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MODEL OPERATING PERMIT FOR PM_{10} EMISSIONS FROM CALCINERS AND DRIERS IN THE MINERAL INDUSTRIES

DRAFT REPORT

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DISCLAIMER

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TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

Title V of the 1990 Clean Air Act Amendments (CAAA) requires States to adopt operating permit programs to be administered by State or local air pollution control agencies. The programs are to issue operating permits to major stationary sources of criteria and hazardous air pollutants, sources covered by new source performance standards (NSPS), sources covered by national emission standards for hazardous air pollutants (NESHAP), sources regulated under the acid rain program (Title IV Acid Deposition Control) and the stratospheric ozone program (Title VI Stratospheric Ozone Protection), and sources covered by State implementation plans.

The permits must meet several requirements. They must contain all the applicable pollution control obligations of a source such as those imposed by State implementation plans and NSPS under the authority of Title I of the CAAA, under the air toxics program of Title III of the CAAA, under the acid rain program of Title IV of the CAAA, or under other applicable provisions of the CAAA. As necessary, the operating permits are to establish maximum source operating rates, maximum pollutant emission rates and/or pollutant control methods, and methods for determining compliance with the emission limits or control methods.

Emissions from many sources of particulate matter (PM) are regulated under the above titles of the CAAA including State implementation plans for particles with an aerodynamic diameter less than or equal to a nominal 10 microns (PM_{10}). Therefore, operating permits will be required for several categories of sources that emit PM. The processes and operations for calciners and dryers used in the mineral industries which cause PM emissions are discussed in this document, and an operating permit for this source category is presented as a model that may be used in implementing a permit program. This model permit covers only the particulate matter aspects of this source category; it does not cover other pollutants for which the source may be regulated.

2.0 SOURCES OF EMISSIONS

2.1 GENERAL

The source category for mineral dryers and calciners includes process equipment used to dry and calcine seventeen types of minerals, as shown in Table 2-1.[1] Drying is the removal of uncombined (free) water from mineral material through direct or indirect heating, while calcining is the removal of combined (chemically bound) water and/or gases through direct or indirect heating. Processing plants for these mineral industries are located domestically in 43 States and in the Virgin Islands. Several of the mineral processes are composed of a large number of individual facilities located in many States, while others are limited to relatively few plants located near natural deposits of the minerals being processed. The mineral industries considered in this source category use a wide variety of processing equipment for the drying and calcining of raw materials.

2.2 DRYERS

Dryers are used by the mineral industries to remove uncombined water from mineral materials. In general, dryers use either a convection (direct) or a conduction (indirect) method of drying. In the convection method, a heating medium, usually air or combustion products, is in direct contact with the wet material. In the conduction method, heat is transmitted indirectly through a heated surface which directly contacts the wet material.[2]

Rotary dryers are the most frequently used dryer type in the mineral industries. A rotary dryer consists of a cylindrical shell, ranging in length from 4 to 10 times its diameter, into which wet charge is fed at one end and from which dried product is discharged at the other end. Material is moved through the dryer by the combined effects of horizontal shell inclination and the action of lifting flights within the shell. As the shell rotates, the lifting flights pick up the material and shower it as a curtain in the path of hot gases. Direct rotary dryers are used when the materials to be dried can be safely brought into contact with heated air or combustion gases and when volatile, flammable, or noxious components are entirely absent or present only in small amounts. The drying medium, heated air or combustion gas, is fed into the dryer at one end and is drawn out the other end, coming into contact with the mineral as it flows through the dryer. The gases may move either concurrently or countercurrently with the movement of the process material.[2]

TABLE 2-1. TYPES OF DRYERS AND CALCINERS USED BY INDUSTRY[a]

Mineral Type	Dryers						Calciners				
	Rotary direct	Rotary indirect	Fluid bed	Vibrating grate	Flash	Spray	Rotary	Flash	Hearth furnace	Kettle	Expansion furnace
Alumina							X	X			
Ball clay		X		X							
Bentonite	X		X								
Diatomite	X				X		X				
Feldspar	X		X								
Fire clay	X			X			X				
Fuller's earth	X		X				X				
Gypsum	X							X		X	
Industrial sand	X		X								
Kaolin	X					X	X	X	X		
Lightweight aggregate							X				
Magnesium compounds							X		X		
Perlite	X										X
Roofing granules	X		X								
Talc	X				X		X				
Titanium dioxide	X	X	X		X	X	X				
Vermiculite	X		X								X

[a]Reference 1.

