

# Prevention of Significant Air Quality Deterioration Review

## Preliminary Determination

March, 2008

Facility Name: Houston American Cement Plant

City: Perry

County: Houston

AIRS Number: 04-13-153-00056

Application Number: 17509

Date SIP Application Received: June 25, 2007

Review Conducted by:

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## SUMMARY

The Environmental Protection Division (EPD) has reviewed the application submitted by Houston American Cement Plant for a permit to construct and operate a new/greenfield Portland cement manufacturing plant. The proposed project will consist mainly of an on-site limestone and clay quarry, raw material handling and storage, kiln feed preparation with a raw mill, a dry process rotary kiln coupled with a preheater/precalciner and a calciner, a clinker cooler, a coal mill, a finish mill, and cement packaging and shipping operations.

The new cement plant will result in emissions of criteria pollutants. The sources of the emissions include the on-site quarry, raw material handling, raw mill, clinker cooler, coal mill, cement finish mill and cement packaging and shipping operations for particulate matter (PM), and the cement kiln with coupled preheater/precalciner and calciner for carbon monoxide (CO), PM, nitrogen oxides (NO<sub>x</sub>), sulfur dioxide (SO<sub>2</sub>), and volatile organic compounds (VOC).

A Prevention of Significant Deterioration (PSD) analysis was performed for the facility for all criteria pollutants to determine if any increase was above the “major source” or the “significance” level. The emissions of CO, PM, NO<sub>x</sub>, SO<sub>2</sub>, and VOC were all above the “major source” level of 100 tons per year under New Source Review (NSR)/PSD rules (Portland cement manufacturing is among the 28 source/industrial categories with 100 tons per year of NSR/PSD major source thresholds).

Houston American Cement Plant is located in Houston County, which is classified as “attainment” or “unclassifiable” for SO<sub>2</sub>, PM<sub>2.5</sub> and PM<sub>10</sub>, NO<sub>x</sub>, CO, and ozone (VOC).

The EPD review of the data submitted by Houston American Cement Plant related to the proposed cement plant indicate that the facility will be in compliance with all applicable state and federal air quality regulations.

It is the preliminary determination of the EPD that the proposal provides for the application of Best Available Control Technology (BACT) for the control of CO, PM, NO<sub>x</sub>, SO<sub>2</sub>, and VOC emissions, as required by federal PSD regulation 40 CFR 52.21(j).

It has been determined through approved modeling techniques that the estimated emissions will not cause or contribute to a violation of any ambient air standard or allowable PSD increment in the area surrounding the facility or in Class I areas located within 200 km of the facility. It has further been determined that the proposal will not cause impairment of visibility or detrimental effects on soils or vegetation. Any air quality impacts produced by project-related growth should be inconsequential.

This Preliminary Determination concludes that an Air Quality Permit should be issued to Houston American Cement Plant for the construction and operation of the Portland cement manufacturing plant. The draft permit contains various conditions to ensure and confirm compliance with all applicable air quality regulations. A copy of the draft permit is included in Appendix A.

## 1.0 INTRODUCTION

On July 2, 2007, Houston American Cement Plant (hereafter "HAC") submitted an application for an air quality permit to construct and operate a new/greenfield Portland cement manufacturing plant. The facility is located at 319 A.E. Harris Road, Perry, Houston County, Georgia.

**Table 1-1: Title V Major Source Status**

Pollutant	Is the Pollutant Emitted?	If emitted, what is the facility's Title V status for the Pollutant?		
		Major Source Status	Major Source Requesting SM Status	Non-Major Source Status
PM	Yes	Yes		
PM <sub>10</sub>	Yes	Yes		
SO <sub>2</sub>	Yes	Yes		
VOC	Yes	Yes		
NO <sub>x</sub>	Yes	Yes		
CO	Yes	Yes		
TRS	N/A	N/A		
H <sub>2</sub> S	N/A	N/A		
Individual HAP	Yes	Yes		
Total HAPs	Yes	Yes		

Table 1-2 below lists all current Title V permits, all amendments, 502(b)(10) changes, and off-permit changes, issued to the facility, based on a review of the "Permit" file(s) on the facility found in the Air Branch office.

**Table 1-2: List of Current Permits, Amendments, and Off-Permit Changes<sup>[1]</sup>**

Permit Number and/or Off-Permit Change	Date of Issuance/ Effectiveness	Purpose of Issuance
N/A	N/A	N/A

[1] The source is a new/greenfield facility/site and thus has no current permits, amendments, or off-permit changes

Based on the proposed project description and data provided in the permit application, the estimated emissions of air pollutants from the facility are listed in Table 1-3 below:

**Table 1-3: Emissions Increases from the Project**

Pollutant	Baseline Years	Potential Emissions Increase (tpy)	PSD Major Source Emission Level (tpy)	PSD Significant Emission Rate (tpy)	Subject to PSD Review
PM	N/A	231	100	25	Yes
PM <sub>10</sub>	N/A	184		15	Yes
VOC	N/A	274	100	40	Yes
NO <sub>x</sub>	N/A	1,068	100	40	Yes
CO	N/A	1,588	100	100	Yes
SO <sub>2</sub>	N/A	548	100	40	Yes
TRS	N/A	N/A		10	N/A
Pb	N/A	0.04		0.6	No
Fluorides	N/A	0.49		3	No
H <sub>2</sub> S	N/A	N/A		10	N/A
SAM	N/A	N/A		7	N/A
Mercury	N/A	0.06		0.1	No

The definition of baseline actual emissions is the average emission rate, in tons per year, at which the emission unit actually emitted the pollutant during any consecutive 24-month period selected by the facility within the 10-year period immediately preceding the date a complete permit application was received by EPD. The net increases were calculated by subtracting the past actual emissions (based upon the annual average emissions from a representative 24-month time period) from the future projected actual emissions of the modified equipment and associated emission increases from non-modified equipment.

As a new/greenfield source without any previous or current emissions, "baseline years" during which the baseline average annual actual emissions were determined did not exist for HAC. The potential emission increases were calculated by subtracting the past actual emissions (based upon the annual average emissions from a chosen 24-month time period during the chosen "baseline years" (which were zero for a greenfield source) from the future actual emissions of HAC's new cement plant (which were the potential emissions for a greenfield source).

The emissions calculations for Table 1-3 can be found in detail in the facility's PSD application (see Sections 3.0, 4.0, 5.0, Appendix A of Georgia Air Quality Application No. 17509, and subsequent submittals requested by EPD). These calculations have been reviewed and either approved or rectified by EPD.

Based on the information presented in Table 1-3, HAC, as specified per Application No. 17509, is classified as a major source under NSR/PSD rules because the potential emissions of CO, PM, NO<sub>x</sub>, SO<sub>2</sub>, and VOC.

Through its NSR/PSD procedure, EPD has evaluated HAC's proposal for compliance with State and Federal requirements. The findings of EPD have been assembled in this Preliminary Determination.

## 2.0 PROCESS DESCRIPTION

According to Application No. 17509, HAC has proposed to construct and operate a new/greenfield Portland cement manufacturing plant. This new facility is a dry process Portland cement plant capable of producing approximately 1,095,000 tons of clinker and 1,171,650 tons of cement per year.

HAC's proposed Portland cement manufacturing plant can be divided into three main sections: (1) kiln feed preparation, (2) clinker production, and (3) finish cement operation.

### (1) Kiln Feed Preparation

The basic ingredients of Portland cement include oxides of calcium, silica, aluminum, and iron. Due to the requirement for large quantities of calcium oxide (CaO), Portland cement plants are generally located near a source of the calcareous materials. The limestone and clay required for HAC's cement kiln is mined from an onsite quarry. A primary crusher reduces the limestone to right sizes. Other raw materials, such as iron ore/mill scale (or other iron sources), and bauxite/fly ash (or other alumina sources), are received from offsite sources. The raw materials are stored in various storage areas including stock piles, buildings, and silos. Then the raw materials are mixed by weighing scales according to production specification and conveyed to pre-blending silos. A raw mill fed by the pre-blending silos mixes, grinds and dries the raw materials to the desired fineness, producing a powdery material referred as dry feed/meal. The dry feed/meal is stored temporarily in silos feeding the kiln.

### (2) Clinker Production

In HAC, clinker production involves high temperature processing/pyroprocessing in a dry process rotary kiln, where necessary chemical reactions take place to produce a black nodule-looking product referred to as "clinker". The rotary kiln consists of a tube made from steel plate, and lined with firebrick. The tube slopes slightly (1 to 4°) and slowly rotates on its axis at between 30 and 250 revolutions per hour.

HAC's cement kiln is a counter-current heating device, meaning material fed into the cool upper end is drawn slowly by gravity to the hot discharge end. The burners at the discharge end of the kiln produce a current of hot gases that heat the clinker, the calcined materials and raw materials in succession as the hot gases pass upward toward the feed end. In the kiln, the clinker formation occurs in a series of stages that correlate with the temperature of the raw materials and in a unit called "calciner". In the preheater/precalciner and calciner, uncombined water evaporates from raw materials. Material temperature increases to the point where calcination begins when carbon dioxide (CO<sub>2</sub>) is liberated from the carbonate components of the raw materials. Sintering of the oxides occurs in the burning zone of the kiln. The sintering (or clinkering) reactions chemically combine calcines material with silica, alumina, and iron to form tricalcium silicate (Ca<sub>3</sub>SiO<sub>5</sub>), dicalcium silicate (Ca<sub>2</sub>SiO<sub>4</sub>), tricalcium aluminate (Ca<sub>3</sub>Al<sub>2</sub>O<sub>6</sub>), and tetracalcium alumino-ferrite (Ca<sub>4</sub>AlFeO<sub>7</sub>). Following the sintering reactions, clinker is quickly cooled by contact with ambient air in a clinker cooler. Some heat transferred to the cooler air is recouped back into the process.

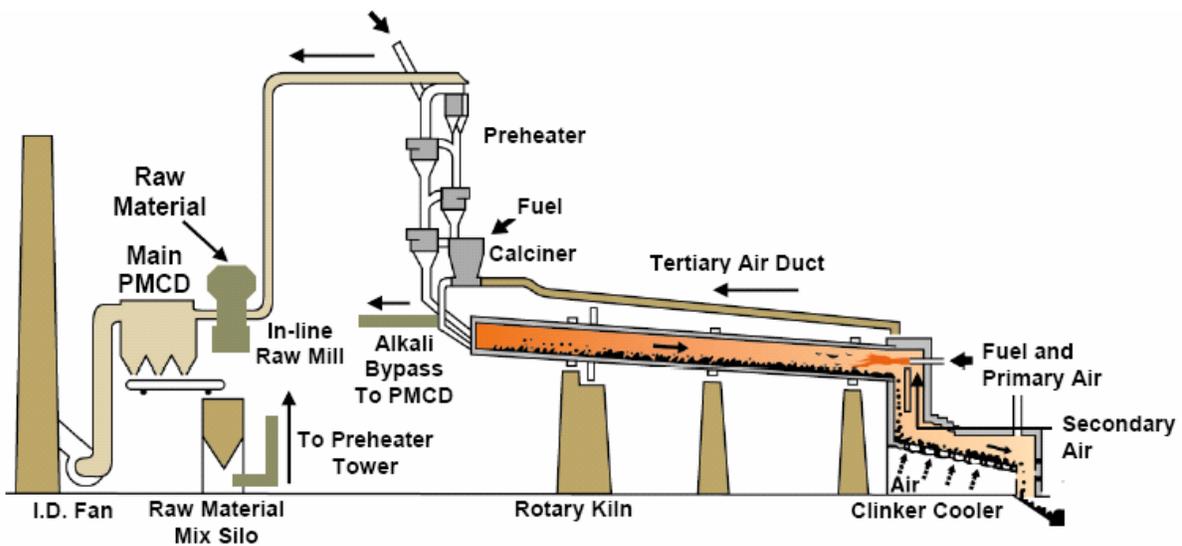
### (3) Finish Cement Operations

The cooled clinker is stored prior to being sent to a finish mill where it is combined with gypsum and other additives as product specification requires. Then the mixed materials are ground to a fine, homogenous powder in a series of ball mills to produce the desired Portland cement. The finished Portland cement is then transferred to the cement storage silos prior to shipment off-site.

HAC's kiln system has a nominal capacity of 229 tons per hour of dry feed input to the preheater/precalciner, and a nominal capacity of 125 tons per hour of clinker output from the kiln. The finish mill can produce nominally 150 tons per hour of Portland cement. Cement produced is packaged as necessary, and distributed by both truck and rail.

Fuel authorized for the kiln include natural gas, coal, petroleum coke, fuel oils, landfill gas, and other non-hazardous liquid and solid fuels such as “on-specification” used oil fuels, plastics, filter fluff and wood wastes. A coal mill grinds approximately 205,618 tons of coal and petroleum coke annually for firing the kiln. Emissions of regulated air pollutants from firing with each fuel are determined via performance testing before the use of the fuel is authorized.

The following figure is a simplified process flow diagram of a typical preheater/precalciner kiln similar to that proposed by HAC except the latter will not be equipped within an alkali bypass. The illustration was borrowed from a study by Trinity Consultants in 2003 for Portland Cement Association assessing pollution control strategies for Portland cement manufacturing process. The mentioned study is available at: [www.cement.org/pdf\\_files/SN2728.pdf](http://www.cement.org/pdf_files/SN2728.pdf)



**Figure 2-1. Process Diagram of Dry Process Preheater/Precalciner Cement Kiln System**

The main air pollutants emitted from Portland cement manufacturing process include CO, NO<sub>x</sub>, PM/PM<sub>10</sub>, SO<sub>2</sub>, and VOC. The major mechanisms for the formation of these pollutants are generalized (and greatly simplified) in Table 2-1.<sup>1</sup> Other regulated pollutants emitted at less significant quantities include hydrogen chloride (HCl), mercury (Hg), and dioxin/furan (D/F).

**Table 2-1. Primary Mechanisms and Sources of Pollutant Formation**

Pollutant	Formation Mechanism	Source
NO <sub>x</sub>	Thermal	Kiln Burner
	Fuel Nitrogen Oxidation	Kiln, Calciner
SO <sub>2</sub>	Oxidation of Raw Material Pyrites	Upper Preheater/Precalciner Stages
	Fuel Sulfur Oxidation	Kiln, Calciner, Coal/Petcoke
CO and VOC	Incomplete Combustion	Calciner
	Thermal Evolution	Raw Materials
PM/PM <sub>10</sub>	Crushing, Grinding, Conveyance	Crusher, Raw Mill, Coal Mill, Finish Mill, Belts, Silos, Bins
	Pyroprocessing	Kiln, Clinker Cooler

<sup>1</sup> Linero, A.A., “What’s Up With Cement Plant Permitting?”, In Proceedings of the 94<sup>th</sup> Annual Air and waste Management Association Conference and Exhibition. June 2001. Orlando, Florida.

Apparently the most direct way to control most of the emissions aforementioned is by process and combustion controls coupled with a judicious selection of fuel and raw materials, with the help of production measurements that minimize fuel consumption and optimize production and pollution control. Table 2-2 summarizes in great simplicity the primary control measures for the main pollutants listed in Table 2-1.

**Table 2-2. Primary Control Techniques for Main Pollutants Emitted from Cement Manufacturing**

Pollutant	Formation Mechanism	Primary Control Techniques
NO <sub>x</sub>	Thermal	Kiln Burner Design, Indirect Firing
	Thermal, Fuel Nitrogen Oxidation	Optimum Process and Raw Mix Control
		Fuel Selection, Staged Combustion in Calciner
SO <sub>2</sub>	Oxidation of Raw Material Pyrites	Raw Material Selection
	Fuel Sulfur oxidation	Lime Powder in Calciner, Alkalis in Kiln
CO and VOC	Incomplete Combustion	Hot Excess Air, Mixing, Residence Time
	Thermal Evolution	Raw Material Selection
PM/PM <sub>10</sub>	Crushing, Grinding, Conveyance	Wet Quarrying, Wet Suppression, Process Cyclones
	Pyroprocessing	Pyroprocessing Cyclones

The primary control techniques generalized in Table 2-2 are greatly constrained by the characteristics and availability of raw materials and fuels, and equipment or process design and feasibility. Such situations lead to various add-on control equipment, as listed in Table 2-3. These techniques are available and each is in use at one or more Portland cement plants in the U.S. or Europe.

**Table 2-3. Add-On Control Techniques for Main Pollutants Emitted from Cement Manufacturing**

Pollutant	Add-On Control Techniques
NO <sub>x</sub>	Selective Non-Catalytic Reduction (SNCR), Selective Catalytic Reduction (SCR)
SO <sub>2</sub>	Hydrated Lime or Lime Slurry Injection/Spray, Wet or Dry Scrubbers
CO and VOC	Thermal Oxidation (both), Carbon Adsorption or SCR (for VOC)
PM/PM <sub>10</sub>	Electrostatic Precipitation (ESP), Baghouse

HAC proposes to use an ammonia (NH<sub>3</sub>)-injection based SNCR system in combination with staged and controlled combustion (SCC) and low NO<sub>x</sub> burners to reduce NO<sub>x</sub> emissions from the kiln system, and baghouses to abate PM/PM<sub>10</sub> emissions from exhaust stacks serving various process and material handling operations/units. Wet suppression/water spray and other precautions are utilized as necessary to reduce fugitive PM emission from the on-site quarry and material handling processes. The cement kiln system is also designed and operated to minimize the emissions of NO<sub>x</sub>, CO and VOC via controlled combustion. Control of SO<sub>2</sub> emissions from the fuel combustion and pyroprocessing of raw materials depends on mainly “inherent scrubbing” of SO<sub>2</sub> by alkalis present in the kiln, judicious selection of raw materials to limit the sulfur input, and hydrated lime injection into the kiln process gas streams/add-on dry scrubbing as necessary.

Upon initial startup, HAC’s cement plant will use continuous emission monitor (CEM) to monitor the CO, NO<sub>x</sub>, SO<sub>2</sub>, and VOC emissions from the main kiln exhaust stack shared by the raw mill, the kiln, and the clinker cooler. Continuous opacity monitor (COM) will be used at the outlet of the main kiln exhaust stack and the finish mill stack. A PM CEM will be used for the main kiln exhaust stack once EPA promulgates the procedural and operational requirements for the PM CEM.

The HAC’s permit application and supporting documentation are included in Appendix A of this Preliminary Determination and can be found online at [www.georgiaair.org/airpermit](http://www.georgiaair.org/airpermit).

