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Phosphate Rock Plants - Background Information for Promulgated Standards

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NSPS

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Emission Standards and Engineering Division

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

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ENVIRONMENTAL PROTECTION AGENCY

Background Information and Final Environmental Impact Statement for Phosphate Rock Plants

Prepared by:

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1. The promulgated standards of performance will limit emissions of particulate and visible emissions from new, modified, and reconstructed phosphate rock plants. Section 111 of the Clean Air Act (42 U.S.C. 7411), as amended, directs the Administrator to establish standards of performance for any category of new stationary source of air pollution that ". . . causes or contributes significantly to air pollution which may reasonably be anticipated to endanger public health or welfare." The promulgated standards are expected to primarily affect the states of Florida, North Carolina, Tennessee, Idaho, Wyoming, Utah and Montana.

2. Copies of this document have been sent to the following Federal Departments: Labor, Health and Human Services, Defense, Transportation, Agriculture, Commerce, Interior, and Energy; the National Science Foundation; the Council on Environmental Quality; members of the State and Territorial Air Pollution Program Administrators; the Association of Local Air Pollution Control Officials; EPA Regional Administrators; and other interested parties.

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1. SUMMARY

On September 21, 1979, the U.S. Environmental Protection Agency (EPA) proposed new source performance standards (NSPS) for phosphate rock plants under the authority of Section 111 of the Clean Air Act. The proposed standards were published in the Federal Register (44 FR 54970) with a request for public comment. A total of 16 commenters representing industry, trade associations, private environmental organizations, Federal agencies, and State air pollution control agencies responded to this request. Their comments and EPA's responses are summarized in this document. The summary of comments and responses serves as the basis for the revisions that have been made to the proposed standards.

1.1 SUMMARY OF CHANGES SINCE PROPOSAL

In response to the public comments, several changes have been made in the original proposed standards. The most significant change has been a revision in the allowed particulate emission and opacity limits for phosphate rock dryers and calciners. The proposed standards would have limited particulate emissions from all dryers and calciners to 0.02 and 0.055 kg/Mg (0.04 and 0.11 lb/ton), respectively. Several industrial commenters indicated that the proposed emission limits did not reflect the level of control achievable with the best demonstrated control systems on dryers and calciners operating under the most adverse control conditions. In support of this argument, the commenters provided test data representing controlled emissions from units operating at worst-case conditions. Based upon the evaluation of these new test data, the particulate emission limits for all dryers and calciners calcining unbeneficiated rock have been revised to 0.03 and 0.12 kg/Mg (0.06 and 0.23 lb/ton), respectively. The emission limit of 0.055 kg/Mg (0.11 lb/ton) will still apply to calciners that are calcining beneficiated rock.

Several commenters also questioned the zero-percent opacity limits for dryers and calciners. They felt that the zero-percent limit was unreasonable since all the observations used to support the standard had steam plume interference, and the observations from an ESP-controlled dryer had readings as high as 7.7 percent. Since the particulate emission limits for dryers and calciners have been revised upward and since the ESP-controlled facility had particulate emissions lower than any of the emission limits with corresponding opacity up to 7.7 percent, the opacity limit for dryers and calciners was revised to 10-percent opacity.

Another important change was made to exempt ground rock storage and handling systems from the continuous monitoring requirements. The proposed standards would have required continuous monitors on ground rock storage and handling system emission control equipment. The primary purpose of continuous monitoring equipment is to ensure continuous and proper operation of required particulate collection equipment. The ground rock storage and handling systems are subject only to an opacity limit under the standards, and there are no specific control equipment requirements. Therefore, compliance can be demonstrated routinely with Method 9, making continuous opacity monitors economically unreasonable and unnecessary.

A commenter also suggested that small laboratory or pilot-scale facilities used exclusively for testing and research should be exempted from the standards. In response to this comment, the standards have been revised to exempt plants with maximum hourly production capacities equal to or less than 3.6 Mg/hr (4 tons/hr). This capacity range is less than that of any existing production facility.

In addition to these changes, several wording and definition changes have been made to clarify the applicability of the promulgated standards. The definition of ground rock storage and handling systems has been changed to more clearly define the exclusion of ground rock transfer sources at fertilizer plants from the standards. The definition of grinders has been modified to more clearly define the exclusions of crushers used during mining operations. Additional explanation has been included to explain that the standards would not be applicable to elemental phosphorus producing facilities.

1.2 SUMMARY OF THE IMPACTS OF THE PROMULGATED ACTION

1.2.1 Alternatives to the Promulgated Action

The alternative control techniques are discussed in Chapter 4 of "Phosphate Rock Plants - Background Information for Proposed Standards." (This document is also referred to as the background information document [BID], Volume I.) These alternative control techniques are based upon the best demonstrated technology, considering costs and environmental impacts, for phosphate rock plants. The alternatives—of taking no action and of postponing the promulgated action—are analyzed in Chapter 6 of the BID, Volume I. These alternatives remain unchanged.

1.2.2 Environmental and Energy Impacts of the Promulgated Action

The environmental impacts of the original proposed standards are discussed in Chapter 6 of BID, Volume I. The environmental impacts presented at proposal were based on the proposed emission limits and 1971 growth-projection data from the U.S. Bureau of Mines. Changes made in the proposed standards that would modify the environmental impacts are the revisions in the particulate emission limits for dryers and unbeneficiated rock calciners. There has also been a change in the growth-projection data. Based on more recent (1979) growth-projection data from the U.S. Bureau of Mines, phosphate rock production in 1985 will be approximately 63.0 million Mg (69.4 million tons).[1] Assuming a 20-year life expectancy of existing equipment, the portion of the 1985 production that will be subject to the standard will be approximately 23.3 million Mg (25.7 million tons). Under typical existing State implementation plan (SIP) regulations, allowed particulate emissions from new, reconstructed, or modified dryers, grinders, and calciners would equal 15,400 Mg (17,000 tons) in 1985. However, actual emissions at the existing level of control are less than the allowed emissions because the industry has employed more effective control techniques than required by existing SIP regulations, such as the use of baghouses on grinders.

Assuming that all phosphate rock sources that would be subject to the new source performance standards are operating at the most adverse control conditions, actual particulate emissions in 1985 from phosphate rock grinders, dryers, and calciners using typical existing control equipment would equal 4,600 Mg (5,000 tons). Under the promulgated emission limits the allowed particulate emissions in 1985 from the same grinders, dryers, and calciners would equal 1,300 Mg (1,400 tons). These figures indicate that the promulgated standards would cause a reduction in 1985 of 14,100 Mg (15,600 tons) in the particulate emissions allowed by typical SIP regulations. However, the promulgated standard would actually cause a reduction of 3,300 Mg (3,600 tons) in the 1985 particulate emissions occurring at the control level typical of current industry practices (i.e., low- or medium-energy scrubber on dryers or calciners and baghouses on grinders).

The revisions in the emission limits as originally proposed for dryers and calciners did not involve a change in the best demonstrated continuous control systems. The best demonstrated control systems remain the baghouse and the high-energy venturi scrubber at the originally proposed design parameters. The promulgated emission limits are instead based on a reevaluation of the emission levels achievable with best demonstrated control equipment on worst-case uncontrolled emissions. Therefore, energy impact of the best demonstrated control systems, as presented in Chapters 1 and 6 of the BID, Volume I, remains unchanged.

1.2.3 Economic Impact of the Promulgated Actions

The economic impact of the promulgated standards, like the energy impact, depends on the best demonstrated control systems used as the basis for the standards. Since there has been no change in the best demonstrated control systems, the economic impact, as discussed in Chapters 1 and 7 of the BID, Volume I, remains unchanged.

1.2.4 Other Considerations

1.2.4.1 Adverse Impacts. Based on test data supplied by the phosphate rock industry, worst-case uncontrolled particulate emissions from dryers and calciners are higher than those used to set the original proposed emission limits. The required control techniques and resulting control performance levels (approximately 99.3 percent) are the same as those that formed the basis of the original proposal. Because the uncontrolled particulate emission rates are higher than originally evaluated, the same reduction level will result in a slightly higher rate of collected emissions.

The collected emissions present a solid-waste disposal problem. However, as explained in Chapters 1 and 6 of the BID, Volume I, the solid waste from particulate control equipment is insignificant in comparison to the solid waste produced by mining and beneficiation. Therefore, the incremental increase in solid waste production at the promulgated standard level over the SIP level is considered reasonable.