Fluid bed dryers are also commonly used by the mineral industries. In a typical fluidized bed dryer, wet feed material is charged in batch or continuous mode to the dryer above the bed. The wet feed bed expands due to the high velocity of the hot gas stream rising from beneath the bed of particulate solids. The solid particles become suspended, thus creating a fluidized bed. In a fluid bed dryer, efficient mixing of the solid particles results in uniform drying. Thus, the gas stream velocity is controlled to yield optimum conditions for drying with regard to particle size and density. Product discharge rate and gas temperature are also monitored to obtain the desired product moisture content.[2] Dried product is removed near the base of the vessel. Gas is exhausted through the top of the dryer to a control device.

Other dryer types used in the mineral industries include indirect rotary, flash, spray, and vibrating grate. Indirect rotary dryers are used if the process material cannot be exposed to combustion gases, if excessive dust carry-over may occur through entrainment, if low-cost steam is available, or if volatile components desirable for recovery are present.[2] Flash dryers are designed to dry material and convey it by a stream of hot gases from the feed point to a point of delivery.[2] Separation of the dried product from the conveying air usually takes place in a cyclone, followed by further separation in other cyclones or baghouses. Spray dryers are used to dry liquids, slurries and pastes. Vibrating-grate dryers are suitable for free-flowing solids containing mostly surface moisture. They are not effective on fibrous materials that form a mat, or on sticky solids that agglomerate or adhere to the deck.

2.3 CALCINERS

Calciners are designed to remove the majority of combined moisture in the process material and are operated at higher temperatures than the dryers. In general, a calciner has up to four zones of heating, each of which has a different heat transfer rate. These include a feed drying zone, a heating zone where charge is heated to the reaction temperature, a reaction zone where process material is reacted and bound moisture is removed, and the soaking zone (wet-feed calciners only) where reacted charge is super-heated or "soaked" at the desired temperature or cooled before discharge.[3] Rotary and flash calciners are the most common types of calciners used in the mineral industries.

A rotary calciner consists of a cylindrical shell into which wet charge (wet feed) or predried (dry feed) material is fed at the elevated end by various methods including chutes, overhung screw conveyors, and slurry pipes. The material is heated, reacted and super-heated. The primary source of heat transfer in rotary calciners is radiation from the refractory to the material bed. Since most rotary calciners have countercurrent air and material flow to

achieve the most energy efficient reduction in moisture content, secondary heat transfer occurs by convection from the hot gas to the exposed material bed surface.[3] Natural gas, oil, or pulverized coal may be used as fuel for the heating source. The calcined product is discharged at the other end into quench tanks, conveyors, or cooling devices.

Flash calciners are similar to flash dryers in principle and operation except that flash calciners operate at higher temperatures. Both multi-stage and direct contact flash calciners are used in the mineral industries. A typical flash calcining unit consists of a two-stage cyclone, a preheater, a venturi-type flash dryer, the calciner, a multi-stage cyclone cooler, and a secondary fluid bed cooler. Partly calcined material formed in the cylindrical heating zone of the calciner is discharged into the reactor just above the fuel inlet. The calcined material is retained for a few seconds and is then separated from hot gases in the separation cyclone, prior to being discharged into the primary cooler. Natural gas and distillate fuel oil are the primary heating fuels used in flash calciner installations.

Other calciner types used in the mineral industries include multiple hearth furnaces, kettle calciners, and expansion furnaces. Multiple hearth furnaces handle granular material and provide a long countercurrent path between flue gases and process material. Kettle calciners are constructed from cylindrical metal shells, which are set in masonry brick and surrounded by a steel jacket. Although some kettle calciners are designed to operate in only a batch mode, most kettle calciners can be operated in either batch or continuous modes. Expansion furnaces are used to process ore that "expand" up to 20 times their original volume when exposed to high temperatures.