### 3.0 REVIEW OF APPLICABLE RULES AND REGULATIONS

#### State Rules

Georgia Rule for Air Quality Control (Georgia Rule) 391-3-1-.03(1) requires that any person prior to beginning the construction or modification of any facility which may result in an increase in air pollution shall obtain a permit for the construction or modification of such facility from the Director upon a determination by the Director that the facility can reasonably be expected to comply with all the provisions of the Act and the rules and regulations promulgated thereunder. Georgia Rule 391-3-1-.03(8)(b) continues that no permit to construct a new stationary source or modify an existing stationary source shall be issued unless such proposed source meets all the requirements for review and for obtaining a permit prescribed in Title I, Part C of the Federal Act [i.e., Prevention of Significant Deterioration of Air Quality (PSD)], and Section 391-3-1-.02(7) of the Georgia Rules (i.e., PSD).

Georgia Rule (b) [391-3-1-.02(2)(b): *Visible Emissions*] is a general rule limiting the opacity of stack visible emissions from a source to less than 40%. This regulation applies to any source with stack visible emissions but is not subject to other more restrictive source specific limit for the same visible emissions.

Georgia Rule (e) [391-3-1-.02(2)(e): *Particulate Emissions from manufacturing Processes*], commonly known as the process weight rule, limits stack PM emissions from any source which is not subject to other more restrictive source specific limit for the same PM emissions. The applicable stack PM emission rate is determined using either of one of three equations, depending on the process input rate and age of the equipment.

Georgia Rule (f) [391-3-1-.02(2)(f): *Portland Cement Plants*] assumes all the applicable New Source Performance Standard (NSPS) emission limits and requirements contained in 40 CFR Part 60, Subpart F – *Standard of Performance for Portland Cement Plants*.

Georgia Rule (g) [391-3-1-.02(2)(g): *Sulfur Dioxide*] limits the sulfur content of liquid or solid fossil fuel(s) or wood residue burned by a new fuel-burning source constructed or extensively modified after January 1, 1972. The limitation is based on the type of the fossil fuel(s) (liquid, solid or wood residue) and the heat input rate of the source. With an heat input rate greater than 250 MM BTUs/hr, HAC's kiln is subject to the following fuel sulfur content requirements:

- 0.8 pounds of SO<sub>2</sub> per million BTU of heat input derived from liquid fossil fuel or derived from liquid fossil fuel and wood residue;
- 1.2 pounds of SO<sub>2</sub> per million BTU of heat input derived from solid fossil fuel or derived from solid fossil fuel and wood residue;
- When different fossil fuels are burned simultaneously, the applicable SO<sub>2</sub> emission standard expressed as pounds of SO<sub>2</sub> per million BTU of heat input shall be determined by proportion using the following equation:

$$a = \frac{y(0.80) + z(1.2)}{y + z}$$

Where:

y = percent of total heat input derived from liquid fossil fuel:

z = percent of total heat input derived from solid fossil fuel:

a = the allowable SO<sub>2</sub> emission in pounds per million BTU.

In no case the Permittee shall burn any fuel which contains more than 3% sulfur by weight even after employing SO<sub>2</sub> emission control.

Georgia Rule (n) [391-3-1-.02(2)(n): *Fugitive Dust*], commonly known as the fugitive dust rule, requires the Permittee to take all reasonable precautions to prevent fugitive dust emissions from any operation, process, handling, transportation or storage facility prone to such emissions, and lists a number of such precautions. In addition, Georgia Rule (n) limits the opacity of such fugitive emissions to less than 20%.

Because the emission standards/limits under pertinent NSPS, National Emission Standards for Hazardous Air Pollutants (NESHAP)/Maximum Achievable Control Technology (MACT) or NSR/PSD rules are more stringent than those in the aforementioned rules, these SIP rules are subsumed by the pertinent federal rules accordingly.

#### Federal Rule - PSD

The regulations for PSD in 40 CFR 52.21 require that any new major source or modification of an existing major source be reviewed to determine the potential emissions of all pollutants subject to regulations under the Clean Air Act. The PSD review requirements apply to any new or modified source which belongs to one of 28 specific source categories having potential emissions of 100 tons per year or more of any regulated pollutant, or to all other sources having potential emissions of 250 tons per year or more of any regulated pollutant. The PSD review requirements also apply to any modification of a major stationary source which results in a significant net emission increase of any regulated pollutant.

Georgia has adopted a regulatory program for PSD permits, which the United States Environmental Protection Agency (EPA) has approved as part of Georgia's State Implementation Plan (SIP). This regulatory program is located in the Georgia Rules at 391-3-1-.02(7). This means that Georgia EPD issues PSD permits for new major sources pursuant to the requirements of Georgia's regulations. It also means that Georgia EPD considers, but is not legally bound to accept, EPA comments or guidance. A commonly used source of EPA guidance on PSD permitting is EPA's Draft October 1990 New Source Review Workshop Manual for Prevention of Significant Deterioration and Nonattainment Area Permitting (NSR Workshop Manual). The NSR Workshop Manual is a comprehensive guidance document on the entire PSD permitting process.

The PSD regulations require that any major stationary source or major modification subject to the regulations meet the following requirements:

- Application of BACT for each regulated pollutant that would be emitted in significant amounts;
- Analysis of the ambient air impact;
- Analysis of the impact on soils, vegetation, and visibility;
- Analysis of the impact on Class I areas; and
- Public notification of the proposed plant in a newspaper of general circulation

### Definition of BACT

The PSD regulation requires that Best Available Control Technology (BACT) be applied to all regulated air pollutants emitted in significant amounts. Section 169 of the Clean Air Act defines BACT as an emission limitation reflecting the maximum degree of reduction that the permitting authority (in this case, EPD), on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such a facility through application of production processes and available methods, systems, and techniques. In all cases BACT must establish emission limitations or specific design characteristics at least as stringent as applicable New Source Performance Standards (NSPS). In addition, if EPD determines that there is no economically reasonable or technologically feasible way to measure the emissions, and hence to impose and enforceable emissions standard, it may require the source to use a design, equipment, work practice or operations standard or combination thereof, to reduce emissions of the pollutant to the maximum extent practicable.

EPA's Draft New Source Review Workshop Manual (NSR Workshop Manual), dated October 1990 includes the EPA guidance on the 5-step top-down process for determining BACT. In general, Georgia EPD requires PSD permit applicants to use the Top Down process described in the NSR Workshop Manual in the BACT analysis, which EPD reviews. The five steps of a top-down BACT review procedure identified by EPA per BACT guidelines are listed below:

- Step 1: Identification of all control technologies;
- Step 2: Elimination of technically infeasible options;
- Step 3: Ranking of remaining control technologies by control effectiveness;
- Step 4: Evaluation of the most effective controls and documentation of results; and
- Step 5: Selection of BACT.

The following is a discussion of the applicable federal rules and regulations pertaining to the equipment that is the subject of this preliminary determination, which is then followed by the top-down BACT analysis.

#### New Source Performance Standards (NSPS)

40 CFR Part 60, Subpart A - *General Provisions*, imposes generally applicable provisions for initial notifications, initial compliance testing, monitoring, and recordkeeping requirements for equipment at the facility subject to a specific NSPS standard, as indicated by the pertinent NSPS standard.

40 CFR Part 60, Subpart Y - *Standards of Performance for Coal Preparation Plants* applies to the coal processing operations/coal mill and associated storage and conveying systems at HAC, excluding the conveying system transfer points which are used to convey coal from the coal mill to the kiln and therefore subject to the NESHAP MACT standard for Portland cement manufacturing industry, i.e., 40 CFR Part 63, Subpart LLL. Subpart Y establishes process/source specific PM and visible emissions limits, and record keeping, reporting, testing, compliance demonstration and reporting requirements for each of affected process units/sources.

40 CFR Part 60, Subpart OOO – *Standards of Performance for Nonmetallic Mineral Processing Plants* applies to the on-site limestone quarry and associated crushing, storage and conveying operations, excluding the conveying system subject to 40 CFR Part 63, Subpart LLL. Subpart OOO establishes process/source specific PM, visible and fugitive emissions limits, and record keeping, testing, compliance demonstration and reporting requirements for each of the affected sources.

40 CFR Part 60, Subpart III - *Standards of Performance for Stationary Compression Ignition Internal Combustion Engines* applies to the new 750 kW emergency stationary diesel engine/generator. This NSPS standard requires the engine to be certified for compliance with the applicable emission standards by the manufacturer, and operated only during emergency power generation and maintenance check and readiness testing. Subpart III also limits the annual operating time for maintenance check and readiness testing, and establishes current and future fuel requirements for sulfur content and cetane index and/or aromatic content. The Permittee is required to keep engine specification, operation and fuel records to demonstrate compliance with this standard.

All the affected sources subject to 40 CFR Part 63, Subpart LLL: *National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry* are exempt from the otherwise applicable NSPS requirements contained in 40 CFR Part 60, Subpart F – *Standard of Performance for Portland Cement Plants*. This means that the whole cement manufacturing line, from the raw material handling to cement shipment, shall comply with the NESHAP MACT requirements in Subpart LLL instead of the applicable NSPS requirements in Subpart F.

NSPS standard for petroleum/volatile organic liquid storage tanks, i.e., 40 CFR Part 60, Subpart Kb: *Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced After July 23, 1984* does not apply to the 10,000-gallon diesel storage tank because its capacity is below the applicability threshold.

#### National Emissions Standards For Hazardous Air Pollutants (NESHAP)

40 CFR Part 63, Subpart A, *General Provisions*, imposes general requirements for initial notifications, initial compliance testing, monitoring, and recordkeeping. HAC shall comply with the applicable general provisions because cement manufacturing process and the emergency stationary diesel engine/generator are subject to 40 CFR Part 63 Subparts LLL and ZZZZ respectively. Both Subparts LLL and ZZZZ contain tables listing the applicable provisions of 40 CFR Part 63, Subpart A.

40 CFR Part 63, Subpart LLL - *National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry* applies to HAC because it is a major source for hazardous air pollutant (HAP) emissions. This Part 63 NESHAP MACT standard establishes process/source specific emission limits for PM, VOC (expressed as total hydrocarbon, i.e. THC), mercury (Hg), dioxins/furans (D/F), and visible emissions. In addition to limit the HAP emissions such as Hg and D/F, Subpart LLL also limits emissions of other solid and gaseous HAP compounds by limiting the PM and THC emissions because portions of such emissions are EPA-listed hazardous air pollutants. Subpart LLL requires HAC to comply with the applicable emission limits on and after the initial startup of the cement production. To further reduce emissions, Subpart LLL also establishes operational requirements for the use of cement kiln dust (CKD), fly ash, fuel and control equipment. Subpart LLL also specifies process/source specific emissions testing, monitoring, record keeping, reporting, and compliance demonstration requirements.

40 CFR Part 63, Subpart ZZZZ: *National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines* applies to the 750 kW emergency stationary diesel engine/generator in this plant. Subpart ZZZZ limits the use of the generator to emergency and limited use (>100 hours per year) situations only, and requires an initial notification for the startup of the source.

HAC will not use any wastes defined as “hazardous wastes” in 40 CFR Part 63, Subpart EEE – “*National Emission Standards for Hazardous Air Pollutants from Hazardous Waste Combustors*”, therefore, Subpart EEE does not apply to this facility.

**State and Federal – Startup and Shutdown and Excess Emissions**

Excess emission provisions for startup, shutdown, and malfunction are provided in Georgia Rule 391-3-1-.02(2)(a)7. Excess emissions from the cement manufacturing line, especially from the in-line kiln/raw mill, clinker cooler or finishing mill, coal mill and associated material conveying, storage, weighing, packaging, and storage systems would most likely result from a malfunction of the associated emission control equipment. The facility cannot anticipate or predict malfunctions. However, the facility is required to minimize emissions during periods of startup, shutdown, and malfunction.

As a greenfield source/site, HAC is required to prepare and submit monitoring plans for emission units subject to the CAM requirements with the initial Title V operating permit application within 12 months of the startup of the cement plant. This PSD construction permit, as issued under the authority of Georgia Rules 391-3-1-.02(7), “*Prevention of Significant Deterioration of Air Quality*” and 391-3-1-.03(1), “*Construction (SIP) Permit*”, is not required to incorporate the applicable CAM requirements.

## 4.0 CONTROL TECHNOLOGY REVIEW

The proposed project will result in emissions of a number of air pollutants, including CO, fluorides, Hg, lead (Pb), PM, NO<sub>x</sub>, SO<sub>2</sub> and VOC. However, only emissions levels for CO, PM, NO<sub>x</sub>, SO<sub>2</sub> and VOC are high enough to trigger PSD review. This section describes in details each piece of equipment with CO, PM, NO<sub>x</sub>, SO<sub>2</sub> and/or VOC emissions, identifies possible control technologies for the pollutants involved, and determine source and emission-specific BACT.

### 4.1 Fugitive PM Emissions from the Onsite Quarry Operations

Because the potential PM emissions from HAC have triggered PSD applicability, and NSR rule requires quantifiable fugitive emissions from this source/cement plant to be included in the PSD applicability analysis, the fugitive PM emissions from HAC's onsite quarry operations are evaluated for BACT. According to the application No. 17509, the total PM and PM<sub>10</sub> fugitive emissions from the on-side quarry operation, including haul roads, storage piles and material transfer, were estimated at 9.2 and 3.4 tons per year respectively based on AP 42.

Limestone and clay will be quarried from this onsite open pit limestone and clay quarry. Equipment involved in the quarry operations include drillers, a primary crusher, front loaders, trucks, belt conveyers, stackers, associated storage buildings and stockpiles. Due to the nature of the operations and equipment design, the only emissions from the quarry operations are fugitive dusts. Fugitive dust sources generally involve the re-entrainment of settled dusts by wind, machine movement, and material transport. Sources of such fugitive emissions include mainly drilling, blasting, crushing and material conveying and storage processes (belt conveyors, stockpiles, loading and unloading, traffic, etc.). Wind-blown dusts from the working area such as stockpiles and paved and unpaved roads also contribute to the fugitive PM emissions.

Of geographical and seasonal factors, the primary variables affecting the fugitive PM emissions are wind and material moisture content. Wind parameters vary with geographical location, season, and weather. It can be expected that the level of the fugitive emissions will be greater during periods of high winds. The material moisture content also varies with geographical location, season, and weather.

The moisture content of the material processed can have a substantial effect on fugitive emissions from the quarry processes. Surface wetness causes fine particles to agglomerate on or to adhere to the faces of larger stones, with a resulting dust suppression effect. However, as new fine particles are created by crushing and attrition and as the moisture content is reduced by evaporation, this suppressive effect diminishes and may disappear. Wet suppression systems (spray nozzles) can maintain relatively high material moisture contents throughout the processes and thus effectively control PM emissions along the processes. Depending on the geographical and climatic conditions, the moisture content of mined rock can range from nearly zero to several percent. Typically, wet material contains more than 1.5% water.

HAC's quarry is an outdoor operation with large open quarry pits and frequent moving work areas/quarrying zones. The machineries involved such as drillers, the primary crusher, and belt conveyors are designed to relocate from time to time along the quarrying zone. Therefore, the two common PM control technologies requiring fixed foundations and enclosures to capture the PM emissions, i.e., wet scrubbing and fabric filtration/baghouse are technically infeasible for the machineries involved. The only feasible PM control technology, as proposed by HAC in the application, is wet suppression, i.e., regular spray of water via spray nozzles, sprinkles and/or water truck water cannons to maintain the moisture of the materials to more than 1.5% and prevent PM from becoming airborne.

## **Fugitive BACT Determination**

Based on the nature of the sources and equipment involved, EPD has determined that HAC's proposal to use wet suppression/water spray to minimize the fugitive PM emissions from the on-site quarry constitutes BACT. The corresponding emission limit for the BACT is 10% opacity for visible emissions from any fugitive PM sources (except the primary crusher whose visible emission limit is 15% opacity), and no visible emissions from any process buildings and wet operations. Specific operating, monitoring, testing, record keeping, and reporting requirements are contained in this PSD permit to ensure the implement of the BACT. Some of these requirements are assumed from NSPS Subpart OOO.

### 4.2 PM Emissions from Material Handling, Mixing, Grinding, In-line Kiln/Raw Mill, Coal Mill, Finishing Mill, Cement Packaging and Shipping Operations

Either generated or disturbed mechanically by process equipment or formed during chemical reactions involved, and consequently entrapped in the exhaust gas streams, PM (including PM less than 10 micrometer, PM<sub>10</sub>) are emitted from various raw materials, solid fuels and process material handling and processing operations, include loading and unloading, conveying and storage, weighing, mixing, grinding, pyroprocessing, combustion, packaging and shipping. Exhaust gas streams in particular from the in-line kiln/raw mill, clinker cooler, coal mill and finish mill contain large quantity of PM/PM<sub>10</sub> generated by the entrapment in the process gaseous streams of the powdery materials or ashes from fuel combustion, especially from coal and solid fuel burning, and to less degree, sulfate particulates from neutralization/alkali scrubbing reactions. Excluding those generated from fuel combustion, most of the process PM/PM<sub>10</sub> emissions are finely dispersed solids as either part of the raw materials, intermediate or final products, and can be returned to the process once captured.

Control of such PM/PM<sub>10</sub> emissions is achieved by the collection of the particles from the facility's exhaust/ventilation stack discharging gas streams and by the prevention of generation of particles from fugitive emission sources. Among Portland cement manufacturing plants, commonly used PM/PM<sub>10</sub> emission control/capture devices for stack/ventilation exhaust gas streams are fabric filters (baghouses) and electrostatic precipitators (ESPs).

ESPs use an electrostatic field to charge particulate matter contained the gas streams. The charged particulates then mitigate to grounded collecting surfaces/plates due to electrostatic attraction. The collected particles are then dislodged by vibrating or rapping the collector surface, and subsequently collected in a hopper at the bottom of the ESP.<sup>2</sup> ESPs are capable of very high collection efficiencies, even for very small particles.

Fabric filter collectors (also known as baghouses) are one of the most efficient means to separate particulate matter from a gas stream. Baghouses are capable of maintaining mass collection efficiencies of greater than 99% down to a particle size approaching 0.3 μm in most applications. In baghouses, gas streams are passed through a felted or woven fabric, causing PM/PM<sub>10</sub> in the gas streams to be collected/captured on the surface of the fabric by sieving and other capturing mechanisms including impaction, Brownian diffusion, and electrostatic attraction

Baghouses and ESPs are considered equivalent for PM control and both can achieve a typical control/removal efficiency of 99% or better. ESPs and baghouses are used extensively as control devices for the modern dry process kiln systems at Portland cement plants, where raw mill, preheater/precalciner, calciner, kiln, clinker cooler, sometimes even coal mill and finish mill, could share a common baghouse or ESP. Baghouses are used almost exclusively to control PM emissions from other material processing operations as long as the PM emissions can be captured reasonably by a ventilation/exhaust system(s) which makes the operations involved a point source(s) with defined exit point(s).