Other adverse impacts are discussed in Chapters 1 and 6 of the BID, Volume I and have not been changed since the standards were proposed.

1.2.4.2 Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity. This impact is discussed in Chapters 6 and 8 of the BID, Volume I and remains unchanged since proposal.

1.2.4.3 Irreversible and Irretrievable Commitments of Resources. This impact is discussed in Chapter 6 of the BID, Volume I and remains unchanged since proposal.

1.3 REFERENCES FOR CHAPTER 1

1. Stowasser, W. F. Phosphate Mineral Commodity Profiles. U.S. Department of the Interior, Bureau of Mines. January 1979.

2. SUMMARY OF PUBLIC COMMENTS

Comments received on the proposed phosphate rock NSPS and on the BID, Volume I have been divided into the following categories:

1. Applicability and Need for New Source Performance Standards
2. Definitions
3. Cost/Benefit Impact
4. Technical Feasibility
5. Testing and Monitoring

The list of commenters and their affiliations is given in Table 2-1.

2.1 APPLICABILITY AND NEED FOR NEW SOURCE PERFORMANCE STANDARDS

2.1.1 Reasons for New Source Performance Standards

The need for NSPS for phosphate rock facilities was questioned because phosphate rock facilities are not currently violating ambient air quality standards. The purpose of NSPS is not limited to ensuring compliance with ambient air quality standards. They are, instead, intended to ensure that best demonstrated systems of continuous emission reduction are applied to new, modified, or reconstructed stationary sources that have been determined to "cause or contribute significantly to air pollution which may reasonably be anticipated to endanger public health or welfare." NSPS will minimize both the deterioration of existing air quality and the costly retrofitting of control equipment that future air quality problems could necessitate. They will ensure the uniform nationwide application of emission controls. NSPS will also prevent unfair competition for industrial growth that would result from nonuniform environmental regulations. As existing equipment is replaced, new source performance standards will also result in improved air quality.

2.1.2 Environmental Impacts

Several commenters questioned the reduction in particulate emissions, as explained in Chapter 6 of the BID, Volume 1, that would be achieved by the standards. Three commenters indicated that the particulate emission reduction claimed in the proposed standards were overrated because they were based on outdated and overestimated production forecasts, which weakens the rationale for the standard. All three commenters argued that EPA should use the most recent production estimates from the Bureau of Mines. In response to the comments, EPA obtained the most recent Bureau of Mines production forecast data. Although these data significantly reduce the originally estimated 1985 emissions reduction due to the standards by 25 percent, the new estimates of environmental benefits still justify the standards.

Bureau of Mines data from 1979 indicate that U.S. phosphate rock production will increase from 47 million megagrams in 1977 to 64 million megagrams in 1986, but will then decrease to 56.0 million megagrams in 1995.[1] An increase in production of 11.0 million megagrams is expected between 1980 and 1986. In addition, some existing equipment must be replaced because of normal wear. The new equipment would be subject to the standards. Assuming a 20-year life expectancy for existing equipment, the production from replacement equipment subject to the standards will be 13.3 million megagrams in 1985. Of the total phosphate rock production, approximately 23.3 million megagrams will be subject to the standards by 1985. As explained in Chapter 1, Section 1.2.2 of this document, the promulgated standards will reduce the SIP-allowed particulate emission level by 14,100 Mg (15,600 tons) and the actual existing emission level by 3,300 Mg (3,600 tons).

Finally, the primary purpose of an environmental impact analysis is to compare the impacts of alternative regulatory options. The Administrator has determined the need for NSPS for phosphate rock plants because they cause or contribute significantly to air pollution which may reasonably be anticipated to endanger public health or welfare. These significant air pollution impacts include not only total national impacts but also significant local impacts. The promulgation standards will significantly improve and protect local air quality and do justify the standards.

Three commenters suggested that the environmental benefits of the standards were exaggerated because actual emissions from grinders are much less than those allowed by the SIP emission limits. Another commenter felt that the standards should be modified since emission reductions were concentrated in the grinding operation. According to this commenter, possible emission reductions from the other controlled sources would be insignificant. EPA agrees that actual emissions from existing grinders are less than those allowed by SIP regulations. However, because of this fact, the emission reductions resulting from the standards are actually concentrated in drying and calcining operations.

Typical industry practice is to control particulate emissions from grinders with baghouses and to control emissions from dryers and calciners with low- to medium-energy venturi scrubbers. Since baghouses and high-energy venturi scrubbers are the designated best continuous control systems, there is much greater emission reduction potential from the control of dryers and calciners than from the control of grinders. The emissions reduction potential in 1985 is presented in terms of allowed and actual emissions. The actual emission reduction figure does not claim any reductions from the control of grinders. Because baghouses are the typical control technique for grinders and are also designated as the best demonstrated control system, the proposed standards support current industry practice and provide uniformity in control levels with minimal incremental economic impact to the industry above current practice.

Two commenters felt that the environmental benefits were exaggerated because actual emission rates are lower than those allowed by the existing SIP level of control. They also stated that the SIP emission rates used in the BID, Volume 1 were based on obsolete SIP regulations for existing plants rather than on current SIP regulations for new plants.

As noted previously, the environmental benefits presented in Chapter 1, Section 1.2.2 include both actual emission reductions achievable from the existing level of control and reductions in the emissions allowed by the SIP level of control. The SIP emission limits used in Volume 1 of the BID are not all obsolete SIP regulations for existing plants. Of the seven states controlling phosphate rock plants, only Idaho has changed its applicable emission limits. This change occurred after Volume 1 of the BID had been completed. As explained in Volume 1, Idaho accounted for just 12.1 percent of the 1977 production capability; thus changes in the typical SIP limits resulting from the revision in the Idaho limits would be insignificant.

Another commenter stated that the air quality improvements resulting from the original proposed standards were exaggerated since new plants would be subject to limitations on air quality impacts imposed by prevention-of-significant-deterioration (PSD) regulations. It is true that many new or modified facilities subject to the NSPS would also be subject to PSD limitations. PSD is a case-by-case review subject to a number of site-specific variables, including stack heights, stack gas velocities, stack gas temperatures, downwash and meteorological conditions, as well as emission rates. With these variations the ambient air quality impact can also vary. Because of the potential variability in the site-specific parameters, an analysis of incremental PSD impacts above the NSPS level is excessively complex and unnecessary. NSPS support PSD by providing the baseline for "best available control technology" determinations. Because NSPS is therefore the minimum control level that new plants will have to meet, the air quality impacts presented are appropriate for NSPS rulemaking. The analysis of air quality impacts compares the NSPS emission rate to both the typical SIP allowed emission rate and the actual existing emission rate resulting from current industry practice. While the commenter is correct in pointing out that PSD requirements may go beyond NSPS, an assessment of PSD impacts is not within the scope of an analysis to support NSPS.

2.1.3 Opacity Standard

The need for an opacity standard was questioned by two commenters. The two commenters felt that it is unrealistic to have both an opacity standard and a particulate emission limit for the same emission source. The primary purpose of an opacity standard is to provide a simple and inexpensive means for enforcing the requirement of continuous and proper operation of emission control equipment. It is true that both the opacity limits and the particulate mass emission limits apply to the same pollutant. However, compliance with the particulate emission limits can only be demonstrated with Reference Method 5 performance tests. Method 5 tests are time consuming and require long-term advance scheduling and sophisticated test equipment. Without additional enforcement procedures, emission control equipment could be improperly operated between or after Method 5 tests. Compliance with opacity standards are determined with Method 9. Method 9 consists of visible observations conducted by a qualified observer following a specified procedure. Method 9 is quicker, simpler, and less expensive than Method 5. It can be performed routinely to document compliance with the intent of the standards. Therefore, opacity limits provide an enforcement tool for routine demonstration of compliance with the standards. It should be noted that the United States Court of Appeals for the District of Columbia Circuit has specifically upheld the use of opacity standards to measure and aid in controlling mass emissions under NSPS. Portland Cement Association v. Train, 513 F.2d 506, 508 (1975).

