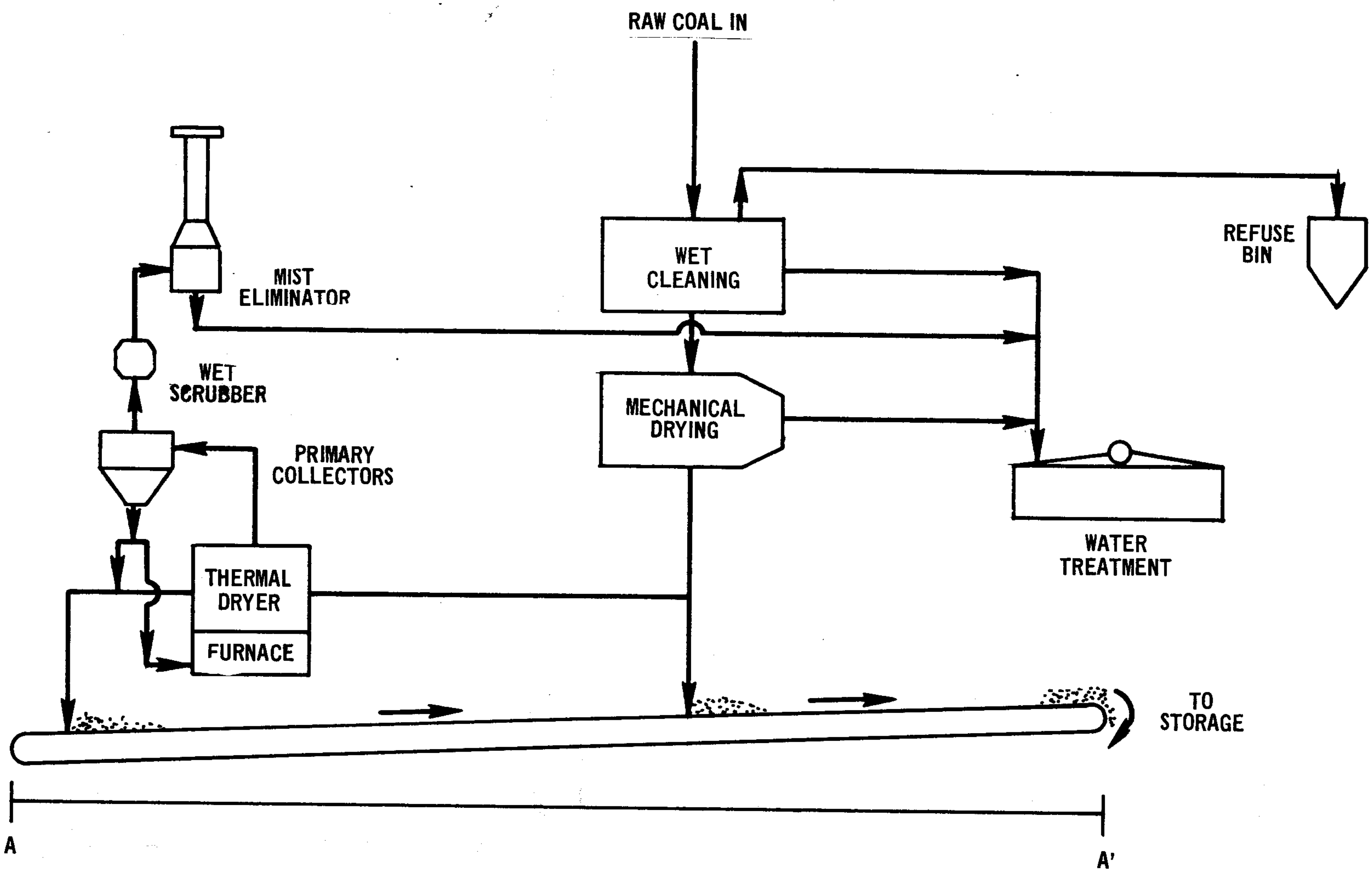


Figure 2. Wet cleaning circuit process.

particle size. As the bed fluidizes, the coal is dried as the fine particles come into intimate contact with the hot gases. Particulate emissions occur predominately from ultrafine (-200 mesh) coal particles which are entrained and carried from the drier by the combustion gases.

The primary control device, a dry centrifugal collector (originally justified primarily to recover product, thereby increasing yield), can retain up to 95 percent of the entrained fines. These are returned to the product coal. All secondary emission control systems are wet collectors. The high dew point and explosion potential of the exhaust gas make other emission control systems impractical. The dried coal is conveyed to storage where it remains until being loaded into railroad cars, trucks, or barges.

Dry Cleaning Systems

Since 1966, all dry coal cleaning systems in operation have used pulsating air columns to separate coal from reject material.[2] Figure 3 is a schematic diagram of such a system. Coal containing refuse particles enters the air table where it is stratified into a bed by pulsating air. The heavier refuse settles in a layer beneath the coal. As the bed travels forward, the refuse drops into packets or wells from which it is withdrawn to the refuse bin. The upper layer of coal is removed as it completes its travel over the slowly moving bed of refuse. Dust, entrained and airborne by the pulsating air, is drawn into an overhead hood to be recovered by cyclone dust

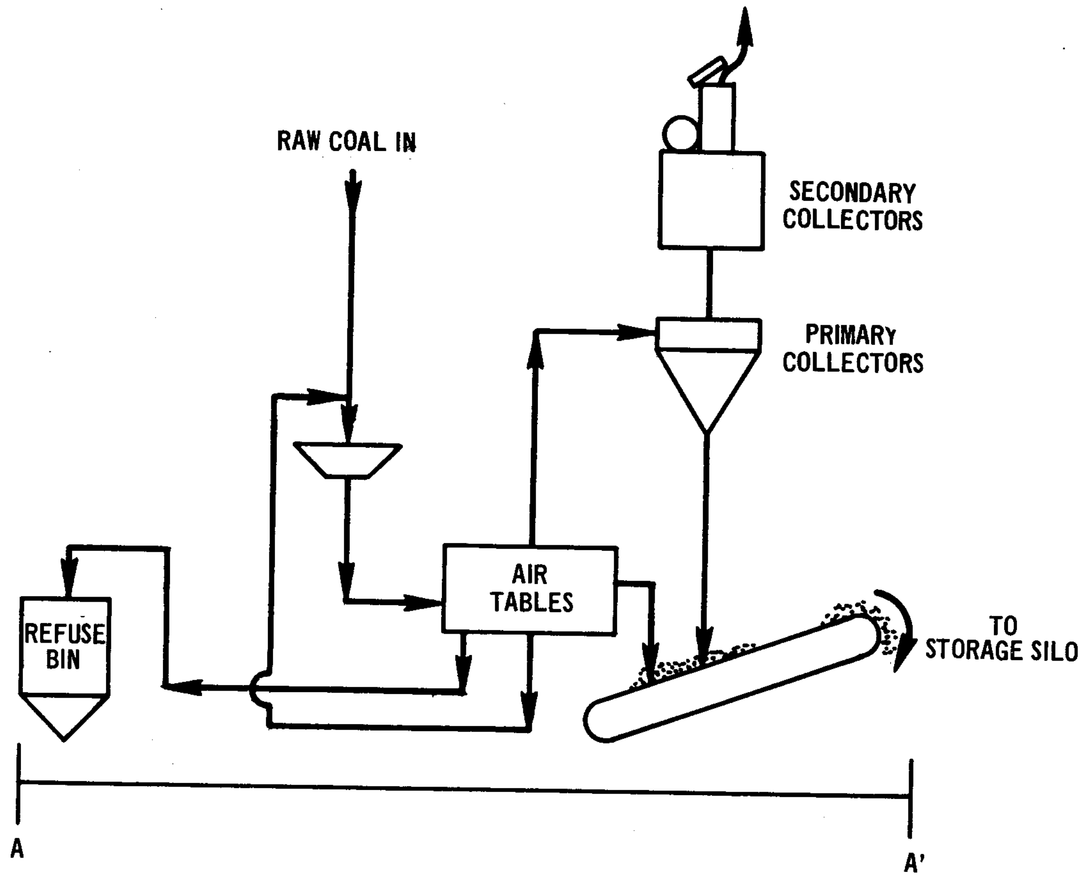


Figure 3. Dry cleaning process.

collectors which have been installed based on economical product recovery. Secondary collectors, which are added for control of air pollution, are usually fabric filters.