Particulate matter emissions from drying and calcining result from entrainment of dust and fly ash particles in the gas stream passing through the equipment, with subsequent carryover to the exhaust system. The variables that affect emissions from calciners include the gas velocity through the unit; the characteristics of the feed material; and the fuel type.[1]

2.4 REFERENCES

1. U.S. Environmental Protection Agency. *Calciners and Dryers in Mineral Industries - Background Information for Proposed Standards*. EPA-450/3-85-025a. Office of Air Quality Planning and Standard, Research Triangle Park, NC, October 1985.

2. Williams-Gardner, A. *Industrial Drying*. Gulf Publishing Company, Houston, TX, 1977.

3. Porter, H.F., G.A. Schurr, D.F. Wells, and K.T. Semrau. *Solids Drying and Gas-Solid Systems*. In: Chemical Engineers' Handbook, 6th Edition, Perry, R.H., D.W. Green, and J.O. Maloney (eds.). McGraw-Hill, New York, 1984.

3.0 MODEL PERMIT FOR CALCINERS AND DRYERS USED IN THE MINERAL INDUSTRIES

3.1 INTRODUCTION

Section 190 of Title I of the Clean Air Act Amendments of 1990 requires the Administrator of the U.S. Environmental Protection Agency to provide guidance to State and local agencies on categories of sources that contribute to nonattainment of the PM_{10} national ambient air quality standard. As part of that guidance, Section 3.5 provides specific conditions that may be included in operating permits that would apply to PM_{10} emission sources from calciners and dryers used in the mineral industries. These specific conditions should be considered as guides for States to use in designing their own operating permit programs.

Individual facilities should be permitted on a case-by-case basis, and the emission limits included in the permit should be based on State implementation plan (SIP) regulations applicable in the area where the source is located. Where applicable, the mass and visible emission limits on an emission source and the operating conditions should be sufficiently detailed in the permit to allow a clear determination of whether the source is or is not in compliance. At a minimum, the permit should contain the following components:

- A fixed term, not to exceed five years [Section 502(b)(5)(B)];
- Limits and conditions to ensure compliance with all applicable requirements under the Act, including requirements of the applicable implementation plan [Section 504(a)];
- A schedule of compliance, which is defined as a schedule of remedial measures, including an enforceable sequence of actions or operations, leading to compliance with applicable requirements under the Act [Sections 504(a) and 501(3)];
- Inspection, entry, monitoring, compliance certification, recordkeeping and reporting requirements to ensure compliance with the permit terms and conditions consistent with any monitoring regulations that EPA promulgates under Section 504(b) [Section 504(c)];
- A provision describing conditions under which any permit for a major source with a term of three or more years must be reopened to incorporate any new standard or regulation promulgated under the Clean Air Act [Section 502(b)(9)];

- Provisions under which the permit can be revised, terminated, modified, or reissued for cause [Section 502(b)(5)(D)]; and

- Provisions ensuring operational flexibility within a permit so that certain changes can be made without a permit revision, if no "modification" (as defined in Title I of the Act) would occur and the changes do not exceed the emissions allowable under the permit (whether expressed as a rate or in terms of total emissions) provided that a notice is sent to the permitting authority at least seven days in advance of the change [Section 502(b)(10)].

Examples of the following sections of a typical operating permit will be provided in a separate document:

- Source Identification
- Findings of Fact, Conclusions of Law, Decisions
- General Conditions
- Compliance Conditions, and
- Operational Flexibility

3.2 SPECIFIC CONDITIONS

3.2.1 Example of Specific Conditions for Calciners and for Calciners and Dryers Installed in Series

1. The permittee shall not cause or allow the [specify mineral] processing rate to exceed [____ Mg/day (____ tons/day)], dry weight, in each [calciner or calciner and dryer installed in series] (maximum design capacity as specified in the permit application).

2. The permittee shall determine the [specify mineral] processing rate daily by weight.

3. The permittee shall not cause or allow to be discharged into the atmosphere from the outlet of any control device for calciners and for calciners and dryers installed in series any gases that contain particulate emissions in excess of [____ g/dscm (____ gr/dscf)].

4. The permittee shall not cause or allow to be discharged into the atmosphere from the outlet of any dry control device for calciners and for calciners and dryers installed in series any gases that exhibit visible emissions greater than [____ percent] opacity.

5. This section should contain operating parameters for the control equipment applied at this emission point (See Section 3.3 for example operating parameters).