2.1.4 Testing Facilities

The need to exclude small sources such as pilot plants or testing facilities was pointed out by one commenter. EPA agrees with the comment and has added an exemption for facilities processing less than 3.6 Mg/hr (4 ton/hr). The decision to exempt small facilities from the standards is based on the cost-effectiveness of control. That is, the costs per megagram (ton) of emissions reduction. The cost-effectiveness evaluated is reduction in uncontrolled emissions, not reductions from the SIP level. Although the commenter requested a .9 Mg/hr (1.0 ton/hr cutoff), the plant capacity level chosen of 3.6 Mg/hr (4.0 tons/hr) is based on the fact that no affected source (i.e., dryer, calciner, grinder) at a production facility has a maximum capacity less than 4.5 Mg/hr (5.0 tons/hr). An economic analysis of a dryer and grinder with capacities of 3.6 Mg/hr (4 ton/hr) has been performed to determine the cost-effectiveness of the standards at this cutoff level.

Since research facilities would not operate sources continuously or as frequently as production facilities an annual operating figure of 500 hours was assumed. Based on industry comments it was assumed that for compliance purposes a high energy venturi scrubber would be chosen for the dryer and a baghouse for the grinder. The cost of the standards would be about $1,075 and $2,000 per megagram ($975 and $1,800 per ton) of particulate removed for the dryer and the grinder, respectively. Comparative cost for a typical 145 Mg/hr (150 ton/hr) dryer and a typical 14 Mg/hr (15 ton/yr) grinder indicate a cost-effectiveness of $79/Mg ($72/ton) and $260/Mg ($236/ton), respectively.

Although the cost of control at the 3.6 Mg/hr (4.0 ton/hr) level may not be excessive, most research and development facilities will actually use smaller equipment. Therefore, the cost of control will increase even higher. Because no production facilities exist with a capacity less than 4.5 Mg/hr (5.0 ton/hr) and control cost become excessive below 3.6 Mg/hr (4.0 ton/hr), the lower capacity cutoff is justified.

2.1.5 Other Pollutants

One State air pollution control agency suggested that the standards should contain emission limits for carbon monoxide, sulfur dioxide, fluoride, nitrogen oxides, and hydrocarbons from dryers and calciners. EPA has analyzed the need for regulating emissions of these pollutants from dryers and calciners and has concluded that there is no justification for their regulation.

In addition to particulates, both phosphate rock dryers and calciners emit sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), hydrocarbons and fluorides. Typical phosphate rock has a fluoride content of approximately 4 to 5 percent by weight, expressed as fluorine. There is a potential to volatilize these fluorides at high temperatures. However, in experiments by the Tennessee Valley Authority (TVA), phosphate rock samples were heated to 500°C, 600°C, 700°C, 800°C, and 950°C for 30 minutes each.[3] Chemical analysis showed fluorine volatilization only in the sample heated to 950°C. Seven percent of the fluorine in that sample was volatilized. Typical final temperatures for dryers and calciners are 95°C and 870°C, respectively. These data indicate that typical process temperatures in both dryers and calciners are insufficient to cause gaseous fluoride emissions. Since any solid fluorides would be controlled by the particulate control equipment, there is no need for a fluoride standard.

SO_2, CO, NO_x, and hydrocarbon emissions from dryers and calciners are primarily due to fuel combustion. Fuel combustion in phosphate rock dryers and calciners does not differ appreciably from fuel combustion in lime kilns. Typical lime kilns operate at approximately 3.25 x 10^6 Btu per ton of rock feed and have exhaust gas temperatures in the range of 593° to 760°C. Process energy varies from 251,000 to 481,000 Btu per ton of rock feed for phosphate rock dryers and from 375,000 to 525,000 Btu/ton for calciners. Therefore, there is a significantly larger amount of fuel combusted per ton of rock in lime kilns with correspondingly higher emissions of SO_2, NO_x, CO and hydrocarbons per ton of rock feed.

Emission tests of NO_x, SO_2, and CO emissions have been performed on lime kilns firing coal, natural gas, and No. 6 fuel oil.[4] These tests indicated that flue gas NO_x concentrations are normally in the range of 200 ppm or approximately 0.45 pounds per million Btu of heat input. At adverse meteorological conditions, with aerodynamic downwash, dispersion modeling indicates a maximum concentration of about 10 μg/m^3 for a typical lime kiln (1,000 tons/day of feedrock). Because of less fuel combustion per unit of rock, this level would be even lower for typical phosphate rock dryers and calciners. Also, NO_x control combustion modifications have not been demonstrated for dryers and calciners. Therefore, NO_x emissions were not selected for control.

Both CO and hydrocarbons result from incomplete fuel combustion. The emission tests on lime kilns indicate that CO emissions are normally in the range of 100 ppm. Under adverse meteorological conditions, with aerodynamic downwash, dispersion modeling indicates that CO emissions from a typical lime kiln would cause an insignificant maximum concentration of about 30 μg/m^3 (8-hour average). CO emissions from typical phosphate rock dryers and calciners would be even lower because of lower fuel consumption. Since hydrocarbons would result from the same incomplete combustion that produces the CO, their emission levels would vary with the CO. The most effective control technique for both CO and hydrocarbons would be incineration of the flue gas. The use of incineration would cause a significant fuel use increase with little environmental benefit. Therefore, neither CO or hydrocarbon emissions from phosphate rock dryers and calciners were selected for control.

The emission tests of the lime kilns indicate that the calcium oxide in the feed rock causes an SO_2 reduction of about 88 percent with dry particulate control devices and about 94 percent with wet scrubbers. The SO_2 reduction is caused by a chemical reaction with CaO that forms solid $CaSO_4$. Because phosphate rock typically contains about 55-percent calcium oxide, similar SO_2 reductions can be expected. Since potential SO_2 emissions from phosphate rock dryers and calciners would likely be significantly reduced by up to 80-90 percent, no additional control requirements were selected.

2.2 DEFINITIONS

2.2.1 Phosphate Rock Plants

Several commenters requested wording and definition changes in the proposed standards to clarify the meaning of certain terms. It was requested that the definition of phosphate rock plants be modified to clearly define the exclusion of elemental phosphorus plants and fertilizer production facilities. The promulgated standards for phosphate rock plants are not intended to include mining, beneficiation, thermal defluorination, elemental phosphorus production, or nodulizing. Section 60.400(a) of the promulgated standards specifies that the standards apply only to facilities at phosphate rock plants, including grinders, calciners, dryers, and ground rock storage and handling systems. The definition of phosphate rock plant implicitly excludes fertilizer plants.

The proposed standards are not intended to apply to elemental phosphorus plants, because no significant growth is expected in these facilities. However, the appropriate method of excluding these facilities is to modify applicability. Section 60.400(a) has been modified to read: "The provisions of this subpart are applicable to the following affected facilities used in phosphate rock plants: dryers, calciners, grinders, and ground-rock-handling and storage facilities, except those facilities producing or preparing phosphate rock solely for consumption in elemental phosphorus furnaces."

2.2.2 Grinders and Ground Rock Handling

A request was also made to more clearly define the exclusion of phosphate rock handling and crushing during mining operations. The promulgated standards are not intended to cover phosphate rock handling or crushing during mining operations. The definition of grinder has been changed to "a unit used to pulverize dry phosphate rock to the final product size used in the manufacture of phosphate fertilizer and does not include crushing devices used during mining operations." Section 60.402(a)(5) has been modified to read: "From any ground phosphate rock handling and storage system any gases which exhibit greater than zero percent opacity." This modification prevents the incorrect inclusion of unground phosphate rock handling and storage at mining or transfer sites.

2.2.3 Feed Rate

One commenter questioned whether the allowable emission limits (weight per megagram (ton) of phosphate rock) were based on wet or dry rock. As specified in the standards, the emission limits are based on the weight of the phosphate rock feed. The term "feed" means all weight entering into the process, including moisture and any recycled materials.

2.3 COST/BENEFIT IMPACT

2.3.1 Sliding Scale Standard

One commenter recommended that production rate size differences be considered in setting the standards, since the cost effectiveness for controlling larger plants is often greater than for controlling smaller plants. The commenter pointed out that under existing SIP regulations, large plants were subject to a more stringent level of control than smaller plants.

EPA agrees that, because of the sliding scale in State process weight tables, larger sources are subject to more stringent emission limits than the typical plants used in the Volume 1 analysis. However, the SIP regulations are all miscellaneous process standards and do not apply solely to phosphate rock plants. The typical plants used in the analysis were selected to compare the environmental, energy, and economic impacts of alternative regulatory options. The actual emission limits in the standard are based on the application of the best demonstrated control technologies to the emission sources. Available data do not indicate that particulate concentration and particle size distributions vary with production rate; therefore, there is no significant variation in the performance of the best demonstrated control techniques on units of different sizes. Thus the promulgated emission limits resulting from the application of the best control techniques do not vary with production rate.