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<sup>2</sup> EPA Handbook: Control Technologies for Hazardous Air Pollutants, EPA/625/6-91/014, June 1991.

Inertial separators (cyclonic and Venturi scrubbers ) can have efficiencies over 90% within narrow particle size ranges. Inertial separators have not been demonstrated as effective controls at cement plants, but they are used extensively as process devices to recover product (meal) at cement plants. The use of cyclones as process devices at cement plants serves to enhance the overall control efficiency of the system by reducing large abrasive particles in the process gas streams.

The PM/PM<sub>10</sub> control efficiency of a wet scrubber (spraying or packed bed) is higher than that of a cyclone, but not as high as that of a baghouse or ESP due mainly to short circuiting. Wet scrubbing is known for creating waste water and sludge disposal problems, straining water supply, and requiring substantially additional energy for pumping water and propelling cooled exhaust air stream out the stacks.

Unlike wet scrubbers which turn captured particulate matter into slurry or sludge, baghouses and ESPs capture/collect particulate matter dry and as they are, allowing the return of the captured materials to the process material flow without additional processing. Therefore, baghouses and ESPs are widely used among cement plants and other industries readily reusing the captured materials.

Control technologies identified as technically feasible for the control of the PM/PM<sub>10</sub> emissions from the HAC are ranked by their control efficiency in Table 4.2-1 below:

**Table 4.2-1: Ranking of PM/PM<sub>10</sub> Control Technology for Portland Cement Plant**

Control Technology Ranking	Control Technology	Control Efficiency
1	Baghouse, ESP	>99%
2	Wet Scrubbing	<99%
3	Cyclone and Venturi Scrubbers	>90%

The baghouse and ESP are considered equivalent as the most efficient/top technology for controlling the PM/PM<sub>10</sub> emissions from Portland cement manufacturing plants such as HAC. Coupled with a properly designed and designated capture system(s), properly designed, maintained and operated baghouses or ESPs can readily reduce such PM emissions by more than 99%, and therefore are widely used among cement manufacturing plants and other industries with similar PM/PM<sub>10</sub> emission sources. A review of previous BACT determinations and various permits issued to Portland cement plants country wide indicated that both ESPs and baghouses are considered as BACT for PM/PM<sub>10</sub> emission controls for cement plants. However, twice as many cement plants are using baghouses instead of ESPs as BACT. One of the reasons for the popularity of baghouses is to avoid ESP trips caused by process CO spikes.

### PM BACT Determination

HAC proposed to use a number of baghouses coupled with capture/exhaust systems to control the PM/PM<sub>10</sub> emissions from the in-line kiln/raw mill and from other ventilated/exhausted process units along the cement process line. In all cases, the collected fines will be returned to the process.

EPD has determined that HAC's proposal of using baghouses to control the emissions of PM/PM<sub>10</sub> from raw materials handling and preparation, coal/solid fuel grinding, preheater, calciner, kiln, clinker cooler, finish mill, cement storage, packaging and shipping processes constitutes BACT.

The BACT emission limit is no greater than 0.153 and 0.129 lbs per ton of clinker respectively for PM and PM<sub>10</sub> from the main kiln stack. This limit is equivalent approximately to a dust loading of 0.008 grains per dry standard cubic foot (gr/dscf) in the exhaust gas stream and at the low end of the previous BACT limits for the similar sources. Since it usually takes between 1.5 to 1.8 tons of dry feed to produce one ton of clinker, depending on the composition of the dry feed and the operation of the kiln, the PM limit of 0.153 lbs per ton of clinker is as stringent as, and could be more stringent than the MACT limit of 0.1 lb of PM per ton of dry feed under 40 CFR Part 63, Subpart LLL. Because HAC's kiln process/exhaust air streams could have relatively more air-borne sulfate particles due to the use of locally quarried raw materials (limestone and clay) with relatively high sulfur contents, EPD considers this limit to be stringent on case-by-case basis.

The BACT limits for PM and PM<sub>10</sub> emissions from the rest of the baghouse-controlled sources/stacks at HAC are 0.010 and 0.0085 gr/dscf respectively. Visible emissions from any stacks controlled the baghouses are limited to no more than 10% opacity.

Pertinent monitoring, testing, compliance demonstration and reporting requirements for PM and visible emissions for the affected sources subject to 40 CFR Part 63, Subpart LLL will be adapted as BACT requirements for the same sources. This adoption is reasonable because these MACT requirements are more updated, detailed, and/or stringent than those established during previous BACT determinations for the similar sources. In addition, the Permittee will be required to perform daily checkup of visible emissions and keep checkup logs under the State rules.

The BACT requires the use of a continuous opacity monitor (COM) for the main kiln exhaust stack and the finish mill stack. In lieu of operating the COM, the Permittee can opt to operate baghouse leakage detection systems (BLDS) to ensure the proper function of the baghouse(s) involved, as allowed by Subpart LLL. The BACT assumes the requirement for the use of a PM CEM for main kiln stack once the US EPA promulgates the procedural requirements for the operation of the PM CEM under Subpart LLL. The PM CEM will enhance the monitoring and compliance with the PM emission limit involved by providing real time continuous sampling of PM emissions.

The initial performance testing involves the use of Methods 5, 9 and/or COM as applicable to determine the PM and visible emissions from each of the stacks involved. Please note that Subpart LLL requires testing on the PM and visible emissions from the main kiln stack every 5 years from the initial performance testing, which will in turn ensure the compliance of the BACT.

#### 4.3 CO Emissions from Preheater/Precalciner, Calciner and Kiln

Because the CO emissions from HAC's kiln system have triggered PSD applicability, the CO emissions are evaluated for Best Available Control Technology (BACT).

As other Portland cement plants, HAC's CO emissions are from two independent sources: (1) incomplete fuel combustion in the kiln and calciner; and (2) incomplete oxidation/combustion of carbonaceous materials in the dry feed/raw meal introduced to the preheater/precalciner. For cement manufacturers, emissions of CO represent a waste of fuel, and also indicate reducing conditions within the kiln which must be avoided at all costs since it causes destruction of the clinker mineral structure. For this reason, the exhaust gas is continually analyzed for O<sub>2</sub>, CO, NO<sub>x</sub> and SO<sub>2</sub> at most of the cement manufacturing plants.

In modern preheater/precalciner kiln cement plants such as HAC, approximately 40 to 50% of the fuel is fired in the kiln burner and the remaining in the calciner. The CO generated in the kiln results from the kiln operating conditions dictated by the production of quality clinker, and more specifically by the amount of excess oxygen/air available at the back of the kiln (where the gases exit the kiln). As the gases exit the kiln and enter the calciner, CO levels become a function of calciner design and the degree to which staged combustion is used to control NO<sub>x</sub>. More aggressive staged combustion creates reducing conditions (for less NO<sub>x</sub> formation) in the low stages of the calciner which will increase CO levels. On the other hand, the CO can be oxidized back to CO<sub>2</sub> by using secondary or tertiary combustion air prior to the bottom cyclone of the preheater/precalciner. Such oxidation is the function of the calciner design which decides the residence time and turbulence after introducing the secondary or tertiary combustion air. Therefore, more NO<sub>x</sub> control via more reducing conditions in the combustion will increase CO levels, and vice versa.

In addition, the use of ammonia-solution based SNCR for  $\text{NO}_x$  control will adversely affect the oxidation of CO to  $\text{CO}_2$  because both reactions will compete for  $\text{OH}^*$  radicals required for reduction of CO and  $\text{NO}_x$ . One study revealed that a molar ratio of  $\text{NH}_3$  to  $\text{NO}_x$  of 0.4 increased CO emissions by up to 0.5 pounds per ton of clinker. When such ratio increased to 0.8 and 1.0, the CO emissions were increased by up to 1.0 and 1.5 pounds per ton of clinker respectively.<sup>3</sup>

In modern preheater/precalciner cement plants such as HAC, raw meal/dry feed is introduced to the exhaust gas stream from the preheater/precalciner and preheated through a series of cyclones (stages). In the heating process, organic materials naturally occurring in the feed (kerogen and bitumen) are progressively heated and begin to degrade. Significant fraction of such materials are oxidized to  $\text{CO}_2$ , with the rest as short-chain VOC's and CO. The amount of CO generated from such pyrolytic process depends the nature of the organics present in the feed materials. Light hydrocarbon species typically produce more VOC and less CO in the kiln preheater gas, and vice versa. Depending on the geological strata of the feed materials, the composition and content of the organic materials in the kiln feed (meal) may vary significant.

Further more, the rate of conversion of feed carbon to  $\text{CO}_2$  is influenced by the temperature profile of the preheater/precalciner, the organic content of the kiln feed, and the composition of the organics in the kiln feed. The temperature of the preheater stages is defined by the kiln and mix designs ( $\text{C}_3\text{S}$ , silica, etc.) and cannot be modified sufficiently to complete oxidation of CO and VOC in the preheater/precalciner.

In addition to the equipment design and materials characteristics affecting CO emissions, the typical operating conditions in a well-operated cement plant create a great deal of variability in CO emission. These conditions include material flushes, build up, blockage, false air, poor material burnability, and changes in fuel and feed characteristics. These factors require constant adjustments in plant operations to maintain a smooth running plant and uniform clinker quality. These adjustments are accomplished through a series of control loops that automatically adjust fuel and feed rate, fan speeds, and other operating parameters. The process operates best if the adjustments are made in small increments to avoid excessively overshooting or undershooting the set point of the burning zone temperature and kiln gas composition, in a fashion of built in time lag. Drastic control measures can be taken, including the shutdown of the plant, on expense of energy cost, wear and tear on the plant, and poor clinker quality.

Review of literature, the BACT/LAER Clearinghouse, and permits issued to similar cement plants by other states indicates that proper equipment design and process operation (i.e., good combustion practice) represents BACT for CO emissions from Portland cement kilns. Properly controlled combustion in the kilns minimizes CO formation by ensuring that temperatures and  $\text{O}_2$  availability are adequate for complete combustion. A properly designed and operated cement kiln acts as a thermal oxidizer, capable of converting 95% of the CO generated to  $\text{CO}_2$ .

In conclusion, maximum CO emissions can be achieved by the combination of following approaches:

- Relatively low carbonaceous matter and hydrocarbons in the raw materials;
- Good combustion at the main kiln burners and calciner;
- Addition of tertiary air from the kiln hood and clinker cooler; and
- Sufficient residence time from proper design of calciner size and duct lengths to complete burnout.

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<sup>3</sup> Erpelding, R.M., *latest Development in  $\text{NO}_x$  Reduction Technology in the Cement Industry*. Cement Plant Environmental Handbook, 2003.

In addition to proper plant design, plant operation and raw material selection, add-on controls can achieve further reduction of CO emissions. Such controls would involve some type of thermal oxidation from CO to CO<sub>2</sub> in clean gas streams with minimal amounts of PM. The oxidation technology includes direct flame incineration/oxidation and energy-saving catalytic oxidation. Thermal oxidation can also control VOC emissions via combustion and turn organic compounds/hydrocarbons into basically water and CO<sub>2</sub>. Because of the presence of chlorides, phosphorus compounds, sulfur, and metals which could foul the catalysts, catalytic oxidation is technically infeasible for control of CO and VOC in cement plants.

To date, two thermal oxidizers have been installed in the U.S. In 1998, TXI Corporations, LP (TXI) in Texas installed a Regenerative Thermal oxidizer (RTO), a wet scrubber, and a baghouse on a kiln for CO and VOC emission abatement in order to avoid a PSD review during a plant expansion.<sup>4</sup> The RTO was not considered as BACT by Texas Commission on Environmental Quality (TCEQ) and had a control efficiency of 75%. The CO emission limit for the RTO exhaust is 1.56 lbs./ton of clinker.

The only other RTO application in cement manufacturing process in the U.S. is at the Holcim Plant in Dundee, Michigan. The main purpose of the two RTOs are for the control of relatively high VOC emissions from two wet cement kilns using raw materials containing high levels of kerogen. The units replaced existing carbon injection systems for VOC control and did not go through PSD/BACT analysis.

Using RTO or other thermal oxidizers to reduce CO (and VOC) emissions from cement kiln incur high cost. The current cost of controlling CO with a similar RTO system is estimated approximately between \$5,800 (95% control) to \$9,900 (79% control) per ton of CO removed.<sup>4,5,6</sup>

### CO BACT Determination

HAC proposed in the application to have the ability to inject some portion of fly ash into the calciner region of the kiln to avoid exposure of organic material present in fly ash to low temperatures and the progressive heating as it travels through the upper regions of the preheater/precalciner tower. Typical fly ash contains complex hydrocarbon compounds not combusted in the original combustion process (power generation). By injecting directly into the calciner, these complex hydrocarbons are exposed to conditions which can greatly reduce the VOC and CO emissions by more completely combusting and destroying the hydrocarbons due to exposure to the high temperatures present in the calciner. Operational and quality factors may limit the amount of fly ash that can be introduced in this manner, but HAC intended to optimize the use of fly ash injection into the calciner region and install equipment to allow for this process in the new kiln system.

**Table 4.3-1: Ranking of Control Technology for CO Emissions from Preheater Cement Kiln**

Control Technology Ranking	Control Technology	Control Efficiency
1	Direct Flame Thermal Oxidation	75 – 95%
2	Good Combustion Practices, kiln Design, calciner fly ash injection, and Raw Material Selection/Management	Vary

The Division has determined based on the cost estimations that the RTO system discussed above is economically infeasible as BACT for controlling the CO emissions from HAC's cement kiln.

<sup>4</sup> Texas Commission on Environmental Quality. *Construction Permit Amendment – Review Analysis and Technical Review, Permit No. 1360A/PSE-TX-632MI. September, 2005.*

<sup>5</sup> Houston American Cement Plant, Georgia SIP Air Permit Application No. 17509, June 25, 2007.

<sup>6</sup> CEMEX Southeast, Georgia SIP Air Permit Application No. 17550, July 16, 2007

EPD has determined that HAC's proposal to use a combination of good combustion practices, proper kiln design, calciner fly ash injection, and judicious selection of raw materials to assure an acceptable input carbon level to minimize the emissions of CO constitutes BACT. Based on the BACT limits and the available emission testing results from similar sources, Division has decided that the BACT limit for the CO emissions is 2.9 pounds of CO per ton of clinker on 30-day rolling average, as tested and monitored by a CO CEM installed at the main kiln exhaust stack. At least four cement plants in Florida have the same BACT CO emission limit, including HAC's sister plant (Suwannee American located in Branford, Florida). Considering that HAC will use the locally quarried limestone and clay containing relatively higher carbonaceous materials than those available in Florida, EPD considers this BACT limit is more stringent than the Florida limits.

#### 4.4. VOC Emissions from Preheater/Precalciner and Kiln

Because the potential VOC emissions from HAC's cement kiln exceed the PSD significant level of 40 tons per year, the VOC emissions are evaluated for Best Available Control Technology (BACT).

As with CO, VOC emissions result mainly from two independent sources: (1) incomplete fuel combustion in the kiln and calciner; and (2) volatilization or oxidation of carbonaceous materials in the raw feed/meal introduced to the preheater/precalciner.

In modern preheater/precalciner cement plants such as HAC, dry feed is introduced to the exhaust gas stream from the preheater/precalciner and preheated through a series of cyclones (stages). In the heating process, organic materials naturally occurring in the feed (kerogen and bitumen) are progressively heated and begin to degrade. Significant fraction of such materials are oxidized to CO<sub>2</sub>, with the rest as short-chain VOC compounds and CO. The amount of VOC generated from such pyrolytic process depends on the nature of the organics present in the feed materials. Light hydrocarbon species typically produce more VOCs and less CO in the kiln preheater gas, and vice versa. Depending on the geological strata of the raw materials, the composition and content of the organic materials in the kiln dry feed (meal) may vary significantly.

Further more, the rate of conversion of feed/meal carbon to CO<sub>2</sub> is influenced by the temperature profile of the preheater/precalciner, the organic content of the kiln feed, and the composition of the organics in the kiln feed. The temperature of the preheater stages is defined by the kiln and mix designs (C<sub>3</sub>S, silica, etc.) and cannot be modified sufficiently to complete oxidation of CO and VOC in the preheater/precalciner.

Review of literature, BACT/LAER Clearinghouse and PSD permits issued to similar cement plants in the U.S. indicates that proper equipment design and operation (i.e., good combustion practice) represents most of BACT requirements for VOC emissions from Portland cement kilns. Properly controlled combustion in the kilns minimizes VOC formation by ensuring that temperatures and available oxygen are adequate for complete combustion. In addition to proper kiln system design, plant operation and raw material selection, add-on controls can achieve further reduction of VOC emissions. Such add-on controls involve some type of thermal oxidation from organic compounds to CO<sub>2</sub> and water in clean gas streams with minimal amounts of particulate matters. The oxidation technology includes direct flame incineration/oxidation and energy-saving catalytic oxidation. Because of the presence of chlorides, phosphorus compounds, sulfur, and metals which could foul the catalysts, catalytic oxidation is technically infeasible for control of VOC in cement plants.

To date, two thermal oxidizers have been installed in the U.S. In 1998, TXI Corporations, LP (TXI) in Texas installed a Regenerative Thermal oxidizer (RTO), a wet scrubber, and a baghouse on a kiln for CO and VOC emission abatement in order to avoid PSD review during a plant expansion. The RTO was not considered as BACT by Texas Commission on Environmental Quality (TCEQ).

The only other RTO application in cement manufacturing process in the U.S. is at the Holnam, Inc. in Dundee, Michigan. The main purpose of the two RTOs are for the control of relatively high VOC emissions from two wet cement kilns using raw materials containing high levels of kerogen. The units replaced existing carbon injection systems for VOC control and did not go through PSD or a BACT analysis. The VOC emission limit for the plant is 13 pounds per ton of clinker.