3.2.2 Example of Specific Conditions for Dryers

1. The permittee shall not cause or allow the [specify mineral] processing rate to exceed [____ Mg/day (____ tons/day)], dry weight, in each dryer (maximum design capacity as specified in the permit application).

2. The permittee shall determine the [specify mineral] processing rate daily by weight.

3. The permittee shall not cause or allow to be discharged into the atmosphere from the outlet of a control device for any dryer any gases that contain particulate emissions in excess of [____ g/dscm (____ gr/dscf)].

4. The permittee shall not cause or allow to be discharged into the atmosphere from the outlet of a dry control device for any dryer any gases that exhibit visible emissions greater than [____ percent] opacity.

5. This section should contain operating parameters for the control equipment applied at this emission point (See Section 3.3 for example operating parameters).

Note: Specific control, performance and reporting information contained in this model permit is provided solely for illustrative purposes and is not intended to establish industrial norms or national standards.

3.3 CONTROL EQUIPMENT OPERATING PARAMETERS

The parameters listed in this section are provided as examples of typical control equipment operating conditions that should be specified. There may be other important parameters not listed below.[1]

3.3.1 Fabric Filter Operating Parameters

Air/Cloth Ratio: _____

Pressure Drop Across Baghouse: ___ in. H_2O (MIN) ___ in. H_2O (MAX)

Inlet Air Temperature: _____(MIN) _____(MAX)

Outlet Air Temperature: _____(MIN) _____(MAX)

Inlet Air Flow Rate: _____

3.3.2 Electrostatic Precipitator Operating Parameters

Pressure Drop: _____

Inlet Air Temperature: _____(MIN) _____(MAX)

Outlet Air Temperature: _____(MIN) _____(MAX)

Gas Velocity through (ESP): _____ ft/sec

Conditioning Agent Additions: _____ gr/ft^3

Voltage and Current Readings for each Transformer-Rectifier (T-R) Set:

Example: first 3 fields - 3 at 50 KVA
($55\ kV_p$, $35\ kV_{av}$, 500 mA)
last 2 fields - 4 at 64 KVA
($70\ kV_p$, $45\ kV_{av}$, 500 mA)

3.3.3 Mechanical Collectors Operating Parameters

Gas Flow Rate: _____ ft^3/min

Pressure Drop: ___ in. H_2O (MIN) ___ in. H_2O (MAX)

Inlet Velocity: _____ ft/sec

Inlet Air Temperature: _____(MIN) _____(MAX)

Outlet Air Temperature: _____(MIN) _____(MAX)

3.3.4 Scrubber Operating Parameters

Scrubbing Liquor: _____

Gas Flow Rate: _____ ft^3/min

Liquor Flow Rate: _____ gal/min

Gas Pressure Drop Across Unit: ___ in. H_2O (MIN) ___ in. H_2O (MAX)

Liquid Pressure Drop Across Unit: ____ psi.(MIN) ____ psi (MIN).

Inlet Air Temperature: _____(MIN) _____(MAX)

Outlet Air Temperature: _____(MIN) _____(MAX)

Solids Content of Recirculated Scrubber Water: _____ gr/gal

Note: Specific control, performance and reporting information contained in this model permit is provided solely for illustrative purposes and is not intended to establish industrial norms or national standards.

3.4 MONITORING REQUIREMENTS

1. The permittee shall install, calibrate, maintain, and continuously operate for each dryer and calciner that uses a fabric filter or a dry ESP control device, a continuous monitoring system to measure and record the opacity of emissions discharged into the atmosphere from the control device. The continuous monitoring device shall be calibrated on a semiannual basis; or

2. If the facility employs a dry control device together with a gypsum flash or kettle calciner or a perlite rotary dryer or expansion furnace, the permittee may, in lieu of a continuous opacity monitoring system, observe and record three six-minute averages of the opacity of visible emissions from the control device, once per week of operation.

3. When a wet scrubber is used to control particulate emissions, the permittee shall install, calibrate, maintain, and operate monitoring devices that continuously measure and record the pressure loss of the gas stream through the scrubber and the scrubbing liquid flow rate. The pressure loss monitoring device shall be accurate to within plus/minus [____ centimeters (____ inches) water gauge]. The liquid flow rate monitoring device shall be accurate to within plus or minus [____ percent] of the design scrubbing liquid flow rate. Both monitoring devices shall be calibrated on a semiannual basis.