2.3.2 Additional Power Requirements

One commenter stated that the increases in particulate and sulfur dioxide (SO_2) emissions from power plants caused by the additional energy production required by the more stringent control techniques of the promulgated standards were not considered in the standard analysis for Florida phosphate rock plants.

EPA has analyzed these impacts and concluded that environmental benefits resulting from the standards outweigh any adverse environmental effects. If high-energy venturi scrubbers are used to comply with the NSPS, the process energy required would increase by about 4,041 Btu per ton of rock processed above the existing SIP level of control. In 1985, the quantity of particulate emissions attributable to the additional NSPS energy demands produced by Florida power plants under existing power plant regulations will be only about 1.1 percent of the total emission reduction potential of the NSPS on Florida phosphate rock dryers. The quantity of SO_2 emissions produced from the power plants supplying the additional energy requirements cannot be compared directly to the particulate reduction potential of the standard, because the two pollutants produce different environmental effects. However, the increase in SO_2 emissions from energy production would amount to about 18 percent of the decrease in phosphate rock plant particulate emissions if a 2.0-percent sulfur coal is utilized. It should also be noted that any new power plants would be subject to NSPS and the increases in SO_2 and particulate emissions from the additional energy production would be even less.

Another commenter indicated that the power grid for some Western plants would not be able to handle the additional energy needs of the proposed standard. The commenter did not supply any specific energy production capability data for the power grids in question. Although the commenter did use the city of Portland, Oregon's energy problems as an example, there are no existing or projected phosphate rock plants in that location. It is expected that the emission limits on Western plants will result in an 8-percent increase in total process unit energy over the SIP level if high-energy venturi scrubbers are used, approximately no change in energy requirements if electrostatic precipitators (ESP's) are used and about a 5-percent increase when baghouses are used. For a typical new western plant with three 54 Mg/hr (60 ton/hr) calciners, one 83 Mg/hr (91 ton/hr) grinder, and two 13 Mg/hr (14 ton/hr) grinders, the estimated annual power usage would be 44.3 million kWh. With an 8 percent increase in total process energy resulting from the standards, the total plant energy requirement would increase to 47.8 million kWh. This incremental increase in power requirements should not adversely affect the ability of the local power grid to supply additional energy needs for new or modified sources. If the local power grid is able to supply the energy requirements for processing equipment and SIP level control equipment for a new or modified source, it should be able to meet the minor incremental increase caused by the promulgated control levels.

2.3.3 Control Cost

Since Western rock usually contains a higher precentage of fines than Eastern rock, one commenter indicated that particulate loadings and corresponding control costs would be higher for Western plants. Western unbeneficiated rock does contain higher percentages of fines than Eastern rock; however, the source tests used to set the emission limits for calciners processing unbeneficiated rock were conducted with unbeneficiated Western rock. The economic analysis of control costs in Chapter 7 of Volume I of the BID conclude that control costs, although higher for Western plants, are not excessive.

Three commenters stated that baghouses on dryers and calciners would require an auxiliary heat source that has not been costed. The need for an auxiliary heat source for baghouses on dryers and calciners was not addressed in the proposed standards because it should be unnecessary. Baghouses are presently operated on similar applications, including asphalt aggregate dryers, without an auxiliary heat source.[5] The temperature differential necessary to prevent condensation can be maintained by properly insulating the baghouse and all ductwork to prevent heat loss. During start-up, the baghouse can be heated to operating temperature by operating the burners at low fire with no rock in the dryer or calciner.

The commenters further stated that the annualized costs for baghouses had been underestimated in comparison to venturi scrubber costs because the costs of the baghouse were depreciated over a fifteen year period, while venturi scrubber costs depreciated over a ten year period. They also suggested that the baghouse cloth area requirements that were costed should have been based on 120 to 125 percent of the calculated cloth area for the designated gas volume processed. They felt that the additional capacity would assure proper operation during unexpected high gas volume flow. However, the baghouse was depreciated over a longer period because experience indicates that baghouses typically have a longer equipment life than venturi scrubbers.[6] The economic analysis was performed to compare the costs of the alternative regulatory options. Therefore, the costed cloth area of the baghouse was based on the same volume of gas processed as was the venturi scrubber. For comparative purposes, it would be inappropriate to cost the venturi scrubber for a particular gas volume and then cost the baghouse at 120 to 125 percent of that same flow.

The commenters also argued that baghouse costs for calciners had been underestimated because the air flows that were costed for the model facilities were too low. However, as pointed out in Volume I of the BID, calciner air flows for typical 45.4 Mg/hr (50 ton/hr) units range from 850 to 1,700 standard m^3/min (30,000 - 60,000 scfm). At a typical exhaust temperature of 120°C, these figures would present an air flow range of 1,160 to 2,310 actual m^3/min (40,800 to 81,600 acfm). The air volume costed for the model calciner facility was 2,930 actual m^3/min (103,460 acfm) for a 54 Mg/hr (60 ton/hr) unit. Therefore, the air flow costed is representative of the upper range of air flows and does not cause an underestimation of control costs.

Another commenter pointed out that, unlike typical Western plants, the model Western plants given in Volume I of the BID do not incorporate a drying cycle between the beneficiation and calcining processes. This omission causes the estimated control cost to be erroneously low. EPA agrees that the addition of a dryer to a model Western rock processing facility would increase annual control costs for typical Western plants. However, existing SIP regulations already require control of dryer emissions. The level of control required by SIP regulations for new dryers will probably be achieved with scrubbers. Based on industrial comments, plant owners would install venturi scrubbers to comply with the promulgated NSPS. Scrubber installation costs are approximately the same even at different performance levels. Since SIP regulations already require scrubbers, there would be no significant increase in installation costs for the promulgated standards above the SIP level. There would, however, be an increase in operating costs for a higher energy scrubber. For a typical 160-ton/hr dryer, increased annualized costs above the SIP level would be approximately $0.07 (1978 dollars) per ton of product. The estimated cost of phosphate rock at model Western plants under the promulgated level of control (venturi scrubbers on calciners, baghouses on grinders, and handling) would increase with the addition of a high-energy venturi scrubber on a dryer from approximately $22.25/ton to $22.32/ton (1978 dollars). This cost increase would not significantly affect the cost-effectiveness of the standards.

A general comment was that the emission limits originally proposed were based on typical rather than worst-case conditions and that the cost estimates to meet these emission limits on a continuous basis were underestimated. Although the original emission limits were erroneously based on typical conditions, the control equipment costs were not under estimated. The promulgated standards are based on the application of best demonstrated continuous emission reduction systems to the emission sources under consideration. Applicable emission limits result from the application of these controls to worst-case conditions. The available control options for phosphate rock plants are baghouses and high-efficiency venturi scrubbers. The costs of these control devices do not vary appreciably at a particular performance level on a particular application. The typical cases used in the original analysis did not reflect worst-case conditions. Therefore, the particulate loading to the control devices are larger than originally analyzed. As a result, the reduction in these uncontrolled particulate emissions available with the best control systems (approximately 99.3 percent) results in higher controlled emission levels. The emission limits for dryers and calciners have been revised upward accordingly. However, the available control systems have not changed, and the costs presented in the analysis for a control system on a particular emission source have not changed.

The comment was also made that collected waste from baghouses and ESP's would probably be slurried for disposal, thus causing higher waste disposal costs than those presented in the analysis. If collected waste from baghouses and dry ESP's were slurried for disposal, there would be an increase in solid waste, water pollution, and energy consumption. However, the resulting solid waste and water pollution treatment requirements would still be insignificant when added to the total plant waste from mining and beneficiation. As discussed in Volume 1 of the BID, these insignificant increases would not affect the cost effectiveness of the standards.

One commenter stated that the control costs presented in Volume 1 of the BID were underestimated since they did not include the costs to install, calibrate, maintain, and operate a device for measuring phosphate rock mass feed. The cost of rock feed rate (by weight) equipment was addressed and considered in Volume 1 (page 7-58). Rock feed measuring equipment is normally used at phosphate rock plants to measure production process feed rates and is not solely a part of control requirements. The installation cost of rock feed measuring equipment is about $14,000 (1978 dollars) for a facility processing 150 tons per hour of rock; the annualized cost is about $3,500.[7] This annualized cost is only about 1.1 percent of the annualized cost for a high-energy venturi scrubber on a 150-ton/hour dryer. This additional cost does not significantly affect the cost-effectiveness of the standards.