Using RTO or other thermal oxidizers to reduce VOC emissions from cement kiln incur high cost. The cost control of VOC emission is estimated more than \$40,000 per ton of VOC removed.<sup>4,5,6</sup>

### VOC BACT Determination

HAC proposed in the application to have the ability to inject a portion of fly ash into the calciner region of the kiln system to avoid exposure of organic material present in fly ash to low temperatures and the progressive heating as it travels through the upper regions of the preheater tower. Typical fly ash contains organic compounds not combusted in the original combustion process (power generation) which are complex hydrocarbons. By injecting directly into the calciner, these complex hydrocarbons are exposed to conditions which can greatly reduce the VOC and CO emissions by more completely combusting and destroying the hydrocarbons due to exposure to the high temperatures present in the calciner. Operational and quality factors may limit the amount of fly ash that can be introduced in this manner, but HAC intended to optimize the use of fly ash injection into the calciner region and install equipment to allow for this process in the new kiln system.

**Table 4.4-1: Ranking of Control Technology for VOC Emissions from Preheater/Precalciner Kiln**

Control Technology Ranking	Control Technology	Control Efficiency
1	Direct Flame Thermal Oxidation	79 – 95%
2	Good Combustion Practices, kiln Design, calciner fly ash injection & Raw Material Selection/Management	Vary

The Division has determined based on the cost estimations that the RTO system discussed above or other add-on thermal oxidation control system is economically infeasible as BACT for controlling the VOC emissions from HAC's cement kiln system.

The Division has determined that HAC's proposal to use a combination of good combustion practices, plant/equipment design, calciner fly ash injection, and judicious selection of raw material to minimize the emissions of VOC constitutes BACT. Considering the relatively high carbonaceous materials locally quarried by HAC, EPD proposes that the BACT limit for the VOC emissions is 0.5 pounds of total hydrocarbons (THC) per ton of clinker expressed as propane on dry basis corrected to 7% oxygen, on 30-day rolling average, as tested and monitored by a THC CEM installed on the main kiln exhaust stack. This BACT limit within the low range of BACT limits imposed on recently permitted cement plants in the country. It should be noted that because of using raw materials essentially free of organic matter, cement plants in Florida were permitted with BACT VOC/THC emission limits in the range of 0.12 to 0.15 lb/ton of clinker.

The conversion of VOC to THC is necessary because the THC CEM is based on EPA Method 25A using a flame ionization detector that is typically calibrated with propane, and "counts" the number of carbon atoms passing through the analyzer. According to U.S. EPA, if gas stream is complex (i.e., gas streams have multiple compounds, unknown compounds and/or variable proportions), then results from Method 25A should be reported on as THC on "as propane" basis.

Please note that in the case of HAC, the proposed THC BACT limit of 0.5 lb/ton of clinker will be approximately 30 parts per million dry volume (ppmdv) based on the characteristics of the exhaust gas stream from HAC's main kiln stack. This limit is below the 50 ppmdv THC limit in 40 CFR Part 63, Subpart LLL for existing Portland cement plants. As a new plant, the proposed HAC cement plant will be subject to the more stringent THC limit of 20 ppmdv under 40 CFR Part 63, Subpart LLL<sup>7</sup>, i.e., approximately 0.33 lb/ton of clinker in the case of HAC. After an in-depth review of 40 CFR Part 63, Subpart LLL and associated background documents, EPD has concluded that to comply with this limit via any technically feasible add-on control techniques, the lowest cost estimation would be over \$40,000 for each ton of THC removed via a RTO system. This cost is too high to for the RTO to be considered as economically feasible for BACT.

On the same day promulgating the current 20 ppm THC limit, EPA announced that it would reconsider this limit because of the petition from the cement manufacturing industry, and make a decision later in 2008. According to EPA, the current THC limit remains in effect till it announces the decision on the reconsideration. Meanwhile, affected new sources such as HAC shall, in addition to complying with other applicable VOC limits in this permit, comply with the current 20 ppmdv Subpart LLL THC emission limit on and after startup of the production, with or without the help of any add-on control, depending on the THC emission level.<sup>8</sup>

#### 4.5 NO<sub>x</sub> Emissions from Preheater/Precalciner and Kiln

NO<sub>x</sub> is formed as a result of reactions occurring during fuel combustion in the preheater/precalciner, calciner, and cement kiln. NO<sub>x</sub> is produced mainly through two mechanisms during combustion: (1) fuel NO<sub>x</sub>, and (2) thermal NO<sub>x</sub>.

Fuel NO<sub>x</sub> is formed due to the oxidation of nitrogen or its compounds contained in fuel. In general, approximately 60% of fuel nitrogen is converted to NO<sub>x</sub> during combustion. The resulting NO<sub>x</sub> emissions are primarily affected by the fuel nitrogen content and excess air/oxygen in the flame. Nitrogen in the kiln feed may also contribute to NO<sub>x</sub> emissions but to a much smaller extent.

In general, substituting a fuel with one with higher heating value will reduce NO<sub>x</sub> emissions in part because fuel/heating efficiency is increased and less total fuel is consumed. Increasing fuel efficiency has the same result. A modern dry-process cement plant with preheater/precalciner and calciner such as HAC is the most fuel efficient Portland cement manufacturing process.

Thermal NO<sub>x</sub> is the most significant NO<sub>x</sub> source in kiln combustion. The rate of thermal conversion from N<sub>2</sub> in the combustion air to NO<sub>x</sub> is controlled by both excess O<sub>2</sub> in the flame and the temperature of the flame. In general, NO<sub>x</sub> levels increase with the higher flame temperatures that are typical in the kiln burning zone.

In a preheater/precalciner kiln, fuel combustion occurs at two locations and each follows a separate mechanism in the formation of NO<sub>x</sub>, i.e., thermal NO<sub>x</sub> dominates in the kiln burning zone and fuel NO<sub>x</sub> dominates in the precalciner. For this reason, the effects of process operation on final NO<sub>x</sub> levels are complex and do not necessarily conform to conventional understanding of combustion as defined through steam generating boilers. Study of various cement kilns also has shown that actual NO<sub>x</sub> emissions are highly site specific.

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<sup>7</sup> §63.1343(c) of 40 CFR Part 63, Subpart LLL

<sup>8</sup> National Emission Standards for Hazardous Air Pollutants From the Portland Cement Manufacturing Industry: Notice of Reconsideration, Federal Register/Vol. 71, No. 244/Wednesday, December 20, 2006

Cement kilns are distinct from conventional combustion sources such as steam boilers in that the combustion chamber is a confined space that is refractory lined. This radiates energy back into the flame, thereby increasing the flame temperature. At given excess air levels, a confined flame will usually produce higher NO<sub>x</sub> emissions than an open flame such as a boiler fire box. In the rotary kiln section, fuel combustion increases material temperature to a level to allow calcined meal/feed to become viscous (liquid) and form calcium silicates/clinkers. This temperature required depends on cement type and meal properties and is in excess of 2,550°F.

NO<sub>x</sub> levels from kiln firing are also strongly related to fuel type, location of fuel introduction, flame shape, and peak flame temperature. At higher peak flame temperatures, more thermal NO<sub>x</sub> is formed. Flame shape is also related to the percentage of primary air used in combustion in the kiln. High levels of primary air increase NO<sub>x</sub> formation by providing excess O<sub>2</sub> in the hottest portion of the flame. A long flame and low primary air volume can minimize NO<sub>x</sub> formation in the main kiln. However, in order to obtain high quality clinker with the best microstructure, a relatively short, strong, and steady flame is necessary. In addition, too long of a flame may also cause kiln rings and lead to incomplete fuel combustion.

A secondary firing zone is the precalciner vessel where fuel such as pulverized coal or petroleum coke is burned in situ with the preheated raw meal. The calciner can also be designed to introduce fly ash and non-hazardous solid waste through the calciner burner. Under these conditions, heat released by fuel oxidation is extracted by meal decarbonization. The efficient use and transfer of energy reduces the peak temperature in the vessel. Normal temperatures are between 1,650° and 1,800°F. This lower temperature and operation at reduced excess air levels reduces the formation of NO<sub>x</sub>. Thermal NO<sub>x</sub> is minimized and fuel NO<sub>x</sub> predominates.

As a non-virgin non-hazardous solid fuel, tires may also be used in either a whole or shredded form that can be injected via an air lock/gate system into the material inlet of the kiln. The tires provide additional heat to the calcination process as well as a localized reduction zone around the tire fuel which assists in NO<sub>x</sub> reduction. A tire gasification system is also available to produce a combustible gas that would be injected into the kiln inlet or calciner. The portion of the tires that do not gasify will form a coke/residue material. This material will be fed into the kiln inlet in the same manner as shredded or whole tires and provides additional heat input while incorporating the ash into the clinker. Air is supplied to the tire gasification system via the tertiary air from the clinker cooler and/or ambient air.

NO<sub>x</sub> emissions can be affected by both fuel firing scenarios and heat input ratios. Fuels higher in volatiles such as fuel oils, coal, and some non-hazardous liquids and solids can increase the free radical pool, allowing for more reduction in NO<sub>x</sub> generated by the main burner of the kiln. Additionally, tires injected via the mechanism described above can create localized reducing zones around the fuel as it combusts. These reducing zones can also enhance the reduction of NO<sub>x</sub> by the creation of additional reduction zones in comparison to highly reactive fuels. The heat input ratio can also play an important role in NO<sub>x</sub> emissions. The more fuel fired in the high heat burning zone through the main kiln burner, the higher the overall NO<sub>x</sub> per unit of heat input. The more fuel that can be utilized in the precalciner or calciner at lower temperatures while still maintaining the needed temperature profile in the burning zone, the less the overall NO<sub>x</sub> per unit of heat input. In modern kilns this ratio is typically 60% in the precalciner and/or calciner and 40% in the kiln main burner. Slight variations as described above may occur as more fuel is needed in the main burner to maintain the needed burning zone temperature.

The heat input percentages can occasionally fluctuate slightly as more or less heat is need in the precalciner or calciner region or burning zone for the kiln main burner, as dictated by raw materials or quality control characteristics. Regardless of the fuel firing scenario or fuels used, overall heat input to the kiln remains fairly constant in comparison to kiln feed rate. Theoretically, constant heat inputs are needed for the overall process of clinker formation with uniformly predictable variations for raw material deviations, heat exchange rates, and other conditions experienced under normal kiln operating conditions.

NO<sub>x</sub> formed in the main kiln combustion passes through the precalciner and the gases are cooled slowly in the preheater/precalciner cyclones. NO<sub>x</sub> formation is an endothermic process and as gases cool, NO<sub>x</sub> tends to revert to N<sub>2</sub> and O<sub>2</sub>. This decomposition process is rapid at elevated temperatures but decreases at temperatures below approximately 1,300°F. In effect, if the flue gases can be slowly cooled to 1,300°F over an extended period, a progressive decrease in NO<sub>x</sub> concentration occurs. This process occurs in the preheater/precalciner after other combustion radicals (OH-, H+, O-, etc.) have been eliminated.

In addition, the burner design, as it affects flame shape, and the fuel to air ratio, can mitigate the formation of thermal NO<sub>x</sub>. In most modern dry process cement plants, low-NO<sub>x</sub> burners are used.

In general, the starting point to control NO<sub>x</sub> is to avoid its formation in the high temperature combustion zone near the main kiln burner via mainly “indirect firing” achieved by proper design of the kiln system. The basic principle of “indirect firing” is to minimize primary air (that carries the coal to and through the main kiln burner) and to utilize more secondary air (from the kiln clinker cooler) as combustion air. This practice minimizes fuel consumption (by increasing system heat efficiency) and high temperature combustion (by creating low temperature combustion zones) and in turn reduce the NO<sub>x</sub> formation.

Available technologies for reducing NO<sub>x</sub> emissions from dry rotary preheater/precalciner cement kiln system like HAC's are discussed below:

**Indirect firing systems** (a low NO<sub>x</sub> technology) can be used on the precalciner and rotary kiln burner systems. This technology fires pulverized solid fuels such as coal and petroleum coke using a dense phase conveying system that limits the volume of air necessary to transport fuel to the burner. This design reduces primary air injected with fuel.

The indirect-firing process allows the flame to be fuel rich, which reduces the oxygen available for NO<sub>x</sub> formation. In some cases it can also result in higher flame temperatures because the heat release occurs with less combustion gases (i.e., excess air).

Indirect firing with a low NO<sub>x</sub> burner attempts to create two combustion zones, primary and secondary, at the end of the main burner pipe. In the high-temperature primary zone, combustion is initiated in a fuel-rich environment in the presence of a less than stoichiometrical oxygen level. The submolar level of oxygen at the primary combustion site minimizes NO<sub>x</sub> formation. The presence of CO in this portion of the flame also chemically reduces some of the NO<sub>x</sub> that is formed.

In the secondary zone, combustion is completed in an oxygen-rich environment. The temperature in the secondary zone is much lower than in the first; therefore, lower NO<sub>x</sub> formation is achieved as combustion is completed.

Low NO<sub>x</sub> burners in general are not as effective when used on the rotary kiln section of a preheater/precalciner kiln system because gases containing the thermal NO<sub>x</sub> formed in the main kiln section are gradually cooled as they move through the system, resulting in NO<sub>x</sub> reduction (as previously discussed). As the gases pass through the precalciner burning zone and preheater cyclones, NO<sub>x</sub> are further reduced. NO<sub>x</sub> contained in the alkali bypass gases, however, would not be subject to this reduction.

**Semi-direct firing technology** separates pulverized fuel from the coal mill sweep air using a cyclone separator. The fuel is then metered from a collect bin to the kiln burner pipe. The exhaust gases of the cyclone are used to transport the fuel from the bin discharge. Advantages in the design are that a portion of the sweep air can be returned to the coal mill or exhausted to the atmosphere and that minor variations in fuel delivery rate are eliminated. The major advantage for NO<sub>x</sub> abatement is that the volume of primary air can be marginally reduced (i.e., 20 to 25% of combustion air). The system is similar to mill recirculation but can include partial sweep air discharge.

Semi-direct firing reduces  $\text{NO}_x$  in a way similar to indirect firing; however, primary air volume will be higher than indirect firing, and would not reduce  $\text{NO}_x$  emissions below that achieved by indirect firing.

**Mill air recirculation** reduces primary air usage by returning a portion of the coal mill sweep air (30 to 50%) to the coal mill inlet. By returning sweep air, the volume of air used to convey pulverized fuel to the burner pipe is reduced. The amount of the return air possible depends on the mill grinding rate (i.e., percent of utilization), volatile content of fuel, moisture in the fuel, grindability of the fuel, and the final conveying air temperature achieved. The reduction in primary air allows the use of low  $\text{NO}_x$  burner technology that further reduces  $\text{NO}_x$  formation.

The use of mill air recirculation can achieve primary combustion air between 15 and 25% but is highly variable. Kilns operating with a hard burning mix do not typically achieve high  $\text{NO}_x$  reductions. Also, recirculation is not possible for fuels containing high free moisture (i.e., fuels stored outdoors exposed to weather).

This technology applies to coal/coke direct-fired kilns not currently using a fuel-rich primary combustion technology, i.e., indirect or semi-direct firing system.

**Mid-kiln firing (MKF)** is a potential  $\text{NO}_x$  reduction technology involving injection of solid fuel into the calcining zone of a rotating long kiln using a specially designed feed injection mechanism. The technology is applicable to conventional wet process and long dry kilns. The fuel used is generally whole tires, although containerized waste fuels have also been used at some plants. Fuel is injected near the mid-point of the kiln, once per kiln revolution, using a system consisting of a “feed fork,” pivoting doors, and a drop tube extending through the kiln wall.

Another form MKF has been used for certain preheater/precalciner kiln systems. Whole tires are introduced into the riser duct using a specially designed drop chute with air lock or thermal suspension. This creates an additional secondary firing zone in which the solid fuel is burned in contact with the partially calcined meal. Combustion is initiated in the riser duct (located midway between the calciner and rotary kiln sections of the kiln system) and is completed within the rotary kiln section in a reducing atmosphere away from the high temperatures of the main kiln burner.  $\text{NO}_x$  formation is inherently lower in this area, and  $\text{NO}_x$  formation may be further reduced due to improvements in fuel efficiency and the shifting of fuel burning requirements (e.g., less fuel must be burned at the main kiln burner).

In general, MKF is a staged combustion technology allowing part of the fuel to be burned at a calcination temperature of 600° to 900°C, which is much lower than the clinker burning temperature of 1,200 to 1,480°C, thus reducing thermal  $\text{NO}_x$  formation. By adding fuel in the main flame at mid-kiln, MKF changes both the flame temperature and flame length, and thus may reduce thermal  $\text{NO}_x$  formation by burning part of the fuel at a lower temperature and by creating reducing conditions at the solid waste injection point that may destroy some of the  $\text{NO}_x$  formed upstream in the kiln burning zone. MKF may also produce additional fuel  $\text{NO}_x$  depending upon the nitrogen content of the fuel. The additional fuel  $\text{NO}_x$ , however, is typically insignificant relative to thermal  $\text{NO}_x$  formation. The discontinuous fuel feed from MKF can also result in increased CO. To control CO emissions, the kiln may require an increase in combustion air, which can decrease production capacity.

Test data showing  $\text{NO}_x$  reduction levels for long dry and wet kilns were compiled for the EPA in the report “*NO<sub>x</sub> Control Technology for the Cement Industry*” (EC/R Inc., 2000). Tests conducted on three wet process kilns using MKF technology showed an average reduction in  $\text{NO}_x$  emissions of 40%, with a range from 28 to 59%.

**Multi-staged combustion (MSC)/staged and controlled combustion (SCC) in calciner** is a combustion technology currently used with preheater/precalciner kilns to reduce NO<sub>x</sub> generation by all major kiln vendors. MSC/SCC, which includes the use of two or more staged air, feed, or fuel burning locations to create low NO<sub>x</sub> burning zones, is supplied by one or more vendors as NO<sub>x</sub> control technology on modern preheater/precalciner cement kilns. MSC/SCC is also considered a common technology as it has been used for many years throughout the cement industry.

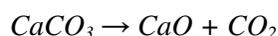
MSC/SCC takes place in and around the calciner and is accomplished in several ways depending on the system design. The purpose of staged combustion is to burn fuel in two stages, i.e., primary and secondary. Staged air combustion suppresses the formation of NO<sub>x</sub> by operating under fuel-rich, reducing conditions (less than stoichiometrical oxygen) in the flame or primary zone where most of the NO<sub>x</sub> is potentially formed. This zone is followed by oxygen-rich conditions in a downstream, secondary zone where CO is oxidized at a lower temperature with minimal NO<sub>x</sub> formation. By burning a portion of the fuel in the calciner burner instead of the main kiln burner, MSC/SCC spreads the thermal load in the pyroprocessing system and thus allows much of the combustion to occur at temperatures of the calciner that are much less than that near the main kiln burner. This reduces the potential for thermal NO<sub>x</sub> formation. Significant fuel NO<sub>x</sub> formation in the calciner is still possible.