EMISSIONS AND METHODS OF CONTROL

Emissions from uncontrolled coal preparation plants include NO_x, SO_2, CO and fine particulates from thermal drying. Particulate emissions come from crushing, screening, storage, transfer, grinding, conveying, or loading operations. Particulate emissions, at times severe and highly visible, increase as the surface moisture in the coal decreases. Their control requires good capture of the emissions which must then be fed to a control device. None of the plants attempt to control combustion products or SO_2.

Wet Cleaning Systems

Thermal driers in a coal plant which uses wet cleaning incorporate cyclones as an integral part of the coal cleaning process. Potential particulate emissions upstream of the cyclone have been measured in the range of 50 to 200 grains per dry standard cubic foot (gr/dscf) for fluid-bed driers.[3] Emissions measured downstream ranged from 0.7 to 14 gr/dscf. An average emission factor often used for fluid-bed driers without secondary control is 3.0 gr/dscf. (With 3.0 gr/dscf, a 500-ton-per-hour thermal drier would emit over 5,000 pounds of particulates per hour.)

Well-controlled thermal driers with high-efficiency, venturi-type wet scrubbers reduce particulate emissions to less than 0.03 gr/dscf. This is equivalent to about 99 percent control efficiency.

Dry Cleaning Systems

Implementation of new health and safety regulations within the coal mines resulted in addition of increasing amounts of water to coal to minimize dust inhalation and reduce its explosive hazard. This has resulted in a rise in the surface moisture of coal from underground mines and has caused a corresponding reduction in emissions from air tables which have a control device. Measurements prior to 1970 indicated grain loadings of 0.16 gr/dscf from plants which had only a primary control device. A 70-tons-per-hour air table with such control could emit up to 50 pounds per hour. In 1973 this same facility would emit only 10-15 pounds per hour. Fabric filter secondary collectors have been reported to further reduce emissions to less than 0.01 gr/dscf.[3] A fabric filter collector is a dry process and all dust which it recovers becomes part of the product.

EXISTING AIR POLLUTION STANDARDS

Most States do not have specific air pollution limitations for coal preparation plants but rather make them subject to a general process weight regulation.[4] This type of restriction is not uniform. For example, under the most restrictive such regulation, a 500-tons-per hour thermal drier could emit 70 pounds of particulate each hour, approximately equivalent to an exit-gas concentration of 0.035 gr/dscf. A smaller air table with a capacity of 75 tons per hour would be allowed to emit 48 pounds per hour, an exit-gas concentration of approximately 0.150 gr/dscf.

Three States have codes applicable exclusively to coal preparation plants.[4] The most restrictive is 0.02 gr/dscf for thermal driers and air tables with capacities above 100 tons per hour. However, it permits exit concentrations to increase with decreasing capacity.

All coal-producing States have a general visible emission restriction that limits all sources to a maximum 20 percent opacity.

RATIONALE FOR PROPOSED STANDARDS

Selection of Pollutants for Control

The only pollutant evolved from air tables is particulate. Emissions from thermal driers include combustion products from the coal-fired furnace, but these quantities of emissions are a small fraction of the particulates entrained by the flue gases passing through the fluidized bed of coal. Initial emission samples from thermal driers were analyzed for products of combustion and heavy metals. Table 1 presents the results of the analyses of combustion products. The table permits a comparison with the standards of performance for coal-fired power plants.

Both NO_x and SO_2 emissions were found below the performance standards required of new coal-fired power plants. Admittedly the driers tested were processing (and using as fuel) low-sulfur coal. However, only 12 percent of all thermally dried coal is greater than 2 percent sulfur, primarily because thermal drying of lower quality coals is not generally an economically attractive alternative.

For those few driers that may thermally dry high-sulfur coal in the future, the cost of controlling SO_2 emissions is considered unreasonable. The largest thermal driers at 500 tons per hour burn

TABLE 1

COMBUSTION PRODUCT EMISSIONS FROM

WELL-CONTROLLED THERMAL DRIERS

Pollutant	Concentration, ppm	Emission rate, lb/(Btu x 10^6)	Coal-fired power plant,[a] lb/(Btu x 10^6)
NO_x	40 to 70	0.39 to 0.68	0.70
SO_x	0 to 11.2	0 to 0.09	1.20
HC (as methane)	20 to 100	0.07 to 0.35	--
CO	< 50	<0.30	--

[a]Standards of Performance for Fossil-Fuel-Fired Steam Generators as promulgated in 40 CFR 60.40.

approximately 5 tons per hour coal as fuel. The accompanying furnace would be rated at 130 million BTU/hr which is less than the smallest power plants required to control SO_2 emissions under standards of performance.

Finally the wet scrubbers used to control particulate emissions from thermal driers also appear to control SO_2 emissions. The two driers tested emitted SO_2 at 0-10 percent of the levels expected, based on firing rate and fuel sulfur content.

For these reasons no standards for SO_2 or NO_x were proposed. Standards for hydrocarbons and carbon monoxide were also rejected because the emission levels were low.

Table 2 shows a typical analysis of the heavy metals content of particulates emitted from thermal driers. The largest well-controlled thermal driers (500 tons/hr feed and 50 lb/hr emissions) would discharge less than 0.005 lb/hr arsenic. Emissions of other heavy metals are somewhat lower. Since most heavy metals are emitted as particulates, a particulate standard limitation will also control these pollutants. Hence, only standards of performance have been recommended for particulate emissions from coal preparation plants.

<u>Selection of Units for the Standard</u>

Both mass and concentration units were considered for the standard. A limitation on mass (such as pounds of particulate emission per ton of coal feed) has the advantage of being universally restrictive in that it precludes circumvention by the addition of dilution

TABLE 2

TRACE METALS ANALYSIS OF PARTICULATE EMISSIONS FROM A COAL DRIER

Element	Concentration, ppmw[a]	Element	Concentration, ppmw[a]
Be	1	K	1000 to 2000
Cd	<<50	Ca	3000
As	< 100	Si	1.5%
V	50	Mg	1000
Mn	50 to 100	Bi	< 10
Ni	20 to 30	Co	< 10
Sb	< 50	Ge	< 30
Cr	30	Mo	< 10
Zn	< 100	Ti	500
Cu	30	Te	< 100
Pb	< 30	Zr	10
Se	--	Ba	200
B	10	Al	1.0%
F	--	Cl^-	40 to 118
Li	< 10	$SO_4^=$	1040 to 3920
Ag	< 1		
Sn	< 50		
Fe	5000		
Sr	100		
Na	300		

[a] Parts per million by weight.

air. Such a standard would require an accurate determination both of mass emission rate and the weight of the feedstock to the process. Also an operator could defeat a mass standard by adding coarse coal to the drier feed, resulting in a significantly larger process weight and little change in emissions.

A limitation based on concentration (such as 0.03 grain per dry standard cubic foot) requires limited knowledge of coal feed rates. Although this type of standard could conceivably be circumvented by dilution, such action would not be an economically viable option to the operator for the following reasons:

1. A thermal drier operates most efficiently with a maximum temperature differential (limited only by safety considerations) between the hot combustion gases and the coal bed. Consequently dilution of the hot combustion gases with much cooler ambient air would reduce drying efficiency and increase fuel costs.
2. Introduction of air between the drier and the final control device would not achieve any operating cost savings since the horsepower required to move the greater volume of air at lower pressure through a lower energy control device is equivalent to that required to move the lower volume of air at the greater pressure with the higher energy venturi type scrubbers.
3. Introduction of air downstream of the control device is not only specifically precluded, but such adulterations to the typical control device would be obvious.

It was concluded that concentration units, grains per dry standard cubic foot (gr/dscf), should be used for the standards of performance for coal preparation plants, with a suitable inclusion to prevent circumvention by dilution air. This conclusion is based on the following:

1. Only precise measurement of emissions is required to enforce a concentration standard.
2. Less precise information on feedstock or product weights is required for a concentration standard than for a mass standard.
3. Emission data used as a basis for development of the standards of performance were measured in concentration units. Since process feed rates were merely estimated, data to support a mass standard would be less reliable.
4. A mass standard based on process weight would be ineffective. An operator could circumvent the standard by passing the larger sizes of coal through the drier, which could increase process weight significantly without increasing emissions.