2.3.4 Exhaust Stacks

Two commenters noted that an opacity standard would penalize companies that use larger than normal diameter stacks or that duct several sources into a common stack for economic considerations. The commenters are correct in stating that the opacity level would increase with increasing stack diameter because the width of the plume would also increase. However, the test data base indicates that facilities with normal diameter stacks which are complying with the mass emission limits will comply with the opacity standard. In addition, stack diameter would have no effect on the particulate mass emission limits. There is site-specific relief (40 CFR 60.11(e)) from the opacity standard for sources achieving the mass emission limit. Facilities considering abnormal stack configurations would have to weigh the benefits of ducting several sources to a single stack or of using larger than normal stacks against the inconvenience of applying for site-specific opacity relief.

2.4 TECHNICAL FEASIBILITY

2.4.1 Particulate Emission Limits

Several commenters complained that the test data base presented in Volume 1 was skimpy, old, and outdated. They further stated that the data base for dryers and calciners did not account for the full range of operating conditions in the industry. One commenter stated that the particle size distribution used in determining control equipment efficiency requirements did not represent worst case conditions and led to incorrect conclusions concerning the ability of available control technology to achieve the proposed limits. Finally, the commenters suggested that the proposed emission limits be revised to 0.085 kg/Mg (0.17 lb/ton) for dryers and 0.20 kg/Mg (0.40 lb/ton) for calciners.

In response to the commenters, EPA has revised the emission limit for dryers and has added an emission limit for calciners processing unbeneficiated rock. The proposed emission limit for calciners was retained for units processing beneficiated rock. The revised emission limits are based on new source test data, as supplied by industry and local air pollution control agencies. However, the evaluation of the new source test data does not justify revisions to 0.85 kg/Mg (0.17 lb/ton) and 0.20 kg/Mg (0.40 lb/ton) for dryers and calciners, respectively, as requested by the industrial commenters. The emission limits for both dryers and unbeneficiated rock calciners are based on actual achieved emission levels from industry-supplied source tests of well-controlled facilities. Only the retained emission limit for beneficiated rock calciners is based on an engineering evaluation of the achievable control level. This engineering evaluation assumed more severe control conditions (particle size distribution from unbeneficiated rock) than would be expected to occur. The emission limit for beneficiated rock calciners is a conservative determination of the consistently achievable emission level. Therefore, these emission limits are more representative of the levels achievable by well-controlled facilities than the limits suggested by industry.

EPA agrees that the achievable emission limits should be set at a level based on the application of the best demonstrated control systems to the worst-case emission control conditions that can reasonably be expected to recur. The test data on whch the emission limits are based must be representative of the full range of operating conditions in the industry. Without consideration of the extremes in emission levels that can be caused by process variables, emission limits cannot be set at levels that can be achieved by all sources on a continuous basis under all reasonable process conditions.

A review of the data base used in the original proposal indicates that the control situations used did not always represent the worst-case control levels. As a result, new test data representing worst-case conditions were requested from the industry and State air programs. The comment period was extended to allow industry time to submit more detailed information concerning the range of operating conditions routinely experienced by dryers and calciners. In response to the request for new data, source tests from two facilities that dry coarse pebble rock in residual oil-fired rotary units were submitted. Test data were also received for a fluidized-bed, natural gas-fired calciner calcining a blend of unbeneficiated and beneficiated Western rock. This is the only existing facility calcining unbeneficiated Western rock.

An analysis of the new test data and additional information submitted by industry indicated three major variables that have the potential to affect particle size distributions and emission levels from phosphate rock dryers and calciners. The three major variables are feed rock characteristics, dryer or calciner unit type, and the fuel type.

The feed rock characteristics are the most important of the process variables that affect emission levels. Industrial contacts have indicated that the effects of feed rock variations greatly outweigh the effects of other variables. Several feed rock characteristics can affect the emission levels and particle size distribution of the exhaust gas streams. Surface properties affect emission levels; rough or pitted surfaces can have greater clay adhesion, resulting in higher emission levels and smaller average particle size. During beneficiation, the least washed rock will have more fines, higher emission levels, and smaller average particle size. The residence time during which the rock is dried or calcined may also affect emission levels. Although increasing the residence time may lower particulate concentration per volume of exhaust gas, the total weight of particulate emisison per weight of feed rock will increase. Other feed rock characteristics can also cause fluctuations in the particulate emission levels. Coarse pebble rock from Florida is beneficiated the least and has the longest residence time in the dryer of all Eastern rock. Along with other properties including hardness and clay adhesion, these properties cause coarse pebble rock to produce the most adverse, or worst-case, control levels for Eastern operations. However, unbeneficiated Western rock has a slightly smaller average particle size then Eastern rock and represents the most adverse of all feed rock control situations.

Fuel combustion that provides the heat source for drying or calcining has the potential to affect emission levels. The four fuel types used in dryers and calciners are natural gas, distillate oil, residual oil, and coal. The particulate emissions resulting from combustion of natural gas and distillate oil are insignificant and will not affect processing unit emission levels or control equipment performance. Residual oil and coal contain noncombustibles that are emitted as ash during combustion. This ash contributes to the particulate emission from dryers and calciners.

Calciners and dryers are direct fired; that is, the products of combustion pass through the dryer or calciner and contact the process feed rock. No data are currently available on what percentage of the residual oil or coal ash would be collected on the process rock by impaction or other processes. Therefore, there is no data available to determine the impact of residual oil or coal firing on achievable emission limits.

Although there is no test data, an analysis of coal and residual oil firing can be performed using those assumptions that would result in the greatest environmental impact. A dryer and a calciner using 10-percent ash coal at 29,073 kJ/kg (12,500 Btu/lb) and AP-42 pulverized coal-fired boiler emission rates would have uncontrolled particulate emissions of about 1.3 and 1.6 kilogram per megagram (2.5 and 3.2 lb/ton) of feed rock, respectively.[8] Pulverized firing has the highest mass emission level and lowest average particle size of all coal-firing types and represents the most difficult control situation. The mass median diameter of the particle size distribution from pulverized coal used in the analysis is 20 μm.[9] The fractional efficiency curves for baghouses and 7.5 kPa (30 inches of water) pressure drop venturi scrubbers used in Volume I of the BID indicate an efficiency of about 99.7 percent with this particle size distribution. Assuming that all of the coal fly ash passes through the process unit and into the collection device, the contribution to the controlled emissions at 99.7 percent control would be 0.0037 and 0.0048 kilogram per megagram (0.0075 and 0.0096 lb/ton) of feed rock for the dryer and calciner, respectively.

Using AP-42 emission factors and assuming a residual oil with 1.5 percent sulfur, the uncontrolled particulate emissions from residual oil combustion would be about 0.025 kilogram per megagram (0.05 lb/ton) of feed rock for a dryer and 0.03 kilogram per megagram (0.06 lb/ton) for a calciner. The average particle size of particulates from residual oil combustion is much smaller than that from coal combustion.[10] The fractional efficiency curves for the 7.5 kPa (30 inches of water) venturi scrubber indicate a control efficiency of about 60 percent on residual oil-fired particulate emissions. Assuming that all the particulate emissions from the oil combustion pass to the control device, the contribution to controlled emissions would be about 0.01 kilogram per megagram (0.02 lb/ton) of feed rock for dryers and calciners. Based on the analysis above, residual oil would have a greater effect on controlled emissions and represent the worst case fuel type.

This analysis assumes the most adverse effects from coal and oil firing. In reality, some percentage of the coal and oil fly ash would probably be collected on the process rock. As a result, any increase in controlled emissions would probably be even less than that calculated.

The major unit types are rotary and fluidized-bed units. Fluidized-bed units are designed to pass the heated combustion gases up through the bed of phosphate rock. Therefore, there would be a greater potential for entrainment of fines than with the rotary unit. However, test data indicate no significant differences in the gas volumes or emission levels from fluidized-bed or rotary units.