MSC/SCC also introduces exhaust gas from the kiln to calciner. Such gas contains relatively low excess air/oxygen and high temperature that is less than required to sinter cement but greater than required to calcine raw materials, and reduces the formation of thermal NO<sub>x</sub>.

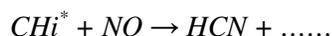
In summary, MSC/SCC allows fuel, air and raw material introduction to the calciner to be “staged” in such a way that it can destroy thermal NO<sub>x</sub> from the kiln and discourage the formation of thermal NO<sub>x</sub> in the calciner.

The following discussion explains the mechanism for reduction of NO<sub>x</sub> by MSC/SCC:

Calcinations of limestone occurs at approximately 900°C and liberates CO<sub>2</sub> to produce lime in the following endothermic reaction:

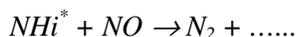


Fuel, such as coal, is heated and burned releasing hydrocarbon radicals. These, in turn, catalytically react with NO to form hydrogen cyanide:



Where: i = 1,2,3

Ammonia-like radicals are also released during fuel burning. Under reducing conditions and the presence of raw meal/kiln dry feed they catalytically destroy NO:



This mechanism suppresses formation of NO by the pyrolyzed fuel nitrogen and employs that nitrogen to further reduce NO<sub>x</sub> in reactions that at first look much like two add-on NO<sub>x</sub> control technologies, i.e., “selective non-catalytic reduction (SNCR)” or ‘selective catalytic reduction (SCR)’ does, as discussion in the following sections.

Other reactions involving CO or hydrogen are also catalytically driven and destroy NO<sub>x</sub> in this reducing atmosphere rich in CO and lean in oxygen. In the subsequent burning of soot and char, the NO<sub>x</sub> reducing reactions proceed much more slowly and some of the remaining fuel nitrogen can still form significant amounts of additional NO<sub>x</sub>.

Research and actual emission monitoring on preheater/precalciner cement kilns have shown that MSC/SCC technology applied to the area of the calciner works to effectively lower NO<sub>x</sub> emissions. Although potential disadvantages to MSC/SCC may exist, experience has shown that when included as part of the kiln system design, it will reduce NO<sub>x</sub> emissions with minimal process problems. The MSC/SCC control option is capable of reducing NO<sub>x</sub> emissions by 10 to 50%, depending on the site-specific kiln operating parameters (i.e., fuel nitrogen content, kiln feed burnability, excess air, etc.).

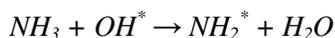
MSC/SCC can have limitations under specific conditions which affect the potential NO<sub>x</sub> control effectiveness. In kiln systems that use a mix with high sulfur to alkali molar ratio, the volatility of sulfur is increased due to the strong reducing conditions in MSC/SCC and the relatively low excess oxygen available in the system. Operationally, this could cause severe preheater plugging due to significant sulfur deposition associated with MSC/SCC operation. As a result, the required conditions needed for optimum MSC/SCC operation (low excess oxygen), conflict with the goal of preventing sulfur deposition and minimizing operational problems. These problems have been documented in Europe and at U.S. cement production facilities. A high sulfur/alkali molar feed ratio prevents the achievement of maximum NO<sub>x</sub> reduction using MSC/SCC.

Available add-on control technologies for NO<sub>x</sub> include selective-non catalytic reduction (SNCR) and selective catalytic reduction (SCR).

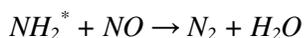
**SNCR** involves injecting an ammonia (NH<sub>3</sub>)-containing solution into the process to reduce NO<sub>x</sub>. The solution may be supplied in the form of anhydrous ammonia, aqueous ammonia, or urea. The injection point shall have the optimum temperature range of 800° to 1,090°C, such as preheater tower. Residence time, turbulence, oxygen content, and a number of other factors specific to the given gas stream are also important for the success of SNCR. Because the optimum temperature range must be present for a sufficient time period to allow the reaction to occur, SNCR is only a viable technology on some preheater or precalciner kiln designs.

SNCR destroys NO<sub>x</sub> by a two-step process as follows:

Step 1: Ammonia reacts with available hydroxyl radicals (OH<sup>\*</sup>) to form amine radicals (NH<sub>2</sub><sup>\*</sup>) and water:

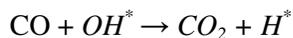


Step 2: Amine radicals combine with nitrogen oxides to form nitrogen and water:



The equations suggest that, theoretically, SNCR will function best in an oxidizing atmosphere.

However, in a reducing atmosphere, CO competes with ammonia for available hydroxyl radicals:



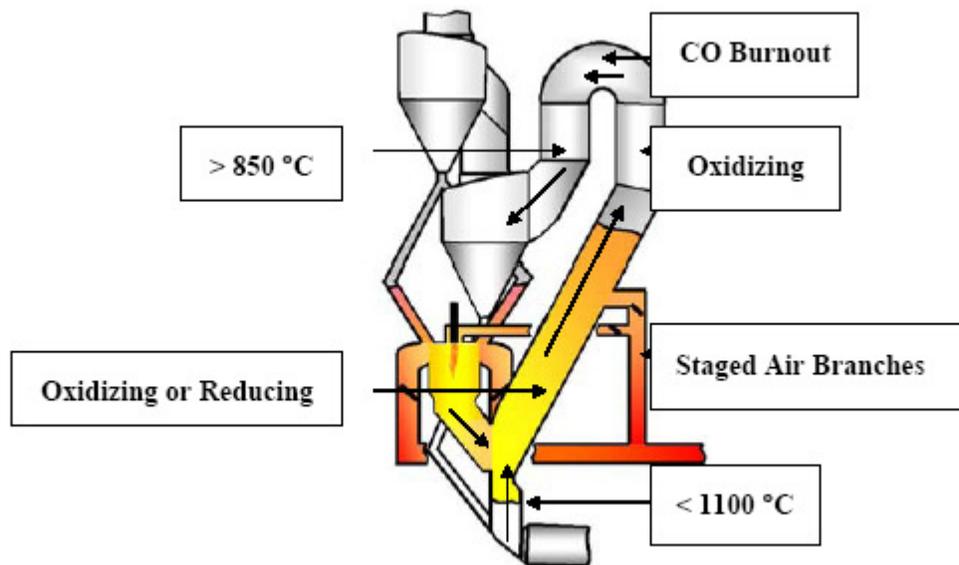
This phenomena will require the optimization of the operation of the kiln system and SNCR to minimize the emissions of both pollutants.

At temperatures lower than 800°C, reaction rates are slow, and there is potential for significant amounts of ammonia to exit or “slip” through the system. This ammonia slip may result in a detached visible plume at the relevant stack, as the ammonia will combine with sulfates and chlorides in the exhaust gases to form inorganic condensable salts, which can become a significant source of condensable PM emissions that cannot be controlled with a baghouse or ESP. Ammonium sulfate aerosols would be a concern under upcoming programs to deal with regional haze. In addition, there may be health and safety issues with on-site ammonia generation.

At temperatures within the optimal temperature range, the above reactions proceed at normal rates. However, as noted in the literature as well as by vendors, a minimum of 5 ppm ammonia slip may still occur as a side effect of the SNCR process.

At temperatures above 1,090°C, the necessary reactions do not occur. In this case, the ammonia or urea reagent will oxidize and result in even greater NO<sub>x</sub> emissions. In addition, SNCR secondary reactions can form a precipitate, resulting in preheater fouling and kiln upset. Ammonia reagent may react with sulfur in kiln gases to form ammonium sulfate. Ammonium sulfate in the preheater can create a solids buildup. Ammonium sulfate in the kiln dust recycle stream may adversely affect the kiln operation.

The optimal temperature window for SNCR occurs somewhere in the preheater system, as illustrated in Figure 4.5-1. Fluctuations in the temperature various points in the preheater are common during normal cement kiln operation. Therefore, selecting one zone for SNCR application in the preheater cannot reliably assure consistent results. Alternatively, selecting multiple zones of injection significantly increases complexity to an already complex chemical process.



**Figure 4.5-1: Temperature and oxidizing atmosphere windows for SNCR in an Air Stage Calciner**

Because raw materials can contain naturally occurring carbon (i.e., bitumen and kerogens), pyrolysis of such organics in the preheater tower produces CO, and results in a reducing atmosphere. The current control practice is to limit oxygen at the calciner exit to reduce NO<sub>x</sub>. SNCR requires an oxidizing atmosphere and the two conditions are opposed in theory, as discussed above. CO emissions are expected to increase as NO<sub>x</sub> is reduced. Data from preliminary testing in Europe and at Suwannee American Cement (SAC) in Branford, Florida, a sister plant of HAC under the same ownership on MSC/SNCR systems indicated a possible increase in CO emissions of 5 to 20%. SAC's testing tried to determine the effectiveness of SNCR and the required reagent injection rate. The short-term data indicated no significant conflict with the reducing atmosphere. Some ammonia slip was noted during the testing but only for small periods while the raw mill was down, even during periods with no ammonia injection. Further long-term operations are needed to completely understand the ammonia cycle and ammonia slip. The testing has initially indicated that SNCR can be successfully applied without the formation of a visible plume. It should be noted that CO emissions showed a moderate increase during the testing.

In addition, ammonia emitted as gas in the plume will react with SO<sub>2</sub> or HCl in the condensed water vapor plume forming a highly visible plume under certain weather conditions. A similar plume has been noted as result of naturally occurring ammonia in the kiln feed at a number of cement plants.

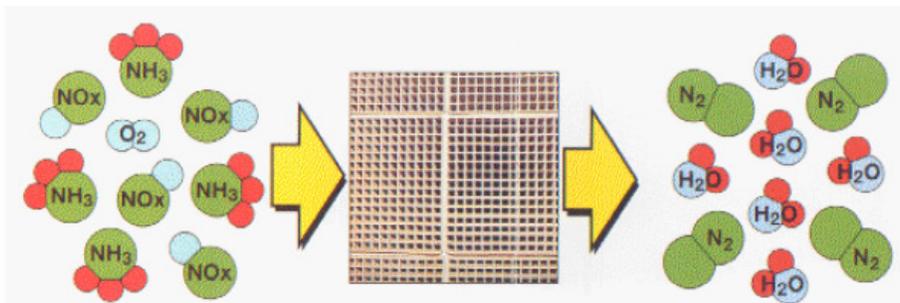
SNCR in combination with MSC/SCC has been demonstrated as a means of reducing  $\text{NO}_x$ . Although SNCR and MSC/SCC can in theory conflict, testing and operations at SAC have shown that the use of MSC/SCC can help to reduce the initial  $\text{NO}_x$  that is subsequently reduced by SNCR. Any reduction in initial concentration of  $\text{NO}_x$  prior to introduction to the SNCR will result in a minimization of reagent used by the SNCR to reduce the  $\text{NO}_x$ . This results in cost savings and makes the SNCR a more effective means of reducing  $\text{NO}_x$  emissions. Low  $\text{NO}_x$  burners and kiln firing rates can also be used in conjunction with SNCR to help reduce the  $\text{NO}_x$  subsequently reduced by SNCR. In the testing conducted at SAC, SNCR in conjunction with low  $\text{NO}_x$  burners and MSC/SCC, resulted in  $\text{NO}_x$  emissions below 1.95 lb per ton of clinker, as mentioned in HACs' permit application. Another advantage of using the SNCR in conjunction with SCC is that SNCR allows running in an oxidizing condition that helps to avoid buildup in the riser duct. This allows having a much more stable operation in the kiln and fewer process upsets.

In summary, the requirements for SNCR include adequate amounts of ammonia, an optimum temperature range (i.e.,  $800^\circ$  to  $1,090^\circ\text{C}$ ) and the presence of an oxidizing atmosphere. At the low flue gas temperature the reaction rate is slow and ineffective. Ammonia introduced will not react and will be lost as gas, known as "ammonia slip" which, under certain atmospheric circumstances, could form visible plume at the stack. When the gas stream contains relatively high concentration of  $\text{SO}_2$  due to the use of high sulfur raw materials, some of the ammonia will react with  $\text{SO}_2$  in the conditioning tower forming ammonium sulfate  $(\text{NH}_4)_2\text{SO}_4$  which is a submicron aerosol uncontrollable by neither baghouses nor ESPs. This aerosol may form a visible plume at the stack, and the visible emissions could be significant when the sulfur contents in the raw materials are relatively high.

It is worth noting that ammonia in the gas stream compete with CO for available hydroxyl radicals, resulting in increases in CO emissions. It has been reported that increasing the molar ratio of  $\text{NH}_3$  to  $\text{NO}_x$  increased CO emissions up to 1.5 lbs./ton of clinker, and the CO increases were proportional to the ratio. Therefore, in addition to the "ammonia slip" and ammonium sulfate submicron aerosol emissions, SNCR's effect on CO emissions should also be taken into consideration during the establishment of the extent of using SNCR to reduce  $\text{NO}_x$ , i.e., the level of  $\text{NH}_3/\text{NO}_x$  ratio. These considerations should balance CO,  $\text{NO}_x$ ,  $\text{NH}_3$  and  $\text{SO}_2$  emissions on a case-by-case basis, and establish relevant emission standards accordingly.

**SCR** uses ammonia in the presence of a catalyst to reduce  $\text{NO}_x$ . The catalyst is typically vanadium pentoxide, zeolite, or titanium dioxide. The SCR process has been proven to reduce  $\text{NO}_x$  emissions from combustion sources such as incinerators and boilers used in electric power generation plants but not in cement kilns.

As illustrated in Figure 4.5-2, in a SCR, the process/exhaust gas is injected with anhydrous ammonia and passed through a catalyst bed to initiate the catalytic reaction, reducing  $\text{NO}_x$  in the gas to nitrogen and water. The catalyst is not consumed in the process. The critical temperature range required for this reaction is  $300^\circ\text{C}$  to  $450^\circ\text{C}$ , which is higher than the typical cement kiln ESP or baghouse exit gas temperature. SCR can be beneficial as well where VOC reductions are also necessary or as a dioxin/furan control strategy.



**Figure 4.5-2:  $\text{NO}_x$  &  $\text{NH}_3$  in kiln flue gas react over SCR's catalyst bed and convert to  $\text{N}_2$  & water.**

SCR requires the catalyst to be placed prior to the gas conditioning tower (dirty side) or after the PM control device (clean side) to prevent bed blockage/fouling. Placing SCR at the preheater exit satisfies the temperature requirements, but subjects the catalyst to the re-circulating dust load and potential fouling. Location at the baghouse exit requires reheating of the gases to the required temperature for catalyst activation.

Installation of the catalyst before the PM control device (i.e., dirty side) increases the potential for fouling from meal/re-circulating dust load, but requires a less significant reheating of the gas stream. The most prohibitive disadvantage of the SCR in this location is fouling of the SCR catalyst. The high dust loading in cement kiln gases may plug the catalyst and render it ineffective. Minor impurities in the gas stream, such as compounds or salts of sulfur, arsenic, calcium, and alkalis, may poison the catalyst very rapidly, strongly affecting the efficiency and system availability and increasing the waste catalyst disposed.

Continual fouling of the SCR catalyst would render it inoperative as a  $\text{NO}_x$  control option. Ammonia injected to a fouled SCR would pass unreacted through the system (i.e., ammonia slip). The unreacted ammonia would combine with sulfates and chlorides in the exit gases, forming inorganic condensable salts, which result in a detached visible plume and a significant increase in condensable  $\text{PM}_{10}$  emissions. In addition, SCR on power plants have been shown to convert  $\text{SO}_2$  to  $\text{SO}_3$  as a secondary reaction.  $\text{SO}_3$  will react with  $\text{CaO}$  between preheater stages forming gypsum ( $\text{CaSO}_4$ ), which can plug the tower and cause kiln shutdown.

Installation of the SCR after the PM control device (i.e., clean side) reduces the potential for fouling from meal/re-circulating dust load, but requires significant reheating of the gas stream. This can be significant if combined with wet scrubbing prior to the SCR.  $\text{SO}_2$  removal is required to prevent conversion of  $\text{SO}_2$  to  $\text{SO}_3$  in the catalyst bed which would increase  $\text{SO}_3$  emission if the SCR is the last system in the gas train.

Placement of the SCR between the baghouse or ESP and wet scrubber would not reduce the  $\text{SO}_3$  emissions if the  $\text{SO}_3$  hydrates and condenses in the scrubber quench.  $\text{H}_2\text{SO}_4$  aerosols are submicron and therefore not collected in wet scrubbers designed for  $\text{SO}_2$  removal.

SCR systems are currently being installed on electric utility boilers in North America for  $\text{NO}_x$  control. These systems use up to three catalyst beds with ammonia gas injection before each bed. Temperature is controlled by placing the reactor beds between the boiler outlet and air heater. For most applications the boilers are base load units with little or no load variation. This allows a stable temperature profile for optimum function and injection of ammonia. Ammonia is typically generated by the thermal decomposition of urea in a water solution under pressure.

The application of SCR on cement kilns is fundamentally different from utility boilers due to their differences in gas composition, dust loading, and chemistry. EPA's "*Alternative Control Techniques (ACT) Document for  $\text{NO}_x$  Emissions from Cement Manufacturing*" (pages 6-32, 6-36, and 6-37), acknowledges that there are no installations of SCR technology in cement plants in the United States, though concluding that SCR technology is technically feasible based on technology transfer from utility boiler and gas turbine applications. The ACT document indicates a control efficiency of 80% for SCR.

Currently no full-scale application of SCR on a Portland cement plant exists in North America. Until recently the only known full scale SCR at a cement plant was at the Solnhofer Portland Zementwerke in Bavaria, Germany. The first known self-funded commercial SCR at a cement plant is located at the Radici Cementeria di Monselice (CM) in Italy. The German SCR mentioned above is experimental and has had some operational problems concerning catalyst deactivation and fouling. Currently the German SCR is still testing for long-term catalyst optimization. The application of SCR to "dirty side" kiln gases is still in an experimental stage.

The most serious issues yet to be resolved for SCR are catalyst life, poisoning of the catalyst, fouling of the bed, system resistance, ability to correctly inject ammonia at proper molar ratio under non-steady state conditions, and creation of detached plume. Additionally, inexperience with SCR limits the availability of such a technology without long-term testing to determine the applicability and long-term reductions of NO<sub>x</sub> associated with the production of Portland cement.