Selection of Sampling and Analytical Methods

All tests of particulate emissions conducted under EPA contract to provide a basis for proposing standards of performance have used Method 5, "Determination of Particulate Emissions from Stationary Sources," as described in Appendix A of 40 CFR Part 60. Therefore, it was concluded that the proposed standards should be based on the same method.

Most control devices now in operation discharge exhaust gases in a swirling pattern. Any flow pattern other than one parallel to the stack wall has a detrimental effect on the accuracy of standard measurement techniques. For this reason, it was concluded that the standard should require new control systems for thermal driers and air tables to discharge exhaust gases in parallel flow and to provide sufficient stack height for representative sampling according to EPA Method 5.

<u>Discussion of Standards Development</u>

Early investigation (which included the preliminary results of an industry study by EPA and discussion with local control agencies, manufacturers of control equipment, and the industry trade association) revealed the location of several reportedly well-controlled coal preparation plants. Of the approximately 130 in the nation which have thermal driers or air tables, 31 were visited to obtain information on the emission control system. During the visits, the plants were critically appraised to determine those which represented the best demonstrated air pollution control technology for the industry. The general criteria used were: (1) the opacity of plant emissions, (2) results of previous emission tests, (3) air pollution control equipment and operating techniques, (4) suitability of control equipment for testing, and (5) maintenance practices.

Communications with persons knowledgeable in coal preparation indicated the major variable which contributes to particulate emissions from thermal driers is the size distribution of the feed. To ensure results of the program were not biased optimistically, it was decided to test installations which processed the largest percentage of "fines" but utilized what appeared to be the best system of emission reduction. Consequently, a specific criterion for selection of test sites was high fines content in the feed to the drier. Representatives of the coal industry, manufacturers of thermal driers, and vendors of control equipment indicated coal from the Pocahontas coal region of West Virginia and Virginia is the most friable and hence most difficult to control. As a result, all but one of the plants which was sampled processed coal from the Pocahontas seam. In all tests by EPA, the maximum available amount of fines was fed to the drier.

Although not apparent during the initial visits, the mode of flow of the exhaust gas was to become a very important consideration in the evaluation of the results of emission tests. Figure 4 represents the general type of control system used by all plants that were selected for testing. Exhaust gases from the primary collector pass through a venturi-type wet scrubber which may operate at pressure differentials of 15 to 32 inches water gauge (but which may be raised as high as 57 inches). Water consumption was about 8 gallons per minute per 1,000 cubic feet per minute of gas cleaned.

The exhaust gases entrain water from the scrubber which is removed by a mist eliminator. Gases enter the cylindrical mist eliminator tangentially and flow upward in spiral flow. In theory,

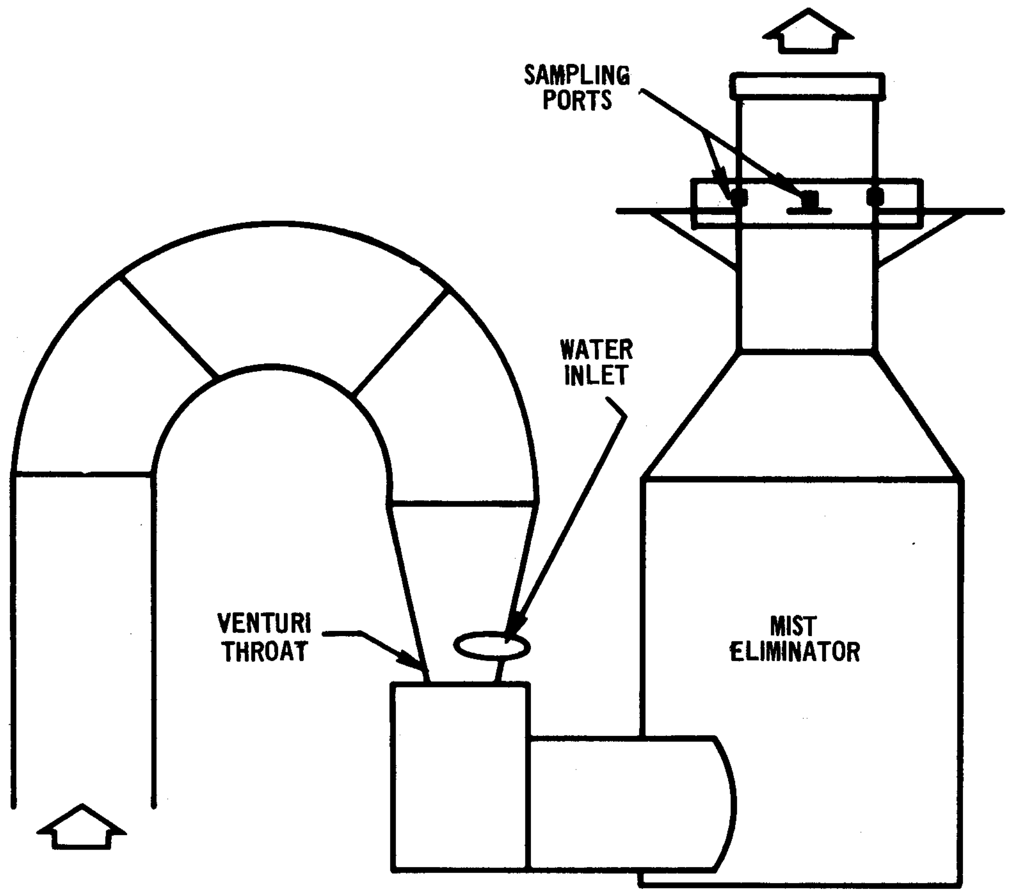


Figure 4. Venturi scrubber-mist eliminator.

the water is centrifugally thrown to the cylinder wall where it flows by gravity to a drain. Mist eliminators of this design can present two problems to accurate emission mc surement:

1. The design parameters used by at least one manufacturer appear inadequate because significant amounts of water exit from the top of the mist eliminator. High gas velocities in the stack continue to carry water up the stack wall until it is ejected from the top of the stack by the turbulent gas stream. A steady "rain" of black, dust-laden water was evident in the vicinity of such stacks. Several of these systems had been retrofitted with a "catch-ring" as shown in Figure 5. It is designed to capture the water which is carried over and return it to a drain. The efficiency of these catch rings appears moderate to poor. Obviously, the contribution to total emissions of the random emissions of mist cannot be accurately measured.

   A similar collector by another manufacture (Figure 6) differs in three obvious aspects: (1) the length-to-diameter ratio of the mist eliminator is greater, (2) it has a taller stack, and (3) it has a proportionately larger stack diameter which permits lower gas velocity within the stack. The exhaust streams from mist eliminators made by this manufacturer contain little or no entrained water.