3.5 TESTING REQUIREMENTS

Section 504(b) of the Clean Air Act, as amended, requires procedures and methods for determining compliance and for monitoring and analyzing pollutants regulated under the Act. An example of testing requirements that should be included in the permit is provided below.

1. The permittee shall perform a compliance test for each emission point from a stack or vent within 60 days of achieving the maximum production rate at the facility, but no later than 180 days after the initial start-up, and annually thereafter. EPA Reference Method 5 shall be used to perform each compliance test on each emission point from a stack. The sampling time and sample volume for each run shall be at least [___ hours] and [___ dscm (___ dscf)], respectively. Emissions testing shall be accomplished at a minimum of [___ percent] of the permitted capacity. If testing is performed at a rate of less than [___ percent] of the permitted capacity, operation is restricted to the process input rate of testing at such level until a subsequent compliance test is performed at a minimum of [___ percent] capacity.

2. EPA Reference Method 9 and the procedures in 40 CFR 60.11 shall be used to determine opacity.

3. During the initial performance test of a wet scrubber, the permittee shall measure and record an arithmetic average of both the change in pressure of the gas stream across the scrubber and the liquid flow rate.

4. At least [___ calendar days] prior to performing a test, the owner or operator shall submit a test plan to the permitting authority that describes the test duration, test locations, test methods, source operation and other parameters that may affect test results.

3.6 RECORDKEEPING REQUIREMENTS

Section 504(c) of the Clean Air Act, as amended, requires permits to contain inspection, entry, monitoring, compliance certification, and reporting requirements to ensure compliance with permit terms and conditions. Provided below are examples of recordkeeping requirements.

1. Records shall be maintained for five years from the date of sample, measurement, report, or application;

2. The permittee shall maintain the following records:

    a. Compliance test reports for each affected vent;

    b. For facilities which operate a gypsum flash or kettle calciner or a perlite rotary dryer or expansion furnace, weekly observances of three six-minute averages of the opacity of visible emissions to the atmosphere from the dry control device;

    c. Daily pressure drop readings across control equipment (e.g., fabric filter, ESP, or wet scrubber);

    d. Daily readings of liquid flow rate to the wet scrubber, where applicable;

    e. Daily mineral processing rate; and

    f. Operating schedule.

3.7 REPORTING REQUIREMENTS

Provided below are examples of reporting requirements.

1. Records of any required monitoring shall be submitted at least every six months and shall clearly identify all instances of deviations from the permit requirements.

   "The total mineral processing rate, in tons per day, shall be recorded and submitted each quarter to the permitting authority."

2. Deviations from permit requirements, including those attributable to upsets, shall be reported promptly, and the report shall include the cause of such deviations and any corrective actions or preventive measures taken. Corrective actions may include a requirement for additional stack testing, or more frequent monitoring, or could trigger implementation of a corrective action plan.

3. Exceedances that must be reported are defined as all six-minute periods during which the average opacity from a dry control device is greater than [___ percent]; or any wet scrubber pressure drop or wet scrubber liquid flow rate that deviates more than plus or minus [___ percent] and [___ percent], respectively, from the average value recorded during initial performance testing as specified in Section 3.5.4.3.

4. Definitions of deviations that trigger additional reporting requirements should be as specific as possible.

   "If the mineral processing rate exceeds the allowable rate as specified in this permit, the permit holder shall immediately notify the permitting authority and shall submit all records specified under the Monitoring, Recordkeeping and Reporting subsections above within two days."

5. The permittee shall send two copies of all reports required above to the [Permitting Authority Field Office].

6. Any document (including reports) required to be submitted by this permit shall be certified as being true, accurate, and complete by a responsible corporate official.

Note: Specific control, performance and reporting information contained in this model permit is provided solely for illustrative purposes and is not intended to establish industrial norms or national standards.

3.8 REFERENCES

1. U.S. Environmental Protection Agency. *Technical Assistance Document: Recommended Recordkeeping Systems for air Pollution Control Equipment - Part 1. Particulate Matter Controls.* EPA-340/1-86-021. Stationary Source Compliance Division. Washington, DC. August 1987.