There is much debate in the industry regarding the relative merits of SNCR versus SCR. Similar very low NO<sub>x</sub> emissions are possible with either technology. The most interesting details regarding the installation at CM relate to the NH<sub>3</sub> consumption and slip. Use of SCR directly minimizes detached plume formation potential and fine particulate precursor emissions. Similar or better results can be achieved with more proven technologies such as SNCR or staged combustion. The use on “clean side” application may be technically feasible but has a high energy cost to reheat the gases.

In summary, the control efficiency of both SNCR and SCR are comparable, and ranked at the top among all the NO<sub>x</sub> control technologies discussed above. The control efficiencies of the rest technologies vary based on such factors as equipment design, raw materials, fuels, combustion and operating parameters, and are difficult to be placed.

### **NO<sub>x</sub> BACT Determination**

Based on the preceding discussion, the technically feasible options for controlling of NO<sub>x</sub> emissions from HAC’s dry process preheater cement kiln system are considered to be:

- SNCR
- SCR
- Indirect Firing and Low NO<sub>x</sub> Burners
- Mid-Kiln (Riser Duct) Firing
- MSC/SCC

HAC proposed in the application to use combination of SNCR, Indirect Firing, Low NO<sub>x</sub> Burners, as well as MSC/SCC as BACT for controlling the NO<sub>x</sub> emissions. Mid-Kiln (Riser Duct) Firing may be used as a fuel burning option. To be more specifically, a form of MSC/SCC (i.e., reducing zone) may be used on the HAC kiln in combination with indirect firing, low NO<sub>x</sub> burners, and SNCR. The use of multi-staged combustion, low NO<sub>x</sub> burners, and indirect firing will assist in reducing NO<sub>x</sub> prior to the SNCR system and help to minimize the amount of reagent needed to reduce the NO<sub>x</sub>. HAC will keep Mid-Kiln (Riser Duct) Firing as an additional option.

Considering scarce application, potential operational problems, and high cost associated with the use of SCR to control NO<sub>x</sub> emissions from Portland cement plants, EPD has eliminated SCR from BACT consideration, and determined that HAC’s proposed combination of SNCR, Indirect Firing, Low NO<sub>x</sub> Burners and MSC/SCC technologies to minimize NO<sub>x</sub> constitutes BACT. This combination of the NO<sub>x</sub> control technologies was determined in 2003 by the State of Florida as BACT for a HAC’s sister plant which is almost identical to HAC in both design and size. The NO<sub>x</sub> emission limit for the BACT is 1.95 lb/ton of clinker based 30-day rolling average, as measured by NO<sub>x</sub> CEM. This limit is identical to that contained in PSD permits issued recently to four cement plants by the State of Florida. The emission rate average time is appropriate to account for the variability in NO<sub>x</sub> emissions from cement kilns and is consistent with EPA’s NO<sub>x</sub> State Implementation Plan (SIP) call guidance for cement kilns. Conditions in this permit will establish the relevant operational, work practice, monitoring, testing, record keeping, compliance demonstration and reporting requirements for the BACT, which include but not limited to, raw material and fuel usage plans and records, firing rate requirements and records, SNCR operating records, and use of NO<sub>x</sub> CEM for performance testing and monitoring.

HAC proposed that mid-kiln firing may be used as a fuel burning option depending on the availability of steady supply of spent tires. EPD has not considered it as part of the BACT because the technology is not expected to reduce NO<sub>x</sub> emissions significantly when combined with the required BACT control technologies, and the technology is limited by the availability of a steady supply of spent tires.

#### 4.6 SO<sub>2</sub> Emissions from Preheater/Precalciner and Kiln

SO<sub>2</sub> can be generated from organic or pyritic sulfur compounds in the raw material fed to the preheater/precalciner of the cement kiln and from sulfur contained in the fuels firing the kiln system. It is generally agreed that very little of the fuel sulfur is released from the stack as SO<sub>2</sub>. The SO<sub>2</sub> emissions from fuel sulfur are generally adsorbed by powdery alkalis species (potassium and sodium) in raw materials in the calciner or lower sections of the preheater/precalciner and are cycled back to the kiln with the majority of the sulfur exiting the kiln in the clinker. Thus, the majority of SO<sub>2</sub> emissions from a modern preheater/precalciner cement kiln are from the sulfur compounds in the raw materials.

Information published by the Portland Cement Association indicates that 15-40% of the pyritic sulfur in the raw feed may be converted to SO<sub>2</sub>. Some fraction of the SO<sub>2</sub> is subsequently adsorbed by alkalis species (potassium and sodium) in kiln feed/raw meal in the upper stages of the preheater/precalciner and/or in the raw mill, and is subsequently reintroduced to the pyroprocessing/kiln sulfur cycle. The remainder enters into the pyroprocessing/kiln system and becomes part of the sulfur cycle in that system. Based on the pyritic content of the raw materials and the continuous SO<sub>2</sub> emission monitoring data, it appears that 10-12% or less of the pyritic sulfur in the raw feed is released to the atmosphere as SO<sub>2</sub>.

The in-line preheater/precalciner kiln/raw mill system as HAC's offers ideal conditions for adsorption of SO<sub>2</sub> from the kiln (from both the fuel and sulfur compounds in the mix) due to the high amount of free CaO and a temperature of approximately 1,650°F in the calciner. In addition to the fraction of the SO<sub>2</sub> adsorbed by alkalis species (potassium and sodium) in kiln feed/raw meal, the majority of the absorbed SO<sub>2</sub> is converted to calcium sulfate through the following reactions:<sup>9</sup>



At 1,045°C, the formation and decomposition reactions for CaSO<sub>4</sub> are at equilibrium at normal excess oxygen levels. As materials move through the high temperature regime in the kiln, the CaSO<sub>4</sub> can break down per the above reaction and release SO<sub>2</sub>, or it can fuse/react with the alkali sulfates and other species to form stable compounds that depart with the clinker.

The operation of the raw mill also has an effect on SO<sub>2</sub> emissions. When the raw mill is in operation, the hot kiln gases containing SO<sub>2</sub> pass through the raw mill to dry the raw materials as they are ground and blended. Due to the intimate mixing of the kiln exhaust gases and the powdery alkaline raw materials, a significant amount of the SO<sub>2</sub> in the kiln gases is absorbed in the dry feed via neutralization. When the raw mill is not operating (approximately 10% of the time in a typical modern Portland cement plant), the kiln gases bypass the raw mill and go directly to the kiln/raw mill/cooler baghouse. Under this operating scenario, SO<sub>2</sub> emissions might increase, depending on the sulfur balance and sulfur cycle in the preheater/precalciner and pyroprocessing system. The averaging time for SO<sub>2</sub> emission standard should factor in the effect of the raw mill on SO<sub>2</sub> emissions and normal fluctuations in the sulfur cycle in the preheater/precalciner and pyroprocessing/kiln system.

The application submitted by HAC named the adsorption of SO<sub>2</sub> by the raw feed/meal in the preheater/precalciner, calciner, the kiln and the running raw mill as "inherent dry (SO<sub>2</sub>) scrubbing".

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<sup>9</sup> An Overview of the Formation of SO<sub>x</sub> and NO<sub>x</sub> in Various Pyroprocessing Systems, Peter Nielson and Ove Lar Jepsen, F. L. Smidth Co.

Sodium sulfate and potassium sulfate from absorption of  $\text{SO}_2$  from fuel combustion are also incorporated into the clinker and in the dust collected by the baghouse (in HAC, all the baghouse dusts could be recycled to the process). Because of the abovementioned “inherent dry scrubbing” and the fact that sulfur input to the kiln system from fuel is less than the sulfur introduced in the feed material,  $\text{SO}_2$  emissions from the main kiln stack are quite insensitive to use of higher sulfur fuels such as petroleum coke.

In summary, the control of fuel  $\text{SO}_2$  is generally not an issue in modern kilns. Limiting fuel sulfur makes little difference in emissions. Generally, severe operational problems such as coating formation and blockages will occur due to use of high sulfur fuels before significant  $\text{SO}_2$  emissions occur.<sup>10</sup>

The generic sulfur circulation includes a bypass for sulfur removal as alkali sulfate salts. When a kiln system is low in alkali and meal sulfur, a bypass may not be included in the design, such as HAC’s kiln system. The sulfur circulation and pathway in dry process preheater/precalciner Portland cement kiln and raw mill system are illustrated in Figure 4.6-1.

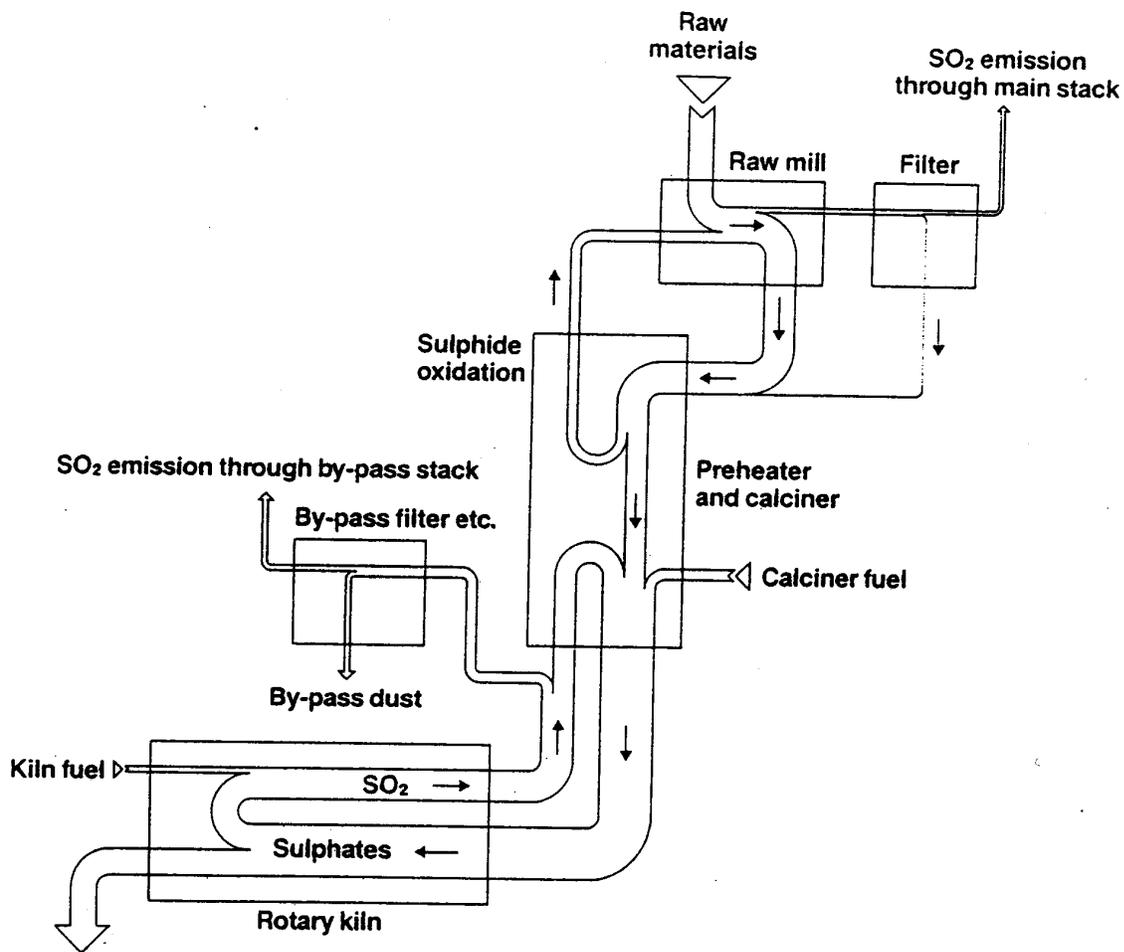


Figure 4.6-1: Sulfur Circulation & Pathway in Dry Process Preheater Cement Kiln System

<sup>10</sup> Presentation. Waste Management Technologies in Japanese Cement Industry. Taiyoho Cement, Taiyoho Engineering, CTI/Industry Joint Seminar, February 2004.

Besides the “inherent dry scrubbing”, additional reduction of the SO<sub>2</sub> emissions can be achieved by other available control or process technologies. These techniques include the following:

- Absorption
- Adsorption
- Low sulfur fuels
- Low sulfur raw materials.

**Absorption/Wet Scrubbing** can be an effective add-on control technology for SO<sub>2</sub> removal via the use of an aqueous alkaline solution to turn gaseous SO<sub>2</sub> into water soluble or insoluble sulfates via neutralization. A wet scrubber has been shown to provide SO<sub>2</sub> control in excess of 90% under optimal operating conditions. Adsorption control devices include packed towers, plate or tray columns, Venturi scrubbers, and spray chambers.

Packed towers are columns filled with packing material that provide a large surface area. The large surface area allows for good contact between the liquid/scrubbing solution and the gas. Packed towers can achieve higher removal efficiencies, handle higher liquid rates, and have lower water consumption requirements than other types of gas absorbers. However, packed towers may also have high pressure drops, high instances of clogging and fouling, and high maintenance costs because of the packing material.

Plate, or tray, tower scrubbers are vertical cylinders where the gas and liquid come in contact in steps on trays or plates. The liquid enters at the top of the column and flows across each plate and through a downspout to the plates below. The gas stream flows upward through holes in the plates, bubbles into the liquid, and passes to the plate above. Plate towers are easier to clean and can handle large temperature fluctuations better than packed towers. However, at high gas flow rates, plate towers exhibit larger pressure drops and have higher liquid holdups.

Venturi scrubbers have a “converging-diverging” flow channel. The cross-sectional area of the channel decreases then increases along the length of channel, which increases the waste stream velocity and turbulence which improves the gas-liquid contact. The liquid droplets are then separated from the gas stream in an entrainment section. A Venturi scrubber control efficiency is increased by increasing the pressure drop, which leads to higher operating costs.

Spray towers use a spray distribution system to deliver liquid droplets through a countercurrent gas stream under the influence of gravity. The droplets contact the pollutants in the gas stream. The required contacting power is derived from an appropriate combination of liquid pressure and flow rate. Spray towers are easy to operate and maintain and have low energy requirements. However, they have the least effective mass transfer capability of the absorbers and have high water recirculation rate requirements.

Wet scrubbing can also remove PM, some VOC, and acidic gases to various extent. Application of a wet scrubber requires passing the exhaust gases through a primary PM control produce a calcium sulfate (CaSO<sub>4</sub>) as byproduct, typically referred to as synthetic gypsum. However, in practice, not all cement plants using wet scrubbing have been successful in obtaining useable synthetic gypsum. If the cement plants can reclaim the scrubber sludge as synthetic gypsum and reincorporate it in the finish grinding process as synthetic gypsum, the overall environmental benefits associated with a wet scrubber can be considerable.

Application of a wet scrubber requires passing the exhaust gases through a PM control device first to reduce the dust load and recover meal. Next, the exhaust gas is cooled by spraying quench water or a slurried reagent (such as slaked lime or finely ground limestone) in an absorption chamber. SO<sub>2</sub> is scrubbed from the exhaust gas by the neutralization reaction with the slurried lime [Ca(OH)<sub>2</sub>] or limestone (calcium carbonate). The Ca(OH)<sub>2</sub> or calcium carbonate reacts with the SO<sub>2</sub> to form synthetic gypsum (CaSO<sub>4</sub>-2H<sub>2</sub>O). In theory, the synthetic gypsum precipitates into small crystals that are dewatered. The dewatered synthetic gypsum can then be used to supplement purchased gypsum in the production of cement and represents a potential beneficial reuse of byproduct materials. However, if the gypsum cannot be effectively crystallized, as has been experienced by some cement plants utilizing wet scrubbing systems, the scrubber sludge must be disposed of at considerable economic and environmental costs.

At the present time there have been six cement plants using the wet scrubbing technology for abatement of SO<sub>2</sub> in the U.S. Five are operational. The following describes the operations of four of these plants.

ESSROC, Nazareth, Pennsylvania – A wet scrubber was installed on a preheater kiln to reduce SO<sub>2</sub> by 20 to 25% to comply with a State emission limit. This old-type scrubber had an availability of 65% of kiln operating hours. Chronic fouling of demisters, piping, and nozzles occurred and the scrubbers were discontinued with conversion of the kiln to a precalciner design during an expansion project.

Holcim, Midlothian, Texas – Wet scrubbers were installed on two kiln lines in an effort to increase production and avoid PSD permitting. These more advanced units have removal efficiencies of between 70 to 90%, and are available 90% or less of the kiln run time.

TXI, Midlothian, Texas – A wet scrubber was installed as part of an upgrade of the plant from a wet kiln operation to a new preheater/precalciner line. No data are available on the performance but it is expected that it is similar to the Holcim experience. This scrubber is located between the kiln fabric filter and a RTO used for CO/VOC control. It is worth noting that based on the experience of this facility, EPA promulgated the current 20 ppm THC emission limit and the alternative standard (98% of THC removal) in NESHAP 40 CFR Part 63, Subpart LLL, the MACT standard for new Portland cement plants constructed after 2007.

Holcim, Dundee, Michigan – Two scrubbers were installed on the two wet kilns for removal of SO<sub>2</sub> prior to control of VOC emissions using an RTO to avoid converting SO<sub>2</sub> to SO<sub>3</sub> in the RTO, causing corrosion and a visible condensing aerosol in the combustion process. The plant installed the RTO to meet stack opacity and odor limitations and the scrubbers were required for the RTO to function properly.

On the other hand, wet scrubbing has a number of downsides:

- Impose an adverse environmental impact by generating solid waste requiring landfill disposal (if a usable synthetic gypsum cannot be produced), and require treatment and disposal of liquid blowdown containing dissolved solids (alkali salts). Changes in product quality cannot be predicted until after scrubber startup in that the quality of synthetic gypsum is site specific.
- Replenish large quantities of fresh water lost due to vaporization of the scrubbing solution has an impact on the water supply in the area.
- The static pressure drop through the wet scrubber and demister increases the electrical energy demand for the project and has an adverse impact on energy usage at the site. In addition, the need to drive and to reheat stack gases for proper atmospheric dispersion and corrosion prevention has a significant energy impact.

**Addition/Injection of Wet Absorbents** such as lime or hydrated lime to the kiln process gas streams can reduce SO<sub>2</sub> emissions in dry cement kiln systems. Various types of wet absorbent systems have been used on dry kilns, with lime slurry addition being the most effective.

Wet absorbent addition is limited to kiln systems where the lime slurry droplet can evaporate to dryness before entering the PM control device. This eliminates the use on wet kilns where flue gas temperatures are too low for rapid evaporation and flue gas moisture is near moisture saturation levels.