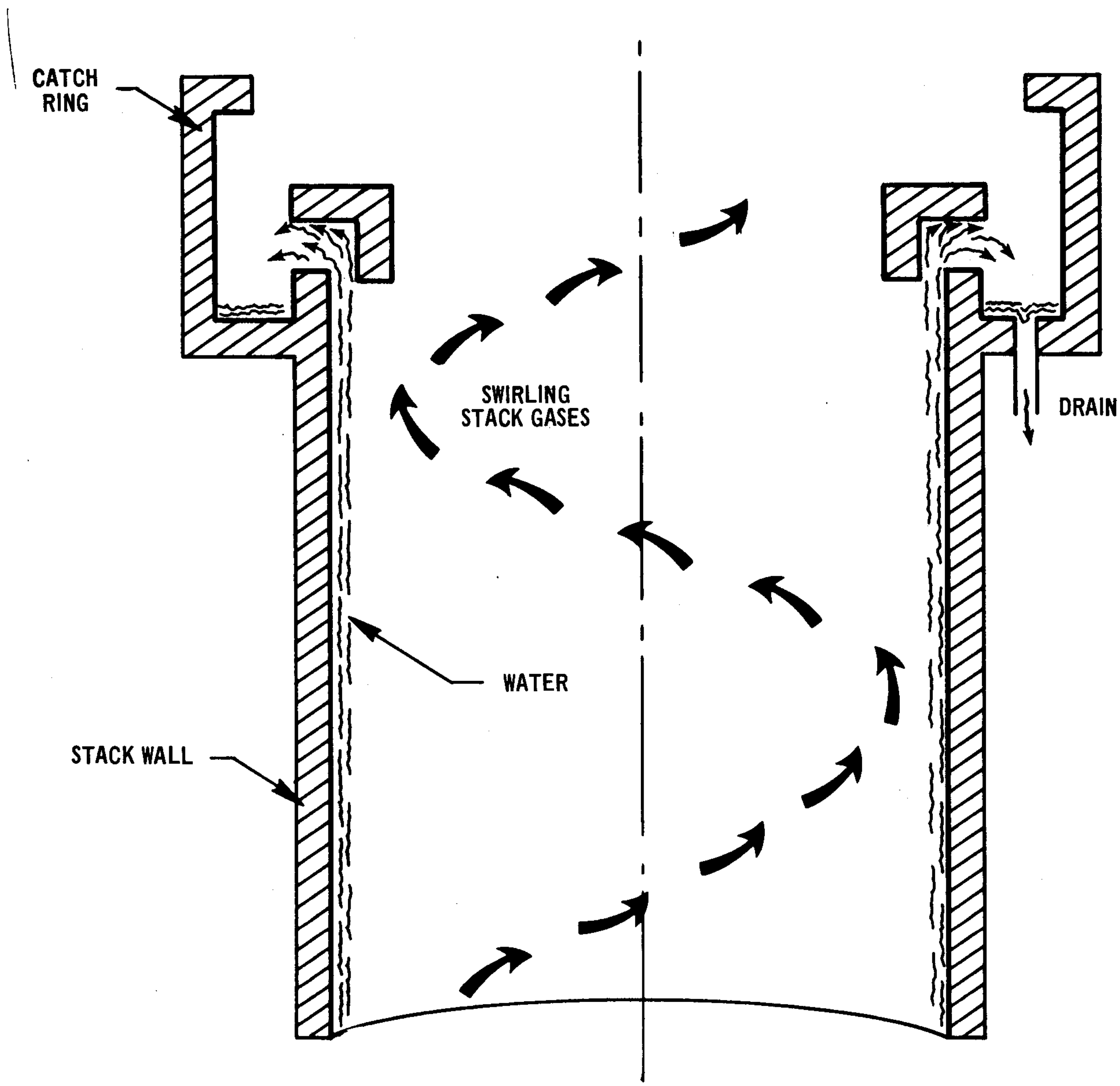


Figure 5. Retrofitted catch ring.

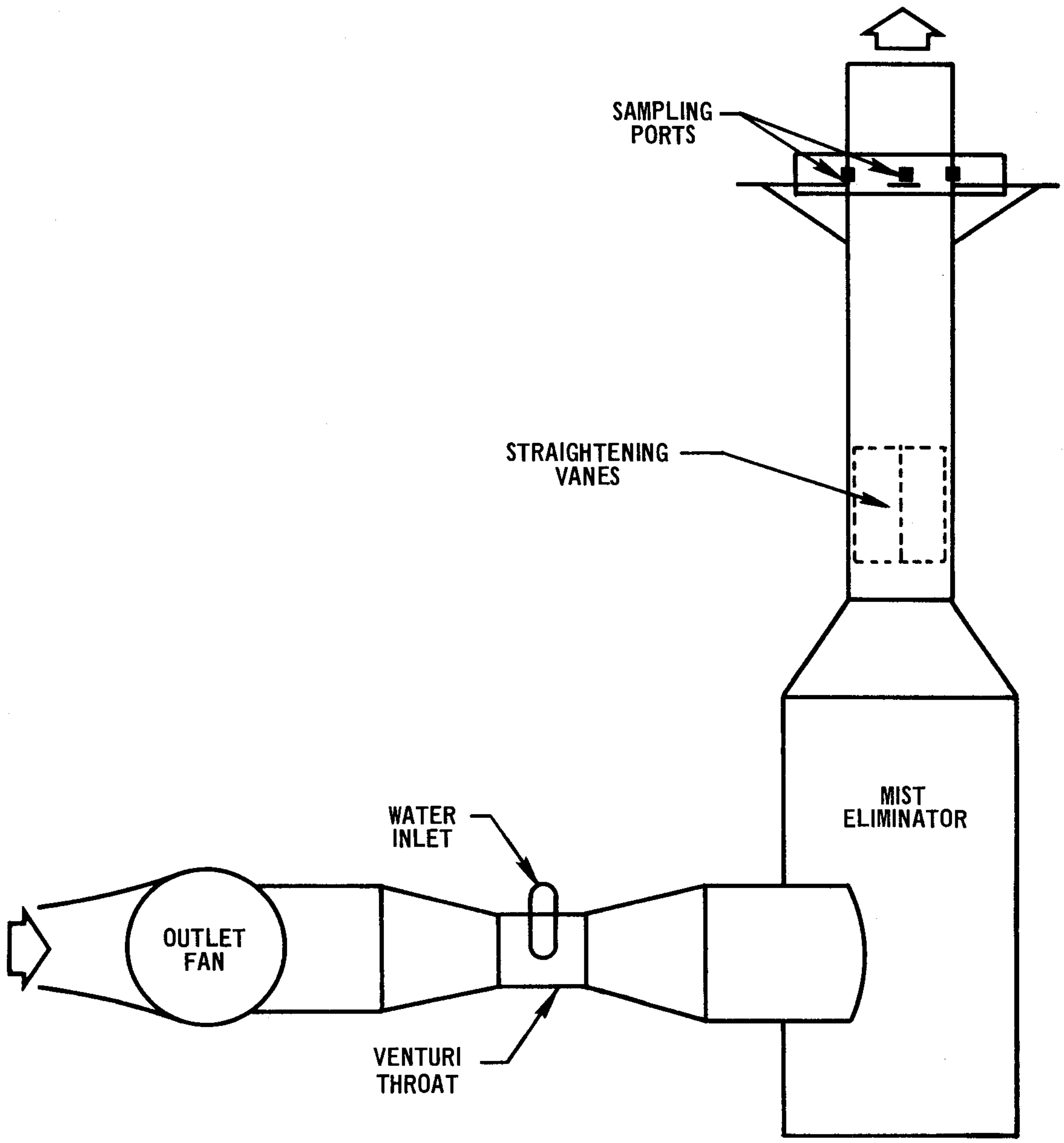


Figure 6. Venturi scrubber-mist eliminator with straightening vanes.

2. The cyclonic flow patterns common to all cylindrical mist eliminators make measurements of particulate emissions suspect.

Wet Cleaning Systems

Twenty-eight thermal driers were inspected. These were of various designs, processed a variety of coals, and utilized wet scrubbers of various designs. Of these, five fluid-bed driers were selected for emission measurement because it is expected that new driers will be of the fluid-bed type. EPA tested three of these facilities, designated C, D, and E in Figure 7. All utilize a mist eliminator with the poorer efficiency. Plant C, the only plant with permanent straightening vanes, was tested twice. The first test (C_1) showed average particulate emissions of 0.014 gr/dscf, the second test (C_2) 0.019 gr/dscf.

Emissions from Plant D were evaluated on two separate occasions. The first test (D_1) indicated an average emission rate of 0.017 gr/dscf (without vanes). Two additional series of tests at a later date were taken in quick succession in an attempt to reveal the effect of straightening vanes. Without vanes (test D_2), average emissions were 0.024 gr/dscf. With temporary straightening vanes installed as shown in Figure 8, three samples averaged 0.044 gr/dscf (test D_3). Also, with the vanes installed, the visibility of the particulate-laden "rain" increased notably. As might be expected, the straightening vanes appear to nullify the centrifugal flow and the effectiveness of the catch ring.