The worst-case test data received for one of the dryer facilities contained seven tests with inlet loadings to the particulate control device. The existing control equipment was not equal in performance to the designated best demonstrated control systems. Therefore, the controlled emission levels could not be used directly to set an emission limit. However, three of the tests were conducted with coarse pebble rock and the inlet loading data were representative of the worst-case control conditions. The inlet loadings to the control device were 3.49, 2.50, and 2.92 kg/Mg (6.98, 5.01, and 5.83 lb/ton). The data base provided in BID, Volume I presented a particle size distribution from coarse pebble rock at this facility. Application of this particle size distribution to the fractional efficiency curves for the best demonstrated control systems used in BID, Volume 1 (page 4-10) indicates a control efficiency of 99.3-99.4 percent. If the highest inlet loading provided is reduced by 99.3 percent, an emission level of 0.025 kg/Mg (0.049 lb/ton) is achievable.

The other dryer facility was controlled by a venturi scrubber operating at 7.5 kPa (30 inches of water) pressure drop, which is equivalent to the designated best demonstrated control systems. Four tests with controlled emissions were provided. During two of the tests, the rock processed was a blend of coarse pebble and pebble rock. The blends were 67 and 33 percent coarse pebble, respectively, during the two tests. The results of the tests indicated that the controlled emission levels were 0.028 and 0.029 kg/Mg (0.055 and 0.057 lb/ton).

Western rock processing facilities usually calcine all rock. As a result dryers at Western facilities are used only to reduce the moisture content before transportation of the rock from mine site to the processing plant. Because Western rock is relatively low in natural moisture content, the moisture removed by a Western dryer is primarily due to beneficiation. Unbeneficiated western rock would require no drying. Therefore, the tested dryer facilities processing coarse pebble rock are representative of dryers processing the worst-case rock type. Because these units are fired with residual oil they are also representative of the worst-case fuel types. Based on the tests from the two dryer facilities, the particulate emission limit for phosphate rock dryers has been revised to 0.03 kg/Mg (0.06 lb/ton). These tests indicate that this emission limit is achievable with either worst-case rock or blends of worst-case and other rock types.

The worst-case calciner test data consists of 10 source tests with controlled emissions. The emissions are controlled with a centrifield scrubber operating at 5 - 7.5 kPa (20-30 inches of water) pressure drop. There is no significant difference in the performance of a centrifield scrubber and a venturi scrubber operating at the same pressure drop.[11] Therefore, this particular centrifield scrubber is equivalent to the designated best demonstrated control systems. The controlled emissions from the 10 tests ranged from 0.019 to 0.104 kg/Mg (0.037 to 0.208 lb/ton). The rock processed during the tests was a blend of unbeneficiated and beneficiated rock. The highest emission level is representative of the upper range of controlled emissions from any mix of beneficiated and unbeneficiated rock; up to 100 percent unbeneficiated. Although the rock processed is representative of the worst-case rock type, the unit is fired with natural gas. The worst-case fuel type as presented previously is residual oil. As explained in the previous analysis residual oil can increase controlled emissions from a high energy venturi scrubber on a calciner by about 0.01 kg/Mg (0.02 lb/ton). This emission increase would raise the highest controlled emission level to 0.12 kg/Mg (0.23 lb/ton). Based on this evaluation, the emission limit for calciners calcining unbeneficiated rock or blends of beneficiated and unbeneficiated rock has been set at 0.12 kg/Mg (0.23 lb/ton). Calciners processing blends with a small percentage of unbeneficiated rock could comply with a lower emission limit. However, existing data are insufficient to determine an exact relationship between emission level and blend ratios. This emission limit applies to all mixtures of unbeneficiated and beneficiated rock, but is not intended for facilities that would normally beneficiate all rock.

The majority of existing calcining facilities are using beneficiated rock. If this trend continues with new facilities, an emission limit based on unbeneficiated rock would allow the many sources using beneficiated rock to comply with the emission limits with less than the best demonstrated control systems. The purpose of NSPS is to require the best demonstrated control systems on emission sources; therefore, the emission limit for calciners of 0.055 kg/Mg (0.11 lb/ton) that was originally proposed is retained for those calciners processing beneficiated rock. The rationale for the original proposed emission limit is presented in Volume 1 and is based on tests at a facility processing beneficiated rock.

Several commenters questioned the modeling techniques used to set the emission limit for beneficiated rock calciners. They felt that it was unreasonable to use theoretical modeling techniques to project the performance of a high-energy venturi scrubber from the demonstrated performance of a low-energy scrubber. They also felt that the particle size distribution used in the scrubber model was in error.

In situations where there are no existing facilities controlled with either best available control systems or equivalent systems available for testing, it is technically feasible to use calibrated modeling techniques. The test data used in the analysis contained controlled emissions from a 3.0 kPa (12 inches of water) pressure drop venturi scrubber. The calibrated scrubber model was used to project the performance of the same venturi scrubber at 6.75 kPa (27 inches of water). The original model analysis presented in Volume I of the BID (page 8-30, 31) indicated that the controlled emissions would decrease by about 71 percent with the increase in pressure drop. Using the industry supplied worst-case particle size distribution for calciners (unbeneficiated Western rock) from Volume I of the BID (page 4-11), the scrubber performance at both pressure drops has been remodeled. This particle size distribution actually presents a more difficult control situation than would occur with beneficiated rock. The remodeling supports the 71-percent decrease in controlled emissions. The highest controlled emissions from the source tests of the 3.0 kPa (12 inches of water) unit is 0.12 kg/Mg (0.24 lb/ton). A reduction of 71 percent in this emission level would indicate an achievable level with the higher-energy venturi scrubber of about 0.035 kg/Mg (0.07 lb/ton). The actual emission limit promulgated for the beneficiated rock calciners of 0.055 kg/Mg (0.11 lb/ton) includes a margin to account for any inaccuracies in the scrubber model and the impact of potential residual oil firing.

A frequent comment was that the particulate emission limits could not be met on a continuous basis because the particulate control equipment could not be operated continuously at maximum efficiency. The particulate matter emission limits are based on the performance of the best available control equipment on the worst-case emission levels. These emission levels represent the most adverse conditions that could reasonably occur. These levels do not represent the emission levels occurring under all conditions in the industry. Therefore, maximum efficiency will not be required to meet the emission limits at all times. However, the specified control equipment has demonstrated the ability to comply continuously with the standards under all conditions. In fact, equipment malfunctions are the only conditions which could conceivably prevent compliance at any time. Section 60.11(a) of the general provisions explains that only reference method performance tests are used to determine compliance with mass emission limits. After or between the performance tests, opacity limits will indicate compliance of emission control systems on a continuous basis. Section 60.11(c) states that opacity standards shall apply at all times except during periods of start-up, shutdown, and malfunction. Therefore, provisions are provided for unavoidable excursions above the standards caused by equipment malfunction. However, it should be noted that Section 60.11(d) requires that the emission control equipment must be maintained and operated at a level consistent with good air pollution control practice at all times, including start-up, shutdown, and malfunction.

2.4.2 Opacity Standard

Several commenters questioned whether the zero-percent opacity requirements could be achieved continuously. Although the opacity limits for calciners and grinders have been revised to 10 percent, the opacity limits for grinders and ground rock storage and handling systems have been retained at zero percent. One reason stated for this comment is that, for any deviation of opacity above zero percent, the average for that time period must exceed zero percent. However, the procedure in Method 9 takes 24 observations in a 6-minute period, recorded in 5-percent increments (i.e., 0, 5, 10, etc.). The arithmetic average of the 24 observations, rounded off to the nearest whole number (i.e., 0.4 would be rounded off to 0) is the value of opacity used to determine compliance with the opacity standard. Consequently, the zero-percent opacity standard for grinders and ground rock handling systems does not necessarily mean that there are no visible emissions. It means that either visible emissions during a 6-minute period are insufficient to cause a certified observer to record them as 5-percent opacity, or that the average of the 24 observations is calculated at less than 0.5 percent.

Another comment was made that high humidities in Florida may result in "steam plume" formation, which will prevent accurate opacity readings. However, there are specific procedures in Method 9 for dealing with steam plume interference. The procedures require that readings on stacks with steam plume interference are taken on the plume after steam dissipation. Because of plume diffusion, opacity readings after steam dissipation should represent more conservative readings than those made at the stack. Therefore, the presence of a steam plume will not increase the probability of an opacity violation.