It should be noted that the limestone in the kiln feed and calcium oxide in kiln dust act as natural absorbents of the SO<sub>2</sub> emissions from fuel combustion and pyritic sulfur in the kiln feed, i.e., “inherent scrubbing”. Further, good burner design and proper operation of the kiln will chemically absorb sulfur into the clinker. Additional SO<sub>2</sub> reduction can be achieved by absorbent addition into the kiln process/flue gas stream.

With wet absorbent addition, CaO or Ca(OH)<sub>2</sub> slurry is injected into the process gas stream. Solid particles of CaSO<sub>3</sub> or CaSO<sub>4</sub> are produced, which are removed from the gas stream along with excess reagent by a PM control device. The SO<sub>2</sub> removal efficiency varies widely depending on the point of absorbent addition according to the temperature, degree of mixing, properties of the absorbent (i.e., size, surface area, etc.), and retention time.

In a dry process cement kiln system, process gases contain a low concentration of water vapor at an elevated temperature and must be cooled and humidified prior to entering the baghouse or ESP. Lime or calcium hydrate slurry can be introduced with the spray cooling water. Flue gas temperatures are reduced through the heat absorbed as sensible heat from evaporation of water. These temperatures are defined by the system design, kiln heat balance, amount of air in-leakage, and radiant and convective heat losses. The conditions present are optimal for proper operation of the kiln.

For slurry injection to succeed as an SO<sub>2</sub> absorption control method the following conditions must occur:

- Generating spray droplets with sufficient surface area to adsorb SO<sub>2</sub>.
- Droplets existing for sufficient time to allow absorption and reaction (typically 3 to 5 seconds).
- Droplets containing sufficient reagent to maintain excess absorbent during droplet life.
- Hydrate particle in the droplet maintaining sufficient activity to replenish dissolved solids in the liquid as SO<sub>2</sub> consumes reagent (i.e., particle size, reactivity, etc.)
- The droplet evaporating to dryness before entering the PM device.

An heat balance analysis for the dry process kiln has to be conducted to determine if there is sufficient sensible heat available in the gas streams to allow evaporation of injected water containing hydrate slurry.

Hydrate solids may be introduced in the conditioning water as suspended/dissolved solids. The normal solids content in the water can be as high as 5% solids by weight using air atomizing spray nozzles. The small droplets and fine hydrate particles generated allow effective absorption of SO<sub>2</sub> to form sulfates. Removal effectiveness can vary between 50 and 90% depending on residence time and hydrate surface area.

Lower SO<sub>2</sub> removal estimates have been documented in applications where the conditioning towers, duct arrangement, and PM control devices are not adequate for injection of lime slurry, resulting in wet bottoms in the conditioning towers and build up on ducts and baghouse walls. These conditions limit the hydrate slurry injection rates and the removal efficiency.

The higher SO<sub>2</sub> removal estimates have been documented at Greenfield installations implementing optimum designs. In these designs, larger conditioning towers and longer straight runs of ductwork are used along with control device gas distribution systems. No adverse environmental impacts are expected from the use of wet absorption at dry process cement kiln systems. Increases in energy required to operating a wet slurry injection system is minimal. Wet slurry injection is not expected to have a significant process impact when it is only used during mill-down periods and therefore added Ca(OH)<sub>2</sub> will not affect the Ca/S molar ratio significantly.

**Addition/Injection of dry absorbents** such as powdery lime, calcium hydrate, limestone, or soda to the process gas stream or in an add-on control device (dry scrubber) can reduce SO<sub>2</sub> emissions. A variety of dry absorbent systems have been used on wet and dry cement kilns.

It should be noted that the limestone in the kiln feed and calcium oxide in kiln dust act as natural absorbents of the SO<sub>2</sub> emissions from fuel combustion and pyritic sulfur in the kiln feed. Further, good burner design and proper operation of the kiln will chemically absorb sulfur into the clinker. Additional SO<sub>2</sub> reduction can be achieved by absorbent addition into the kiln process gas stream.

With absorbent addition, powdery dry CaO or Ca(OH)<sub>2</sub> is injected into the process gas stream, and reacts with SO<sub>2</sub> to form solid particles of CaSO<sub>3</sub> or CaSO<sub>4</sub>, which are removed from the gas stream along with excess reagent by a downstream PM control device. The SO<sub>2</sub> removal efficiency varies widely depending on the point of absorbent injection according to the temperature, degree of mixing, and retention time.

The single known application of an add-on dry scrubber uses a Venturi reactor column to produce a fluidized bed of dry slaked lime and raw meal. As a result of contact between the exhaust gas and the absorbent, as well as the long residence time and low temperature characteristic of the system, SO<sub>2</sub> is efficiently absorbed by this system. An additional application injects Ca(OH)<sub>2</sub> in the gas stream after the preheater first stage cyclone.

Dry absorbent injection to flue gas streams has been used at Roanoke Cement in Troutville, Virginia and has been proposed at several new cement plants. Effectiveness and cost are specific to each application and depend on the gas stream conditions and residence time available for reaction.

Typically the molar ratio (Ca/S) for absorption is on the order of 3.0 to 15.0 and requires approximately 2 seconds for completion. For increased effectiveness, a very fine particle is required or a high Ca/S ratio. Typical removal efficiency is between 20 and 50% depending on gas stream conditions.

Powdery hydrates/absorbents needed for dry absorption would be received by truck, pneumatically conveyed to a storage silo, and then injected through nozzles into the gas stream. Complete and uniform distribution and mixing in the gas stream are necessary. The best location for injection will be determined by each facility to allow for adequate residence time for reaction.

No adverse environmental or energy impacts are expected from the use of the dry absorption at dry process cement plants in general. The process is not expected to have a significant process impact because in general it would only be used during mill-down periods to compensate the loss of the portion of the "inherent scrubbing" contributed by the raw mill, and the addition of the Ca(OH)<sub>2</sub> powder will not affect significantly the original Ca/S molar ratio in the kiln system.

Table 4.6-1 presents a summary of the cost analysis for each of the add-on control options as provided with HAC' permit application.

**Table 4.6-1: Cost and Impact Summary for Add-on SO<sub>2</sub> Control Technology**

Method	% removal	SO <sub>2</sub> Removed, tons/yr	Capital Costs, MM \$	Annualized Cost, 1000 \$	Cost Effectiveness \$/ton	Impacts		
						Environmental	Product	Energy
Wet Scrubbing <sup>1</sup>	70 (90)	408 (525)	27.46	9,340.5	22,900 (17,797)	Yes	No	Yes
Wet Absorbent <sup>2</sup>	40 (60)	22 (33)	3.17	740.1	33,796 (22,531)	No	No	No
Dry Scrubbing/ Absorbents <sup>3</sup>	33 (50)	171 (259)	2.17	1,029.4	5,462 (3,606)	No	No	No

1. Expected control efficiency for wet scrubbing is 70% with raw mill on (7,446 hrs/yr), 80% with the raw mill off (1,314 hrs/yr), and 90% at maximum under both circumstances.
2. Expected control efficiency for wet absorption is 40% with maximum at 60%. Wet absorbent would only be added when the raw mill is off (1,314 hours/year) due to water spray limitations.
3. Expected control efficiency for dry scrubbing is 33% with maximum at 50%.

### **Raw Material Sulfur Management**

Limited analyses of raw materials by HAC have shown that Fuller's earth and clays mined locally contain measurable amounts of pyrites (FeS<sub>2</sub>). The Fuller's earth contains approximately 3% pyrites and constitutes approximately 15% of the raw feed. The clays constitute approximately 5% of the raw feed and contain approximately 1% pyrites. The analyses further show that limestone, which constitutes approximately 78% of the raw feed to the kiln system, contains non-detectable levels of pyrites. The mill scale acquired off-site constitute 2% of raw feed and has non-detectable levels of pyrites.

As cement plants are typically constructed adjacent to, or nearby a quarry (as is the case with HAC), it is not practical to use the management of the sulfur content of on-site mined materials as a means of controlling SO<sub>2</sub> emissions. Some material management discretion is possible, such as mining around or blending materials from mining areas with higher than normal organic or pyritic sulfur. But overall, on-site raw material management is limited mainly to the fact that the facility is designed and thus depends on the on-site quarry for a majority of the raw materials. Materials imported from off-site however, can be managed to assure they have acceptable sulfur levels. A computerized raw material management system as such employed by HAC' sister plant (Suwannee Cement Company in Florida) can inform the operators the sulfur content of different batches of raw materials and thus allows the operator to blend the raw materials accordingly to even out the sulfur input to the kiln to certain degree.

### **Fuel Sulfur Management**

As discussed previously, it is generally agreed that very little of the fuel sulfur is released as SO<sub>2</sub> from the cement kiln thanks to the overwhelming alkali scrubbing/neutralization processes occurring the in-line kiln/raw mill. Once generated at the burners, the fuel sulfur cycles in the calciner and kiln with the cycle dependent upon the sulfur/alkali balance, the oxidizing/reducing conditions in the kiln and calciner and the CaO/CaSO<sub>4</sub> equilibrium. Most of the sulfur eventually reacts with alkalis (primarily sodium and potassium) to form alkali sulfates that are incorporated in the cement clinker. If the sulfur/alkali balance is too much out of balance, alkali additives can be incorporated in the mix, the sulfur content of the fuel can be reduced, or if the alkalis are in excess, a by-pass can be installed to bleed off a fraction of the kiln duct.

Conventional wisdom is that if the sulfur-alkali balance in the pyroprocessing/kiln system exceeds unity, sulfur emissions (as SO<sub>2</sub>) will increase and/or there will be sulfur deposits in the riser duct and/or preheater. However, experienced cement producers indicate that a sulfur-alkali ratio of up to 2.0 can be maintained without increasing SO<sub>2</sub> emissions or experiencing sulfur deposits. This is important when petroleum coke (typically with high sulfur) is considered as a fuel.

Operating with a high sulfur-alkali ratio requires a complete burnout of the fuel under oxidizing conditions early in the kiln. This allows the fuel sulfur to form sulfate complexes in the clinker and exit the kiln with the clinker. To assure early burnout of the fuel requires pulverization of the fuel such as coal and petcoke and the presence of sufficient oxygen to assure the burnout under oxidizing conditions.

Without the early burning of high sulfur fuel under oxidizing conditions, the fuel sulfur will form salts that will volatilize in the sintering zone and return to the riser duct and calciner where they will condense and return to the sintering zone; thus creating a sulfur cycle in the kiln/calciner. In the temperature range 750-1,200°C (which includes the calcination temperature of limestone), the salts have sticky properties. Thus, if excessive sulfur is present under these conditions, plugging problems will occur at the kiln feed shelf, the riser duct and/or the calciner, causing plant operating problems well before the sulfur can break through and cause SO<sub>2</sub> emission problems. Thus, the release of SO<sub>2</sub> generated by fuel combustion is extremely unlikely as plant operating problems, potentially resulting in a plant shutdown, will occur before SO<sub>2</sub> breakthrough. But, as discussed previously, the sulfur cycle can be managed by controlling combustion conditions.

As a result of the self-limiting mechanism for fuel sulfur to generate SO<sub>2</sub> emissions and combustion management practices just described, SO<sub>2</sub> emissions as a result of fuel sulfur are essentially nonexistent.

### **SO<sub>2</sub> BACT Determination**

EPD has determined that based on the cost estimations, the wet scrubbing option is not economically feasible and the wet absorbent addition option is not technically feasible for its very limited application condition (only operable during raw mill down time) as BACT for the control of the SO<sub>2</sub> emissions from the HAC's cement kiln system.

EPD has determined that the combination of the inherent dry scrubbing in HAC's in-line preheater/precalciner kiln/raw mill, the addition/injection of hydrated lime/add-on dry scrubbing into the process gas stream, and the judicious selection of raw materials regarding to their sulfur contents constitutes BACT to minimize the SO<sub>2</sub> emissions. Taking into consideration that the raw materials mined onsite by HAC contain relatively more sulfur than those used by similar plants recently permitted in Florida, EPD has decided that the BACT limit for the SO<sub>2</sub> emissions from HAC is 1.0 pound of SO<sub>2</sub> per ton of clinker based on a 30-day rolling average. The SO<sub>2</sub> emissions will be determined and continuously monitored by a SO<sub>2</sub> CEM installed at the outlet of the main kiln exhaust stack.

Conditions in this PSD permit will establish the relevant operational, work practice, monitoring, testing, record keeping, compliance demonstration and reporting requirements for the BACT, which include but not limited to, records of raw material and fuel usage and sulfur content, records of the operation of the hydrated lime injection system, and the use of the SO<sub>2</sub> CEM for performance testing and monitoring.

### **4.7 Summary of Proposed BACT Technologies and Emission Limits**

Table 4.7-1 summarizes the proposed BACT technologies and corresponding emission limits by EPD for the CO, NO<sub>x</sub>, SO<sub>2</sub> PM/PM<sub>10</sub> and VOC/THC emissions from HAC's Portland cement kiln system.

Pollutant	Operation & Control	Emission Limit	Compliance Method	Averaging Time
PM	Air Heater, Raw Mill, Preheater/Precalciner, Calciner, Kiln, and Clinker Cooler/Stack No. PT35;	0.153 lb PM/ton clinker	Method 5	Average of three 1-hour runs
		19.1 lb/hr	CEM	Per EPA's requirement; may substitute the Method 9 testing
PM <sub>10</sub>	Control: Baghouse	0.129 lb PM <sub>10</sub> /ton clinker	Methods 201 or 201A and 202	Per Methods 201 or 201A and 202
Visible		10% opacity	COM	6-minute block average

Pollutant	Operation & Control	Emission Limit	Compliance Method	Averaging Time
PM/PM <sub>10</sub>	Finish Mill	0.01 gr/dscf (0.0085 gr/dscf for PM <sub>10</sub> )	Method 5	Average of three 1-hour runs
Visible	Control: Baghouse	10% opacity	COM	6-minute block average
PM/PM <sub>10</sub>	All other plant point sources	0.01 gr/dscf (0.0085 gr/dscf for PM <sub>10</sub> )	Method 5 if possible	Average of three 1-hour runs;
Visible	Control: Baghouse	10% opacity	Method 9 or COM	6-minute block average
			Daily visual observation	N/A
Fugitive	All fugitive sources including excluding the quarry operations;  Control: Precaution measurements and wet suppression	10% opacity	Method 22	75-minute observation
			Daily visual observation	N/A
Fugitive	Outdoor transfer point on belt conveyors or from other fugitive sources in the quarry operations excluding the crusher, enclosed process building and wet process  Control: Precaution measurements and wet suppression	10% opacity	Method 9	6-minute block average
			Daily visual observation	N/A
Fugitive	Fugitive emissions from crusher  Control: wet suppression	15% opacity	Method 9	6-minute block average
			Daily visual observation	N/A
Fugitive	Fugitive emissions from enclosed buildings and wet process in the quarry operations	No visible emissions	Method 22	75-minute observation
			Daily visual observation	N/A
SO <sub>2</sub>	Air Heater, Raw Mill, Preheater, Calciner, Kiln, and Clinker Cooler/Stack No. ST35;  Control: Inherent dry scrubbing, raw material management, hydrated lime injection if necessary	1.0 lb/ton clinker  125.0 lb/hr	CEM	30-day rolling CEM average
NO <sub>x</sub>	Air Heater, Raw Mill, Preheater, Calciner, Kiln, and Clinker Cooler/ Stack No. ST35;  Control: SCC, SNCR & Low NO <sub>x</sub> burner control	1.95 lb/ton clinker  243.8 lb/hr	CEM	30-day rolling average
NO <sub>x</sub> (Initial Startup)	Air Heater, Raw Mill, Preheater, Caciner, Kiln, and Clinker Cooler/ Stack No. ST35;  Control: SCC, SNCR & Low NO <sub>x</sub> burner control	3.0 lb/ton clinker  375.0 lb/hr	CEM	30-day rolling average

Pollutant	Operation & Control	Emission Limit	Compliance Method	Averaging Time
CO	Air Heater, Raw Mill, Preheater, Calciner, Kiln, and Clinker Cooler/ Stack No. ST35;  Control: Good equipment design & combustion process; calciner fly ash injection	2.9 lb/ton clinker  362.5 lb/hr	CEM	30-day rolling average
VOC	Air Heater, Raw Mill, Preheater, Calciner, Kiln, and Clinker Cooler/ Stack No. ST35;  Control: Good equipment design and combustion processes; calciner fly ash injection	0.50 lb/ton clinker  62.5 lb/hr.	CEM	30-day rolling average

- a. Continuous monitoring data collected during periods of startup, shutdown, and malfunction may be excluded from the compliance demonstration in accordance with applicable monitoring requirements in the permit.
- b. Method 201 or 201A in conjunction with Method 202 shall be used in combination with Method 5 to demonstrate compliance with the relevant PM<sub>10</sub> emission limits during the performance testing. As an alternative to Method 201 or 201A, the Permittee may assume that 100% of the PM emissions from the baghouses as determined via Method 5 are PM<sub>10</sub> in the emission compliance demonstration. When an actual PM emission rate based on Method 5 exceeds its corresponding PM<sub>10</sub> emission limit, additional Method 201 or 201A test will be required to demonstrate compliance with the PM<sub>10</sub> emission limit.
- c. A PM CEM will be used for the PM emissions from the in-line kiln/raw mill after U.S. EPA promulgates procedural requirements for the application of the PM CEM under 40 CFR, Part 63, Subpart LLL.
- d. For shakedown and optimization of the SNCR system for NO<sub>x</sub> emission control, during an “initial startup” period the NO<sub>x</sub> emissions shall not exceed 3.0 lb/ton of clinker based on a 30-day rolling average. The “initial startup” period shall begin after initial certification of the NO<sub>x</sub> CEM and shall end when any of the following conditions are met:
  - i. The kiln system produces 75,000 tons of clinker or more in any 30-day rolling period.
  - ii. The kiln system produces 150,000 tons of clinker. Or
  - iii. 365 calendar days elapse after the initial certification of the NO<sub>x</sub> CEM.

After the “initial startup” period ends, the NO<sub>x</sub> emissions shall not exceed 1.95 lb/ton of clinker based on a 30-day rolling average.
- e. The VOC emissions shall be measured by a THC CEM, expressed as THC as propane and corrected to 7% oxygen on a dry basis, and converted to the same unit as the emission limit.

## 5.0 TESTING AND MONITORING REQUIREMENTS

### Testing Requirements:

HAC's Portland cement manufacturing operations at this site, including the on-site quarry operations, will be subject to mainly the testing requirements under federal rules including PSD/BACT, NSPS (Subparts Y and OOO), and NESHAP MACT standard (Subparts LLL). These testing requirements are emission or source/process specific, and sometimes complementary to each other.