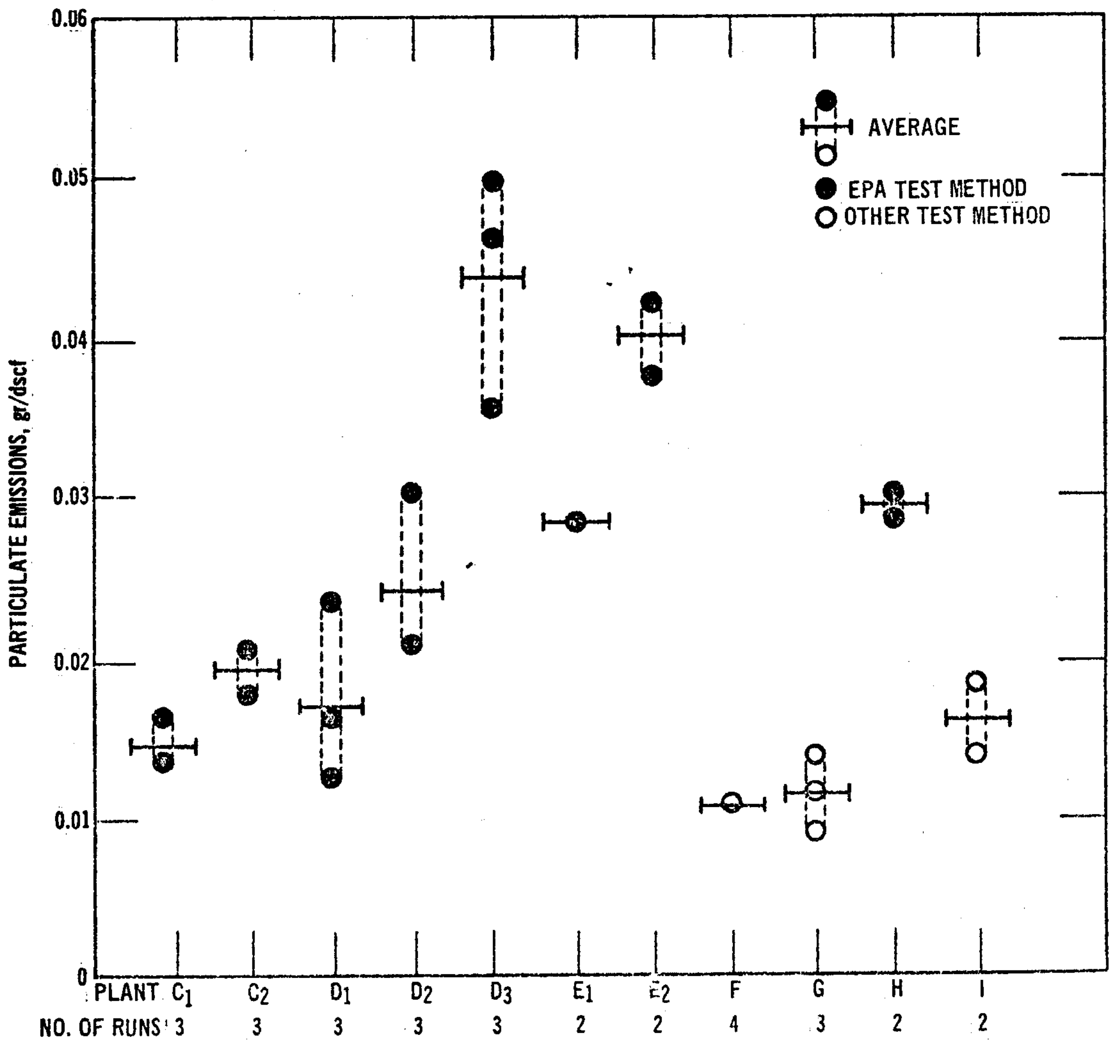


FIGURE 7. Particulate emissions from thermal dryer exhausts controlled by wet scrubbers.

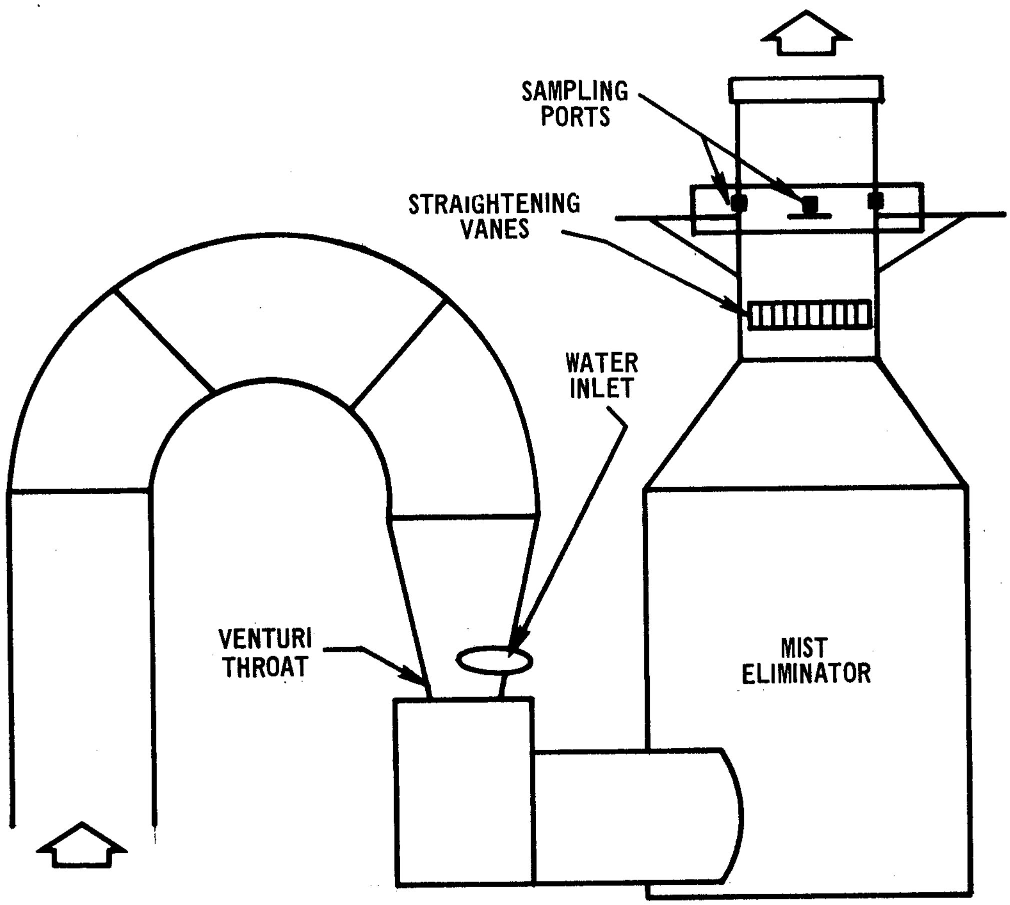


Figure 8. Venturi scrubber-mist eliminator with straightening vanes.

The scrubber at Plant E operated with the lowest energy consumption, 21 inches of water. This plant was also sampled on two occasions. During the test labeled E_1 on Figure 7, the drier was operating normally. The surface moisture content of the product coal was about 3 percent. However, when the test represented by point E_2 was made, the surface moisture content of the product coal was about 1.2 percent, far below normal. "Overdrying" of coal is generally acknowledged to greatly increase particulate emissions. For this reason, data from test E_2 were not considered in the selection of the standard.

Test results shown for Plants F, G, H and I were provided by the industry. Only the results of the test on Plant H, 0.029 gr/dscf, were reportedly obtained using EPA methods. The methods used at the other plants is not known. The proposed standard of 0.031 gr/dscf is supported by measurements of emissions at all plants tested. There are two instances where the proposed standard was exceeded. The first occurred when flow straighteners were inserted at Plant D. This obviously increased emissions because the discharge of dirty water increased. (Doubtlessly the particulate in the dirty water reentrained from the stack wall after installation of flow straighteners was largely responsible for the difference in test results D_2 and D_3.) Secondly, during test E_2 coal was being dried to about 1 percent surface moisture, well below the 2 percent threshold at which dust emissions become severe.[5] The overdrying was confirmed both by moisture analysis on the product coal and the abnormally high temperatures recorded on the drier exit monitor.

Vendors of control equipment have guaranteed emissions of less than 0.030 gr/dscf. One vendor has guaranteed 0.020 gr/dscf, while another is considering such a guarantee.[6,7] Based on these findings it is the Administrator's judgment that the achievability of the proposed standard of 0.03 gr/dscf for particulate emissions from thermal driers has been adequately demonstrated.