Several commenters questioned the zero-percent opacity standard for phosphate rock dryers and calciners. They stated that the data base for the proposed opacity standards on dryers and calciners did not justify zero-percent opacity, since there were no observations of baghouses, all the observed scrubbers had steam interference, and one observed ESP-controlled dryer facility had readings as high as 7.7 percent. They felt that a 5- to 10-percent opacity standard would be more realistic.

Opacity of a plume varies with the concentration, particle size distribution, and physical characteristics of the particulates in the plume and with the thickness of the plume itself. Since the opacity level is a function of the particulate characteristics of the plume, opacity is subject to the same variations as the particulate emission levels from dryers and calciners. Opacity standards are intended to ensure that particulate emission control systems are properly maintained and operated to comply with particulate emission limits on a continuous basis. Opacity limits should be set at levels no more restrictive than corresponding particulate mass emission limits and should be based on the demonstrated performance of the best control systems. Opacity limits are set at levels no more restrictive than particulate limits to ensure that any observed violation of the opacity standard will accurately indicate a violation of the particulate mass emission limits. As noted in Section 2.4.1, the particulate emission limits for dryers and calciners have been revised based on new data supplied by industry. This worst-case emission test data did not contain corresponding opacity data. However, the opacity data base contains observations from an ESP-controlled dryer with observed average opacity up to 7.7 percent. This particular ESP system was designed to process twice the gas volume actually processed. Therefore, the exhaust stack diameter is larger than would typically occur. If the stack had been designed for half the volume of gas, the diameter would have been reduced by approximately 29 percent. A reduction of 29 percent in the stack diameter would theoretically reduce the opacity level from 7.7 percent to about 6 percent. At the time of these opacity observations, a Method 5 source test performed on the stack indicated a particulate emission rate of 0.02 kg/Mg (0.039 lb/ton) and a particulate concentration of 0.023 gm/m^3 (0.010 gr/acf).

The particulate emission limit for dryers of 0.03 kg/Mg (0.06 lb/ton) is based on test data from a 7.5 kPa (30 incheds of water) venturi scrubber-controlled facility processing coarse pebble rock. This source represents the application of the best available control system to the worst-case emission control conditions. The particulate concentration during the source test was 0.037 g/m^3 (0.016 gr/acf). EPA emission test data from an asphalt aggregate dryer indicated that, for this source, the opacity increased by about 1.1 percent for every 0.023 g/m^3 (0.01 gr/acf) increase in particulate concentration.[12] Since the particle characteristics from an asphalt aggregate dryer are similar to the particle characteristics from phosphate rock dryers and calciners, the correlation between opacity and particulate concentration should also be similar. This correlation data indicate that the increase in concentration from 0.023 g/m^3 (0.010 gr/acf) to 0.037 g/m^3 (0.016 gr/acf) would increase opacity from 6 percent at the 0.02 kg/Mg (0.039 lb/ton) level to 7 percent at the 0.03 kg/Mg (0.06 lb/ton) emission limit level. The calculated 7 percent opacity supports a revision in the opacity limit for phosphate rock dryers to 10 percent. The 10 percent limit was selected to account for possible deviations above the calculated level. The standard has been revised accordingly.

The source test data used as the basis for the particulate emission limit for calciners processing unbeneficiated rock were also supplied by the industry. This source test data also did not contain any corresponding opacity data. However, particulate emissions from phosphate rock calciners are very similar in particle composition and particle size distribution to emissions from phosphate rock dryers. Therefore, the opacity observations from phosphate rock dryers can be used to estimate opacity levels from phosphate rock calciners. The particulate concentration during the emission test used to set the promulgated emission limit for calciners processing unbeneficiated rock was 0.06 g/m^3 (0.026 gr/acf). Based on the 6-percent dryer exhaust opacity at 0.023 g/m^3 (0.010 gr/acf) and the concentration and opacity correlation data from the asphalt aggregate dryer, the opacity expected at 0.06 g/m^3 (0.026 gr/acf) would be about 8 percent.

The source test used as the basis for the particulate emission limit for calciners processing beneficiated rock did have corresponding opacity data at zero-percent opacity. However, there was an attached steam plume during the observations that may have affected the accuracy of the reading at the stack. During the emission test, the particulate concentration was 0.073 g/m^3 (0.032 gr/acf). As explained in Section 2.4.1, this unit was controlled with a 3.0 kPa (12 inches of water) pressure drop venturi scrubber. With an increase in pressure drop to 7.5 kPa (30 inches of water) the particulate concentration in the stack would be expected to decrease to about 0.023 g/m^3 (0.010 gr/acf). At this concentration, opacity should be about 6 percent as observed on the phosphate rock dryer. Based on this data, the opacity limits for calciners processing beneficiated and unbeneficiated rock have been revised to 10-percent opacity.

A commenter requested a provision to provide for site-specific relief from the opacity standard at sources where other emission limits were being met. No provision is necessary in these standards, because provisions for individual review and site-specific relief are included in the general provisions under §60.11(e) of 40 CFR 60. These provisions allow an owner/operator to petition the Administrator for site-specific opacity standards in specific cases in which it can be demonstrated that the opacity standard is being violated while the particulate mass emission limit is being met.

Another commenter asked whether the visible emission data base for dryers was based on units firing natural gas, oil, or coal. It was stated that high sulfur oils and coals would cause higher opacity readings than natural gas. It was further stated that, if the tested units were fired with natural gas, the opacity standard should be modified.

EPA acknowledges that some sulfur compounds, because of high light-reflective properties, can cause disproportionately high opacity levels. However, the visible emission tests were based on oil-fired, not natural gas-fired, units. Although the sulfur content of the oil was not specified, the fuel was a No. 6 fuel oil (indicating moderate to high sulfur content), and no observations exceeded zero percent opacity. Also, stack test data has indicated that fuel-bound sulfur reacts chemically with the calcium oxide in the rock and will form solid calcium sulfate or sulfite, both of which could be collected in particulate control devices.

2.4.3 Available Control Technology

The comment was made that Volume I of the BID should not have contained ESPs as a control technique because it was stated in Volume I that ESPs were not the best demonstrated system, although they are equally efficient as baghouses and high-energy venturi scrubbers. The commenters further questioned EPA's judgement that ESPs were equally as efficient as baghouses or high energy venturi scrubbers on dryers and calciners. The commenters felt that the source test data base did not support this judgment, and ESPs should not be used as a basis for the standards.

Alternative particulate control equipment options with control efficiency levels in the range of, or above, existing controls on phosphate rock plants are baghouses, venturi scrubbers, and ESPs. Therefore, ESPs were analyzed in Volume I as a control alternative. The level of control required by the standards is estimated to be approximately 99.3 percent when processing the worst-case rock types. EPA agrees that the source tests of ESPs presented in the BID, Volume I, do not achieve this level of control. The ESPs tested achieved efficiencies in the range of 93 to

99 percent efficiency. However, ESP efficiency is a direct function of the collector plate area to gas volume ratio. By increasing the collector plate area of the tested ESPs, the efficiency can be increased to 99.3 percent. The economic evaluation of ESPs presented in Volume I of the BID presented the cost of ESPs at the increased plate area to gas volume ratio necessary to achieve 99.3 percent control. Because the cost of ESPs is primarily a function of collector plate area, the larger plate area results in significantly higher cost. The annualized costs of an ESP on a model dryer or calciner are 2 to 2.5 times higher than high energy venturi scrubber or baghouse costs on the same source. Because of these higher costs, ESPs were not designated as a basis for the standards. The promulgated emission limits are based on the performance of high energy venturi scrubbers and baghouses.

The designation of baghouses as best available control technology was questioned. The commenters complained that no baghouses are in current use on dryers or calciners, and technological problems associated with high temperatures and moisture blinding of the bags limit their use. EPA agrees that no baghouses are currently in use on phosphate rock dryers or calciners. The selection of baghouses as one of the best available control equipment options is based on transfer of technology from similar applications in other industries. Baghouses have been installed and are operating effectively on kaolin rotary-kiln dryers. The typical particle size entering filters from kaolin dryers is 80 percent less than 2 micrometers. The kaolin gas stream typically contains between 20- and 50-percent moisture, a dew point between 160° and 180°F, and a dry bulb temperature between 200° and 250°F.[13] These conditions represent more severe conditions than typically occur from phosphate rock dryers or calciners. Two baghouse manufacturers contacted have stated that baghouses have been applied successfully to more difficult applications, such as asphalt plants.