Dry Cleaning Systems

Of the 37 plants that operated air tables in 1972, 13 had emission control equipment. EPA representatives visited three plants. Two, which used fabric filters for control, exhibited no visible stack emissions and were subsequently tested. The third, which had no air pollution control device, showed visible emissions of greater than 20 percent opacity. Results of the two series of tests on the air tables with fabric filter controls are presented in Figure 9. Particulate loadings averaged 0.008 gr/dscf and 0.005 gr/dscf for Plant A and B, respectively. Figure 9 also presents, as test B_2, emission data provided by the operator of Plant B. Their results averaged 0.007 gr/dscf and ranged from 0.004 to 0.011. Based on these findings it is the Administrator's judgment that the achievability of an 0.018 gr/dscf particulate emission standard for pneumatic cleaning has been adequately demonstrated.

A projected decline in the use of air tables (substantiated by the small number of new installations during the past 2 years) diminished the requirement for extensive testing. Although it is expected

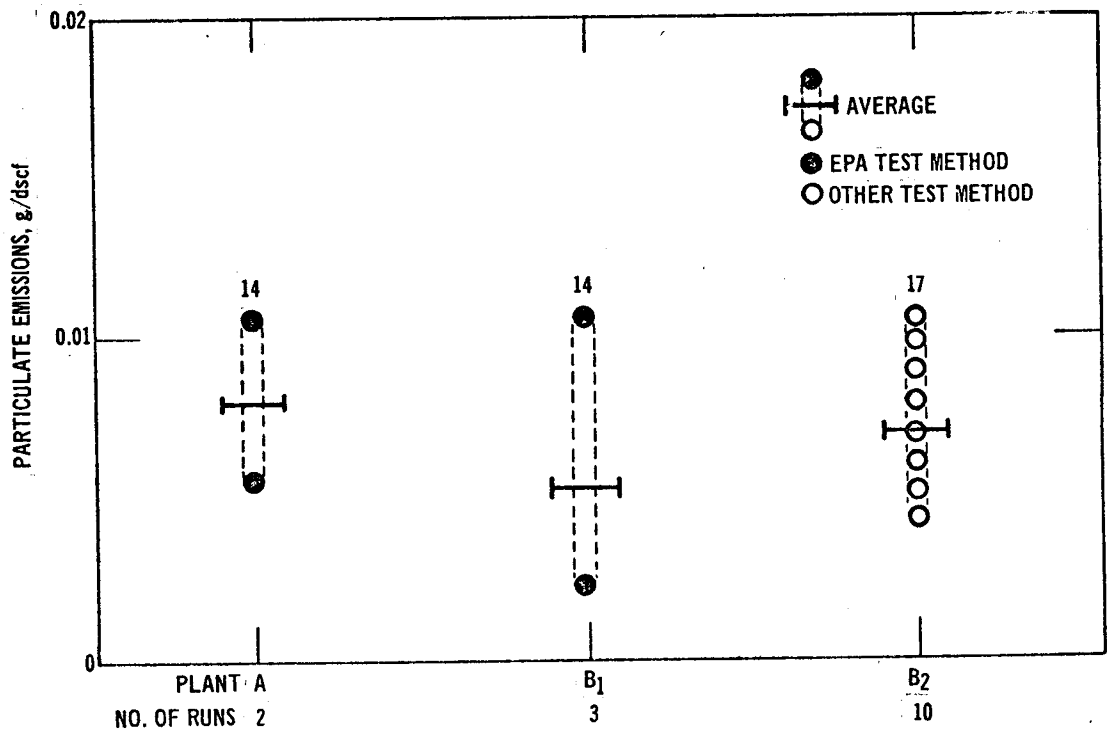


FIGURE 9. Particulate emissions from air table exhausts controlled by fabric filters.

that few new air tables will be constructed, the standard is proposed because they are still available from equipment vendors.

Visible Emission Data

Visible emission readings were made at well-controlled coal preparation plants operating at or near design rates. The sources monitored at each of two plants were:

(1) thermal drier exhaust, controlled by 35" ΔP venturi scrubber,

(2) breaker and raw coal transfer exhaust, controlled by a fabric filter,

(3) cleaned coal transfer exhaust, controlled by a fabric filter, and

(4) cleaned coal loadout exhaust, controlled by a 6" ΔP wet scrubber.

One plant showed visible emissions of 10 percent or less from all sources monitored during a 7-hour period. A second plant experienced frequent upsets in which visible emissions from all sources exceeded 20 percent. Duuring normal operation visible emissions from all sources at the second plant were 10 percent opacity or less.

Visible emissions from both thermal driers exceeded 20 percent during routine startups and shutdowns. These periods of excessive visible emissions were 10-20 minutes for startups and 10-15 minutes for shutdown.

Excessive visible emissions would be expected from a startup or shutdown; however, these periods are exempt from the standards [40 CFR 60.11(c)].

Furthermore, visible emissions from wet scrubber exhausts are a function of ambient atmospheric conditions. Visible emissions on a cold, damp day are masked by uncombined water vapor, hence may be zero while the same exhaust on a hot, dry day may exhibit emissions of 20 percent opacity. Therefore, it is concluded that a "cushion" should be included in the opacity limits for thermal driers to compensate for the seasonal variations in visible emissions.

It is the policy of EPA in proposing particulate emission standards to include visible emission standards as an enforcement tool. Since the operator of an affected facility may be penalized for violation of these visible emission standards, they are established such that a violation of a visible emission standard would unquestionably indicate a simultaneous violation of the particulate standard.

Thus, a 30 percent opacity limit for thermal driers during normal operation is proposed, while for all other sources which are unaffected by operating parameters or seasonal variations, a 20 percent opacity limit is proposed.

Conclusions

The proposed particulate emission standards of 0.031 gr/dscf for thermal driers and 0.018 gr/dscf for pneumatic coal-cleaning equipment are supported by emission measurements by EPA on Plant C, D, and E and Plants A and B, as presented in Figures 7 and 9, respectively.

Proposed opacity standards of less than 30 percent for thermal driers and less than 20 percent for air tables and all other affected facilities are supported by visible emission observations. The standards will require installation and proper maintenance of equipment representative of the best technology which has been demonstrated for the industry. In the Administrator's judgment, the achievability of the proposed standards has been adequately demonstrated.

ENVIRONMENTAL IMPACT OF PROPOSED STANDARDS

Coal preparation plants generate large quantities of solid wastes and waste water. Solid wastes include mine rock scalped from raw coal and fine impurities from wet coal cleaning. Liquid wastes are generated by wet coal washing and scrubber discharges.

For a typical coal preparation plant processing 600 TPH raw coal, approximately 180 TPH of solid refuse and 4500 gpm waste water are generated.[3] A wet scrubber used to meet the proposed thermal drier standard would contribute 640 gpm waste water and 1.54 TPH solids in the waste water discharge.

Since all plant waste waters are clarified and reused in plant processing no water pollution will result. Solids in the scrubber liquid discharge may or may not be reclaimed as product coal. If the scrubber solids are discharged with other solid refuse the contribution is less than one percent of total wastes. With the rising price of coal, it seems unlikely that new preparation plants would discard the 1.54 TPH fine coal in scrubber liquids.

In dry coal processing, all material captured by emission controls is returned to the process. No water is used by best emission controls. Thus no water or solid waste pollution is generated.

Energy requirements of emission controls used to meet the proposed standards for thermal driers are roughly 3 kilowatt-hours per ton of coal dried. Based on anticipated growth of 5.6 million tons per year of dried coal, the annual energy consumed by new thermal drier controls would be 16.8 x 10^6 kilowatt-hours. Of this, one-third or 5.6 x 10^6 kilowatt-hours would be used to meet Federal standards over existing State standards.

Since zero growth is anticipated for dry coal cleaning, no additional energy is required to meet the proposed standard.

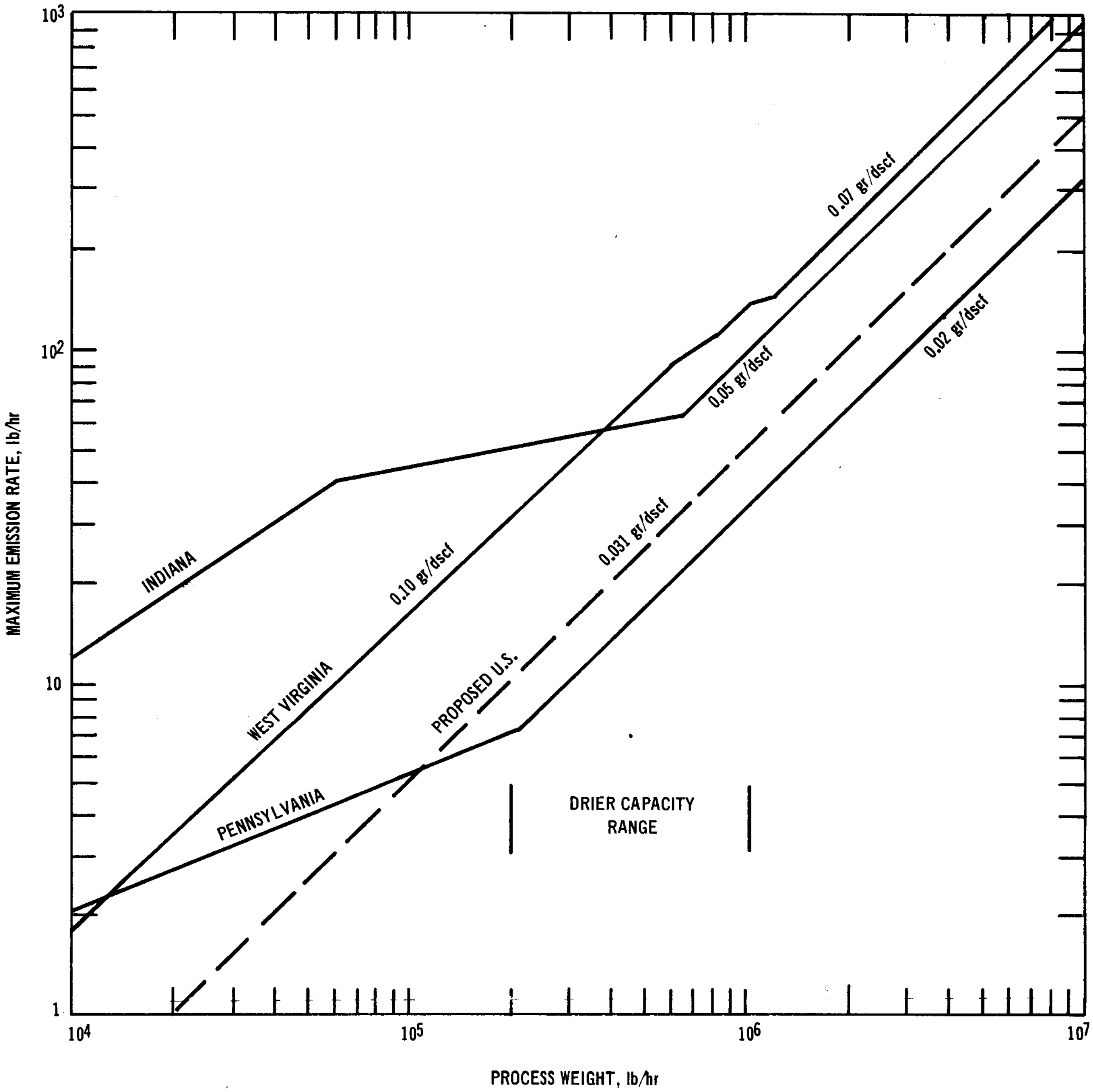
ECONOMIC IMPACT OF PROPOSED STANDARDS

The outlook for growth in the coal cleaning sector is clouded by several factors. Current restrictions imposed by State Implementation Plans on the burning of high-sulfur coal could cause dislocations in the Eastern coal-producing areas during the next few years. The use of air tables, one of the two prime sources of particulate pollution, may be discontinued. Compliance with Department of Interior dust abatement regulations promulgated under the authority of the Coal Mining Health and Safety Act results in a high moisture content in the coal which renders the coal unsuitable for air table processing.

Nevertheless, long-term forecasts of energy requirements indicate a rise in cleaned coal requirements from 323 million tons in 1970 to 580 million tons in 1985. The new thermal driers required for this expansion plus replacement driers, which historically have run at about 4 to 5 percent of existing capacity per year, indicate that nine new driers per year will be required. No new or replacement air table installations are projected.

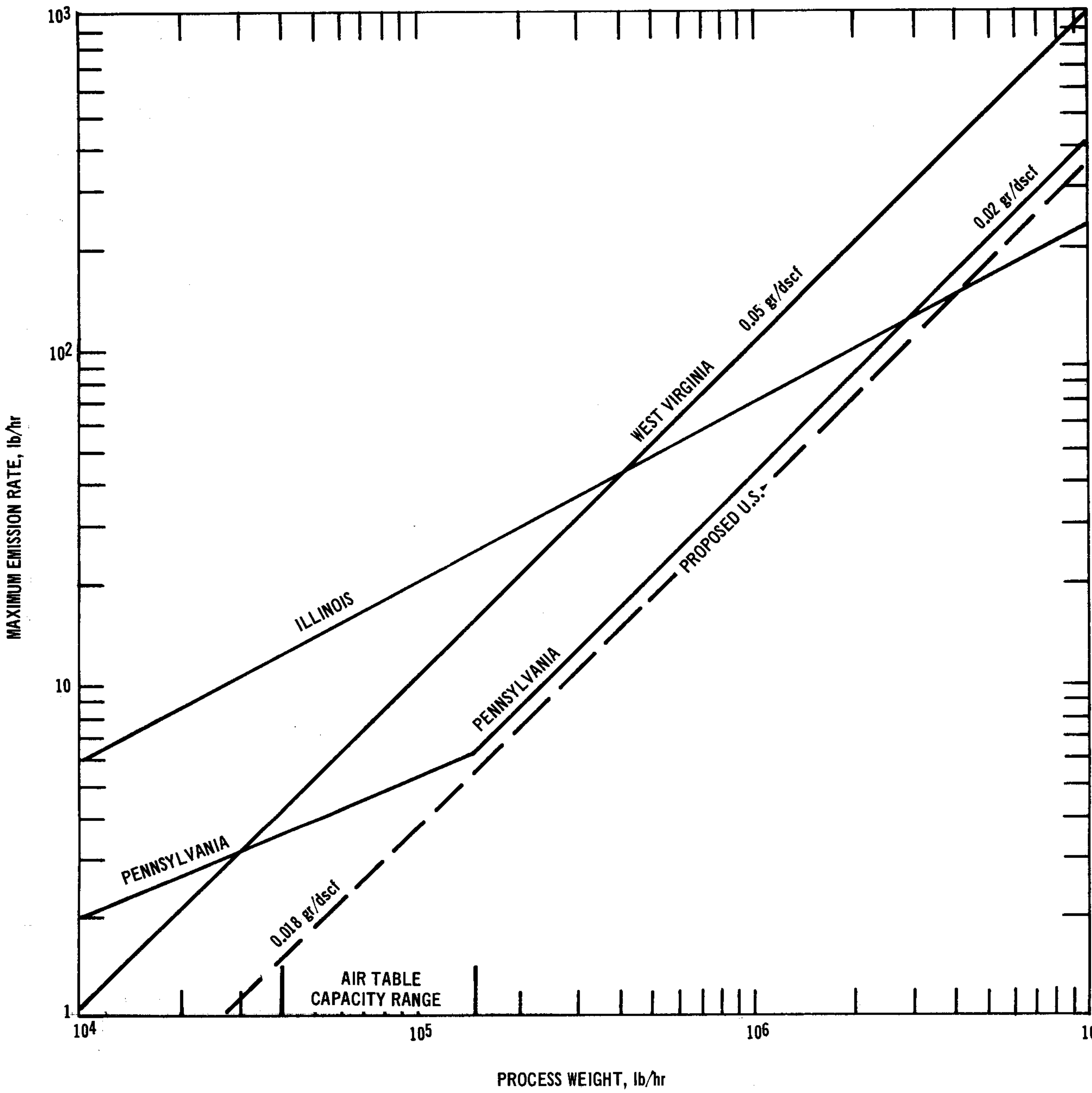
Essentially all of the current coal cleaning operations are subject to particulate regulations. Figures 10 through 12 show the proposed standard of performance in relationship to existing State regulations covering 88 to 98 percent of the coal cleaned. Air table operations are typically controlled by a fabric filter and this control device is capable of meeting all existing State regulations as well as the proposed standard of performance of 0.018 gr/dscf. Therefore, if a fabric filter capable of handling the entire air table effluent is installed, it will, if adequately maintained, meet the proposed standard and result in no adverse economic impact.