Moisture blinding of the bags can be prevented by maintaining temperatures in the baghouse above the dew point of the water vapor. This can be accomplished by proper insulation of the baghouse walls to maintain a 50°F difference between wet-bulb and dry-bulb temperatures. During cold start-up, the burner can be operated at low fire with no rock in the dryer or calciner until the temperature in the baghouse is raised above the dew point.[14]

High temperature operation is required for baghouses on phosphate rock dryers and calciners. Filter fabric that has a high-temperature limit (450°F) well above the typical exhaust temperature from dryers and calciners (Nomex) is available. However, high-temperature protection devices may be required to protect the filter bags from damage if exhaust gas temperatures should rise above the operating limit of the filter material. The bags can be protected from high temperatures by installing a temperature sensor in the baghouse inlet with shutoff valves in the burner fuel supply or by installing an "air bleed" system where a temperature sensor opens a door in the inlet duct so that cold external air is pulled in to dilute the hot exhaust.[14] There are no technical reasons that prohibit the use of baghouses on phosphate rock dryers or calciners. In addition, baghouses are not the only control alternative. There is no reason to prevent an owner from complying with the standards with a scrubber. The baghouse was designated as the best control system based on a lower annualized cost.

2.4.4 Coal Firing

A comment was also made that, in the future, calciners and dryers may be fired with coal, but coal-firing problems had not been considered or analyzed in the development of the standard. During the development of Volume 1, a review of existing industrial sources revealed no coal-fired units. However, as explained in Section 2.4.1 the impacts of coal and residual oil firing on achievable emission levels has been evaluated. This analysis indicated that residual oil firing would have the greatest effect on controlled emission levels. The potential impacts from residual oil firing have been included in the dryer and calciner emission limits.

2.5 TESTING AND MONITORING

2.5.1 Continuous Opacity Monitoring

The method of determining opacity readings for continuous monitoring were questioned. The commenters asked whether continuous monitoring equipment would be needed, or if periodic readings by qualified human observers would suffice. Section 60.403 of the standards requires that continuous opacity monitoring equipment be installed, calibrated, maintained, and operated on the exhaust from all control equipment except scrubbers. Continuous pressure-drop and liquid-supply-pressure monitoring equipment is required for wet scrubber-controlled facilities. However, scrubber-controlled facilities must still comply with the opacity standard. The purpose of continuous monitoring equipment is to ensure continuous and proper operation of particulate control equipment. Sections 60.403(d) and (e) require that continuous monitoring violations be reported. The United States Court of Appeals for the District of Columbia Circuit has specifically upheld the use of continuous opacity monitors in National Lime Association v. EPA 627 F.2d 416 (1980). However, only EPA reference method tests can be used to determine compliance with regulations. Section 60.404 specifies that Method 5 is used to determine compliance with the particulate standards and Method 9 (using a trained observer) is used to determine compliance with the opacity regulation.

Several commenters pointed out that the EPA performance specifications for continuous opacity monitors allow for a cumulative accuracy error of up to 9.2 percent. They contend that this allowed error would prevent accurate demonstrations of attainment of the opacity standards. The purpose of continuous monitoring equipment is to ensure continuous operation of control equipment and not to demonstrate compliance with the opacity standards. Only Method 9 can demonstrate attainment of the opacity standards. Therefore, the possible 9.2-percent variation will not affect demonstration of attainment of the standards. Section 60.13(c) requires that continuous monitoring equipment be evaluated during particulate performance tests. The performance of the continuous monitoring equipment can then be correlated to particulate control equipment performance. Enforcement agencies can incorporate any demonstrated variations in continuous monitoring equipment performance in evaluating continuous operation of the control equipment at the required control level.

Two commenters stated that opacity averaging periods of 6 minutes with overlapping time intervals would produce an excessive amount of paperwork. The required 6-minute opacity averaging periods are discrete, successive 6-minute periods and are not composed of overlapping time intervals. Section 60.13(e)(1) states that opacity continuous monitors shall complete a minimum of one cycle of sampling and analyzing for each successive 10-second period and one cycle for data recording for each successive 6-minute period. The volume of paperwork produced would not be as large as believed by the commenter.

The comment was also made that the costs to purchase, install, operate, and maintain continuous opacity monitors is totally unreasonable. The cost impact to purchase, install, operate, and maintain continuous opacity monitoring equipment was addressed and evaluated in Volume 1 of the BID (page 7-58). The annualized cost of a typical opacity monitoring system is about $12,500 per year (1978 dollars). This cost is relatively minor compared to emission control system costs (about 4.2 percent of a high-energy venturi scrubber on a 150-ton/hour dryer) and was determined to be cost-effective.

One commenter questioned the rationale for requiring continuous monitoring equipment on the small control equipment usually located on ground rock storage and handling system emission points. The purpose of continuous monitoring equipment is to ensure the proper and continuous operation of emission control equipment. Because ground rock storage and handling systems vary greatly from plant to plant, no typical handling and storage system can be defined. Most of the potential emissions from storage and handling systems are fugitive emissions. These fugitive emissions often result from holes in enclosures. Therefore, it is difficult to define or predict emission points and appropriate emission control equipment. However, Method 9 opacity observations can routinely locate and quantify fugitive emissions from these sytems. Observations have indicated that properly maintained ground rock storage and handling systems have no visible emissions; therefore, these systems are subject only to a zero-percent opacity standard. The annualized cost of a typical opacity monitoring system is about $12,500 per year (1978 dollars). Because there is no specified emission control equipment requirement and compliance with the opacity standard can be routinely demonstrated with Method 9, these costs are considered excessive. Therefore, the requirement for continuous opacity monitors on ground rock storage and handling systems has been deleted from the standards.

Table 2.1 LIST OF COMMENTERS ON THE PROPOSED STANDARDS OF PERFORMANCE FOR PHOSPHATE ROCK PLANTS

Commenter	Affiliation
IV-D-1	Marion DeRonde, President The Sarasota Audubon Society, Inc. Post Office Box 15423 Sarasota, Florida 33579
IV-D-2	James W. Cooper, Director Division of Air Pollution Control Alabama Air Pollution Control Commission 645 S. McDonough Street Montgomery, Alabama 36130
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IV-D-4	Archie Carr III, Ph.D. Special Assistant to the President Florida Audubon Society
IV-D-5	William R. King Environmental Manager FMC Corporation 2000 Market Street Philadelphia, Pennsylvania 19103
IV-D-6	James H. Rathlesberger Special Assistant to the Secretary U. S. Department of the Interior Office of the Secretary Washington, D. C. 20240
IV-D-7	William A. Schimming, Director Environmental Affairs CF Industries Post Office Box 1480 Bartow, Florida 33830

(continued)

Table 2-1. Continued

Commentor	Affiliation
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IV-D-11	Edwin M. Wheeler The Fertilizer Institute 1015 18th Street, N. W. Washington, D. C. 20036
IV-D-12	J. F. Cochrane, Director Environmental Engineering Department J. R. Simplot Company Post Office Box 912 Pocatello, Idaho 83201
IV-D-13	Mohamed T. El-Ashry Director of Environmental Quality Tennessee Valley Authority Norris, Tennessee 37828
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(continued)

Table 2-1. Concluded

Commenter	Affiliation
IV-D-16	Samuel M. Lane, Manager Environmental and Manufacturing Services Mobil Chemical Company Phosphorus Division Post Office Box 26683 Richmond, Virginia 23261

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

Standards of performance for the control of particulate and visible emissions from phosphate rock plants are being promulgated under the authority of Section 111 of the Clean Air Act. These standards apply only to phosphate rock dryers, calciners, grinders and ground rock storage and handling systems for which construction or modification began on or after September 21, 1979. This document contains comments received on the proposed standards and responses to those comments. The promulgated standards will limit particulate emissions from all dryers and from calciners processing unbeneficiated rock to 0.03 and 0.12 kg/Mg, respectively. Particulate emissions from beneficiated rock calciners will be limited to 0.055 kg/Mg. Visible emissions from all dryers and calciners will be limited to 10 percent opacity. Particulate emissions from grinders will be limited to 0.006 kg/Mg with 0 percent opacity. Visible emissions from ground rock storage and handling systems will be limited to 0 percent opacity.

17. KEY WORDS AND DOCUMENT ANALYSIS

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