Emissions from thermal driers are universally controlled by wet scrubbers. A significant explosion potential exists as hot gases come in contact with finely divided coal. Electrostatic precipitators have not been considered for this reason. Fabric filters are generally unsuitable for the same reason and because the high dew point of the gases could result in blinding the filtration surfaces. The degree of control available from wet scrubbers is a function of the pressure drop across the unit and thus cost is directly proportional to the emission limits. Table 3 depicts the maximum impact of the proposed standards of performance (0.031 gr/dscf) for driers by comparing it to the 0.07 gr/dscf standard of a State where 49 percent of the thermally



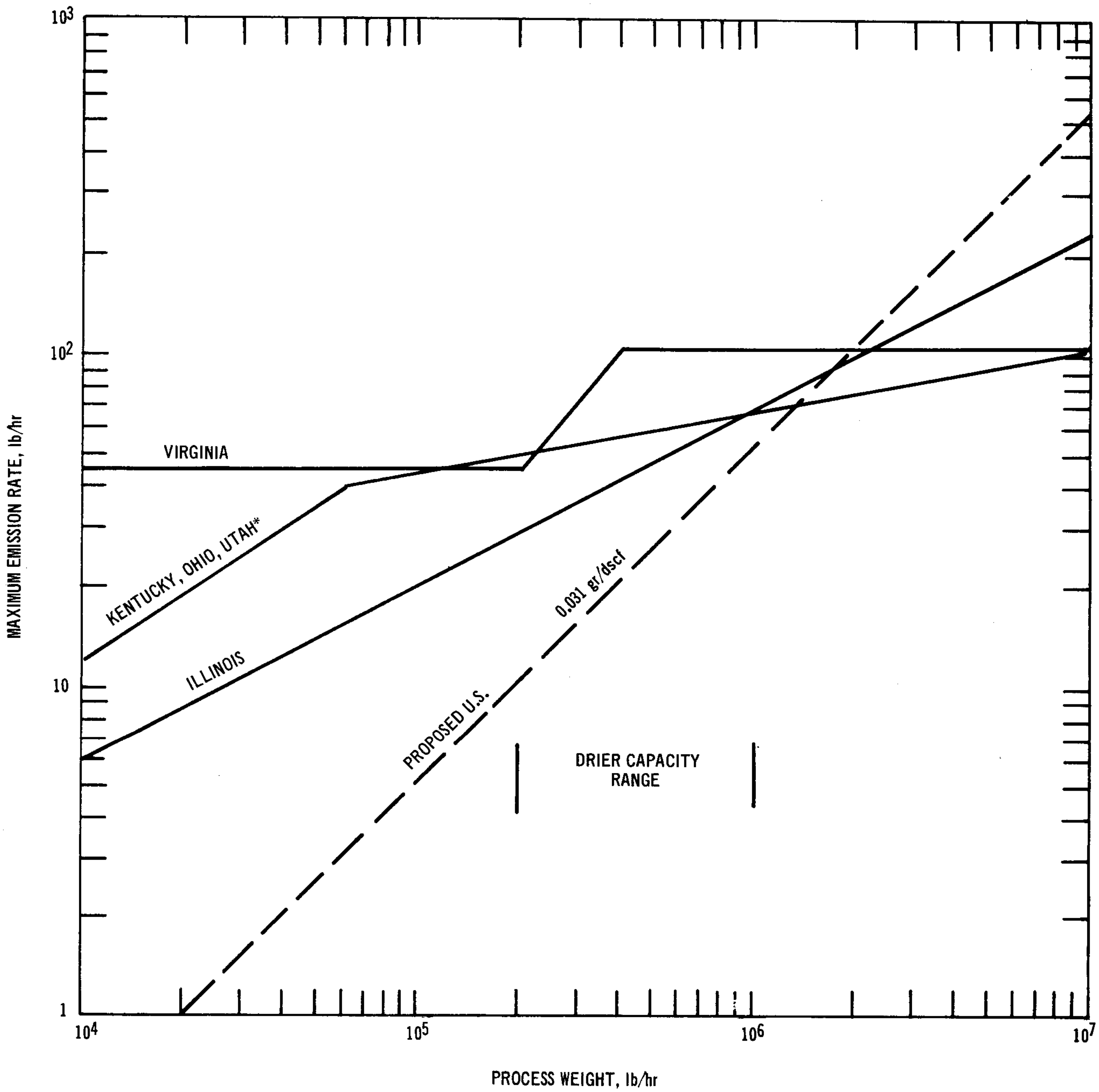
SOURCE: STATE IMPLEMENTATION PLANS, BUREAU OF MINES

Figure 10. Proposed thermal drier regulation (0.031 gr/dscf) compared with existing State regulations (62% of 1971 production represented) - basis: 24,000 dscf/ton.



SOURCE: IMPLEMENTATION PLANS

Figure 11. Proposed air table regulations (0.018 gr/dscf) compared with existing State regulations (98% of 1971 production represented) - basis: 30,000 dscf/ton.



*THIS REGULATION WAS PROPOSED FOR UTAH IN THE FEDERAL REGISTER, JULY 27, 1972, TO BE PROMULGATED BY EPA.

SOURCE: STATE IMPLEMENTATION PLANS, BUREAU OF MINES.

Figure 12. Proposed thermal drier regulation (0.031 gr/dscf) compared with existing State regulations (26% of 1971 production represented) - basis: 24,000 dscf/ton.

dried coal is produced. The State standard will require a unit with 16 inches of water pressure drop. To meet the proposed standard a pressure drop of 25 to 35 inches water gauge is required. The operating costs are geared for that level. However, prudence would dictate the purchase of equipment capable of doing better than just meeting the current regulation. Therefore, where possible, the equipment is sized to provide 10 more inches of water pressure drop than that required by regulation.

Table 3 shows that the total drier investment will be increased by about 3 percent.

Annualized operation costs including additional power, maintenance, taxes, insurance, depreciation, and interest charges were in the range of 6.5¢ per ton of coal cleaned for the plant sized considered.

The after-tax drop in net income, if the increase cannot be passed on, is anticipated at less than 1 percent. However, since the price of coal has risen $1.43/ton to $8.50/ton from 1971 to 1973, the extra cost of 2 cents per ton representing the impact of Federal standards over State standards should be easily passed along.

Since all States require particulate control, the impact of standards of performance on equipment suppliers will amount to a need to upgrade equipment rather than to increase the number of units.

TABLE 3

CONTROL COSTS FOR COAL CLEANING - WET SCRUBBING EQUIPMENT FOR THERMAL DRIERS

Plant Size, Run of Mine	3,000,000 Tons/Year		5,000,000 Tons/Year	
Drier Feed*	401 Tons/Hour		668 Tons/Hour	
Drier Investment	$883,000		$1,199,000	
Emission Standard	A State Regulation (0.07 gr/dscf)	Proposed U.S. Standard (0.03 gr/dscf)	A State Regulation (0.07 gr/dscf)	Proposed U.S. Standard (0.03 gr/dscf)
Control Investment**	$256,000	$284,000	$409,000	$454,000
Investment Increase Required		2.5%		2.8%
Annual Cost	$88,200	$118,200	$142,600	$192,300
Cost Per Ton of Cleaned Coal	4.9¢	6.6¢	4.7¢	6.4¢

*Based on 3480 hours/year and 46.5% feed to driers.
**Fabric filters for fugitive dust would add about $20,000 to each system and $5000 to annual costs.

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16. ABSTRACT

This volume is the first of a series on standards of performance for coal preparation plants. This volume presents the proposed standards and the rationale for the degree of control selected. The volume also discusses the analytical methods for sampling emissions and the environmental and economic impact of the standards.

17. KEY WORDS AND DOCUMENT ANALYSIS

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