**40 CFR Part 63, Subpart LLL:** This NESHAP MACT standard for Portland cement manufacturing industry requires HAC to conduct initial performance tests on the PM, visible, THC/VOC, D/F and Hg emissions from the in-line kiln/raw mill and clinker cooler, using Method 5 for PM, COM for opacity, Method 23 for D/F, Method 25A for THC/VOC, and Method 29 or ASTM D6784-02 for Hg emissions respectively. When the use of COM is not practicable, such as in the case of multiple stacks or monovents, Method 9 shall be used instead. Because the operation of the raw mill may affect the emissions, all the tests shall be conducted while the raw mill is under normal operating conditions, i.e., "raw mill on" and while the raw mill is not operating i.e., "raw mill off". The PM and visible performance tests shall be repeated every 60 months. The D/F emission test shall be repeated every 30 months. Each of the COM and CEM shall be certified before testing.

For other affected sources only subject to a visible emission limit of 10% opacity under Subpart LLL, including each raw material, clinker, or finished product storage bin; conveying system transfer point; bagging system; bulk loading or unloading system; and raw material dryer, HAC shall conduct initial performance tests to demonstrate compliance with the opacity limit using Method 9.

During the performance tests, the Permittee shall establish operating parameters which could affect the emissions and/or are required for emission calculations. These operating parameters include, but not limited to, process weight input and output rate, fuel type and usage rate, exhaust gas flow rate, exhaust gas temperature, exhaust gas oxygen content, exhaust gas moisture content, baghouse pressure drop range, ammonia solution injection rate, fay ash injection rate, and/or CKD recycle rate, whichever is necessary.

When any source change in operation(s) that may adversely affect any of the emissions involved, HAC shall conduct an appropriate performance test(s) for the affected emissions from the source(s) involved, and establish new operating parameter(s) that could affect the emission(s).

**40 CFR Part 60, Subpart OOO:** This NSPS standard requires HAC to demonstrate compliance with the applicable visible emission limits (expressed as opacity) using either Method 9 or Method 22, depending on the nature of the source involved. HAC shall follow the applicable procedures specified in Subpart OOO to conduct the fugitive emission testing/opacity. HAC's on-site quarry operations will not have any point/stack emissions.

**40 CFR Part 60, Subpart Y:** This NSPS standard requires HAC to demonstrate compliance with the applicable PM or visible emission limit for the affected coal processing units/sources using Method 5 or Method 9 respectively.

**PSD/BACT:** Results of the PM, THC/VOC and visible emission performance tests aforementioned are considered adequate to demonstrate compliance with the PSD/BACT PM and/or visible emission limits for the same sources. No additional PSD/BACT tests are required for these emissions.

Certain point sources/stacks (controlled or uncontrolled) not only have visible emission limits under Subpart LLL or Subpart Y, but also have both visible and PM emission limits under PSD/BACT rules. HAC shall conduct Method 5 tests on each of the sources respectively if possible to demonstrate compliance with the applicable PSD/BACT PM emission limits. Such point sources may include, but not limited to, raw material, clinker, or finished product storage bins; conveying system transfer points; bagging systems; bulk loading or unloading systems; raw material dryers; coal processing and conveying equipment, coal storage systems; or coal transfer and loading systems.

The Permittee shall determine PM<sub>10</sub> emissions from each of the stacks/point sources of PM emissions using Method 201 or 201A in conjunction with Method 202 when no Division-approved PM<sub>10</sub> emission factor(s) is available or actual PM emissions from the Method 5 test exceed the applicable PM<sub>10</sub> emission limit.

Compliance with the PM<sub>10</sub> emission limits is important because the ambient impacts of the potential PM<sub>10</sub> emissions from HAC have been assessed via computerized atmospheric dispersion modeling.

The Permittee shall conduct initial performance tests on the CO, NO<sub>x</sub> and SO<sub>2</sub> emissions from the in-line kiln/raw mill and clinker cooler using certified CO, NO<sub>x</sub> and SO<sub>2</sub> CEM respectively, and establish operating parameters that may affect the emissions, such as ammonia solution-injection rate/NH<sub>3</sub>-NO<sub>x</sub> molar ratio, combustion temperature profile, burner setting, fly ash injection rate, and hydrated lime injection rate, in addition to the operating parameters determined during the performance tests as required by 40 CFR Part 63, Subpart LLL. Because the operation of the raw mill will affect the test results, the performance test for SO<sub>2</sub> emissions shall be conducted while the raw mill is “on” and “off” respectively.

When any source modifications or change in operation(s) that may adversely affect the PM/PM<sub>10</sub> emissions from any such source, HAC shall conduct a performance test on the source using Method 5, and establish new operational parameter(s) that could affect the PM emissions.

Results of the performance test requirements aforementioned are considered adequate to demonstrate compliance with the applicable SIP limits for the same emissions from the same sources.. No additional SIP performance tests are required.

### **Monitoring Requirements:**

HAC's Portland cement manufacturing plant at this site, including the on-site quarry operations, will be subject to mainly the monitoring requirements under federal rules including PSD/BACT, NSPS (Subpart IIII), and NESHAP MACT standard (Subparts LLL). These monitoring requirements are either emission or source/process specific or complementary to each other.

**40 CFR Part 63, Subpart LLL:** This NESHAP MACT standard for Portland cement manufacturing plant requires HAC to continuously monitor the visible and THC/VOC emissions from the in-line kiln/raw mill and clinker cooler using COM and THC CEM. HAC will be required to use a PM CEM for the main kiln stack once EPA promulgates the procedural requirements for the use of the PM CEM. Such monitoring is important because THC and PM emissions are considered under Subpart LLL as surrogates of the emissions of hazardous air pollutants (HAPs) from the in-line kiln/raw mill which emits almost all the HAPs.

HAC shall use Method 22 to periodically monitor the visible emissions from each raw material, clinker, or finished product storage bin; conveying system transfer point; bagging system; and bulk loading or unloading system; and raw material dryer. The monitoring frequency may be decreased from monthly to semiannually if no visible emissions are observed in 6 consecutive monthly monitoring, and from semiannually to annually if no visible emissions are observed during the semiannual monitoring.

If visible emissions are observed during any Method 22 test, HAC shall conduct a 6-minute test of opacity using Method 9 within 1 hour of any observation of visible emissions.

The requirement to conduct Method 22 visible emissions monitoring shall not apply to any totally enclosed conveying system transfer point, regardless of the location of the transfer point. If any partially enclosed or unenclosed conveying system transfer point is located in a building, HAC may opt to conduct a Method 22 visible emissions monitoring as mentioned above.

HAC shall conduct daily visual emissions observations of the mill sweep and air separator PM control device of the raw mill or finish mill using Method 22. The observation shall last 6 minutes. If visible emissions are observed, HAC shall initiate, within 1 hour, the corrective actions specified in the site specific operating and maintenance plan. Within 24 hours of the end of the Method 22 monitoring, in which visible emissions were observed, HAC shall conduct a followup Method 22 test on each stack from which visible emissions were observed during the previous test. If visible emissions are observed during the followup test from any stack from which visible emissions were observed during the previous test, conduct a 30-minute visual opacity test on that specific stack using Method 9.

The requirements to conduct daily Method 22 testing shall not apply to any specific raw mill or finish mill equipped with a COM or (baghouse ) bag leak detection system (BLDS).

Because the formation of D/F is affected by the temperature, Subpart LLLL requires continuous monitoring of the temperature of the exhaust gases from the in-line kiln/raw mill at the inlet to, or upstream of the baghouse(s) serving the in-line kiln/raw mill, using continuous temperature monitor. The temperature record is used as surrogate to the D/F emissions.

**40 CFR Part 60, Subpart IIII:** To ensure compliance with the 100-hour operating time limit for maintenance check and reliable testing, this NSPS standard requires the emergency stationary diesel generator/ engine to be equipped with a non-resettable hour meter to track the number of hours of various operations.

**PSD/BACT:** Results of the PM, THC/VOC, visible and/or fugitive emission monitoring aforementioned are considered adequate to demonstrate compliance with the PSD/BACT PM, THC/VOC, visible and/or fugitive emission limits for the same sources. No additional PSD/BACT monitoring of the same emissions is required.

HAC is required under pertinent PSD/BACT rules to use the same CO, NO<sub>x</sub> and SO<sub>2</sub> CEM used for performance tests to monitor continuously the same emissions from the same sources.

HAC shall perform a daily check of visible emissions (VE) from all the sources with visible emissions and retain a daily VE checkup log suitable for inspection or submittal. The daily VE check shall be conducted at least once for each day or portion of each day of operation and shall be conducted using the following procedure:

To convert the CEM monitoring data to the mass charge/emission rates or concentrations in the same units as the relevant emission limits, HAC shall continuously monitor and record the indicated parameters:

- Exhaust/flue gas stream temperature, oxygen content, and moisture content at each location where CO, NO<sub>x</sub>, SO<sub>2</sub> or THC emissions are monitored by respective CEM.
- The stack exhaust gas flow rate of the stack(s)/exhaust vent(s) with CO, NO<sub>x</sub>, SO<sub>2</sub> or THC CEM.
- The hourly rate of dry feed entering the kiln and clinker exiting from the clinker cooler.

Each monitoring system/device shall be maintained and calibrated periodically according to manufacturer's specifications or pertinent State or Federal rules.

HAC shall perform the following daily operation and maintenance checks on each dust suppression device :

- Visual inspection of wet suppression/water-spray control systems to ensure that the designated nozzle water spray pattern is produced (i.e., a fine, conical mist).
- Inspection of water-spray nozzles to ensure that they are properly directed.
- Inspection of water spray nozzles to ensure none are clogged, and there is proper and adequate water flow sufficient to wet the surface area of the materials being processed.

**CAM Applicability:**

Because HAC is a new/greenfield source, no CAM requirements are required to be incorporated into this construction permit. The applicable CAM requirements will be provide by the initial Part 70 operating permit application within 12 months of the startup of HAC's cement plant.

## 6.0 AMBIENT AIR QUALITY REVIEW

An air quality analysis is required to determine the ambient impacts associated with the construction and operation of the proposed HAC's new Portland cement plant. The main purpose of the air quality analysis is to demonstrate that emissions emitted from the proposed cement plant, in conjunction with other applicable emissions from any existing sources (including secondary emissions from growth associated with the new project) if applicable, will not cause or contribute to a violation of any applicable National Ambient Air Quality Standard (NAAQS) or PSD increment in a Class I or Class II area. NAAQS exist for NO<sub>2</sub>, CO, PM<sub>2.5</sub>, PM<sub>10</sub>, SO<sub>2</sub>, Ozone (O<sub>3</sub>), and lead. PSD increments exist for SO<sub>2</sub>, NO<sub>2</sub>, and PM<sub>10</sub>.

The proposed Portland cement plant triggers PSD review for CO, PM<sub>10</sub>, NO<sub>x</sub>, VOC and SO<sub>2</sub>. An air quality analysis was conducted to demonstrate the facility's compliance with the NAAQS and PSD Increment standards for these pollutants. An additional analysis was conducted to demonstrate compliance with the Georgia air toxics program. This section of the application discusses the air quality analysis requirements, methodologies, and results. Supporting documentation may be found in the Air Quality Dispersion Report of the application and in the additional information packages.

### Modeling Requirements

The air quality modeling analysis was conducted in accordance with Appendix W of Title 40 of the Code of Federal Regulations (CFR) §51, *Guideline on Air Quality Models*, and Georgia EPD's *Guideline for Ambient Impact Assessment of Toxic Air Pollutant Emissions (Revised)*.

The proposed project will cause net emission increases of CO, PM<sub>10</sub>, NO<sub>x</sub>, and SO<sub>2</sub> that are greater than the applicable PSD Significant Emission Rates. Therefore, air dispersion modeling analyses are required to demonstrate compliance with the NAAQS and PSD Increment. TRS and VOC do not have established PSD modeling significance levels (MSL) (an ambient concentration expressed in either µg/m<sup>3</sup> or ppm). While TRS does not have established modeling significance levels, it does have an ambient monitoring *de minimis* threshold that is concentration-based. Therefore, TRS modeling was conducted to demonstrate that the project impact is below the ambient monitoring *de minimis* concentration. Modeling is not required for VOC emissions; however, the project will likely have no impact on ozone attainment in the area based on data from the monitored levels of ozone in City of Macon, Bibb County and the level of emissions increases that will result from the proposed project. The southeast is generally NO<sub>x</sub> limited with respect to ground level ozone formation.

### Significance Analysis: Ambient Monitoring Requirements and Source Inventories

Initially, a Significance Analysis was conducted to determine if the CO, PM<sub>10</sub>, NO<sub>x</sub>, VOC and SO<sub>2</sub> emissions increases at HAC would significantly impact the area surrounding the facility. Maximum ground-level concentrations were compared to the pollutant-specific U.S. EPA-established Significant Impact Level (SIL). The SIL for the pollutants of concern are summarized in Table 6-1.

If a significant impact (i.e., an ambient impact above the SIL) does not result, no further modeling analyses would be conducted for that pollutant for NAAQS or PSD Increment. If a significant impact does result, further refined modeling would be completed to demonstrate that the proposed project would not cause or contribute to a violation of the NAAQS or consume more than the available Class II Increment.

Under current U.S. EPA policies, the maximum impacts due to the emissions increases from a project are also assessed against monitoring *de minimis* levels to determine whether pre-construction monitoring should be considered. These monitoring *de minimis* levels are also listed in Table 6-1. If either the predicted modeled impact from an emission increase or the existing ambient concentration is less than the monitoring *de minimis* concentration, the permitting agency has the discretionary authority to exempt an applicant from pre-construction ambient monitoring. This evaluation is required for CO, PM<sub>10</sub>, NO<sub>x</sub>, and SO<sub>2</sub>.

If any off-site pollutant impacts calculated in the Significance Analysis exceed the SIL, a Significant Impact Area (SIA) would be determined. The SIA encompasses a circle centered on the new cement plant with a radius extending out to (1) the farthest location where the emissions increase of a pollutant from the project causes a significant ambient impact, or (2) a distance of 50 km, whichever is less. All sources within a distance of 50 km of the edge of a SIA are assumed to potentially contribute to ground-level concentrations within the SIA and would be evaluated for possible inclusion in the NAAQS and PSD Increment analyses.

**Table 6-1: Summary of Significant Impact Levels**

Pollutant	Averaging Period	PSD Significant Impact Level (ug/m <sup>3</sup> )	PSD Monitoring Deminimis Concentration (ug/m <sup>3</sup> )
PM <sub>10</sub>	Annual	1	--
	24-Hour	5	10
SO <sub>2</sub>	Annual	1	--
	24-Hour	5	13
	3-Hour	25	--
NO <sub>2</sub>	Annual	1	14
CO	8-Hour	500	575
	1-Hour	2000	--

### NAAQS Analysis

The primary NAAQS are the maximum concentration ceilings, measured in terms of total concentration of pollutant in the atmosphere, which define the “levels of air quality which the U.S. EPA judges are necessary, with an adequate margin of safety, to protect the public health.” Secondary NAAQS define the levels that “protect the public welfare from any known or anticipated adverse effects of a pollutant.” The primary and secondary NAAQS, listed in Table 6-2 below, are equivalent for NO<sub>2</sub>, PM<sub>10</sub>, and SO<sub>2</sub>; no secondary NAAQS have been developed for CO.

**Table 6-2: Summary of National Ambient Air Quality Standards**

Pollutant	Averaging Period	NAAQS	
		Primary/Secondary (ug/m <sup>3</sup> )	Primary/Secondary (ppm)
PM <sub>10</sub>	Annual	50 / 50	--
	24-Hour	150 / 150	--
SO <sub>2</sub>	Annual	80/None	0.03/None
	24-Hour	365/None	0.14/None
	3-Hour	1300/None	None/0.5
NO <sub>2</sub>	Annual	100/100	0.053/0.053
CO	8-Hour	10,000/10,000	9/None
	1-Hour	40,000/40,000	35/None

If the maximum pollutant impact calculated in the Significance Analysis exceeds the SIL at an off-property receptor, a NAAQS analysis is required. The NAAQS analysis would include the potential emissions from all emission units at HAC, except for units that are generally exempt from permitting requirements and are normally operated only in emergency situations. The emissions modeled for this analysis would reflect the results of the BACT analysis for the modified emission unit. Facility emissions would then be combined with the allowable emissions of sources included in the regional source inventory. The resulting impacts, added to appropriate background concentrations, would be assessed against the applicable NAAQS to demonstrate compliance. For an annual average NAAQS analysis of any of these pollutants, the highest modeled concentration among five consecutive years of meteorological data would be assessed, while the highest sixth-high impact would be assessed for the 24-hour PM<sub>10</sub> concentration, and the highest second-high impact for the rest of the short-term averaging periods of the rest of the pollutants.

### **PSD Increment Analysis**

The PSD Increments were established to “prevent deterioration” of air quality in certain areas of the country where air quality was better than the NAAQS. To achieve this goal, U.S. EPA established PSD Increments for certain pollutants. The sum of the PSD Increment concentration and a baseline concentration defines a “reduced” ambient standard, either lower than or equal to the NAAQS that must be met in an attainment area. Significant deterioration is said to have occurred if the change in emissions occurring since the baseline date results in an off-property impact greater than the PSD Increment (i.e., the increased emissions “consume” more than the available PSD Increment).

U.S. EPA has established PSD Increments for NO<sub>x</sub>, SO<sub>2</sub>, and PM<sub>10</sub>; no increments have been established for CO. The PSD Increments are further broken into Class I, II, and III Increments. HAC’s new cement plant is located in a Class II area. The PSD Increments for Class I and II areas are listed in Table 6-3.

**Table 6-3: Summary of PSD Increments**

Pollutant	Averaging Period	PSD Increment	
		Class I (ug/m <sup>3</sup> )	Class II (ug/m <sup>3</sup> )
PM <sub>10</sub>	Annual	4	17
	24-Hour	8	30
SO <sub>2</sub>	Annual	2	20
	24-Hour	5	91
	3-Hour	25	512
NO <sub>2</sub>	Annual	2.5	25

To demonstrate compliance with the PSD Increments, the increment-affecting emissions (i.e., all emissions increases or decreases after the appropriate baseline date) from the cement plant and those sources in the regional inventory would be modeled to demonstrate compliance with the PSD Class II increment for any pollutant greater than the SIL in the Significance Analysis. For an annual average analysis, the highest incremental impact will be used. For a short-term average analysis, the highest second-high impact will be used.

The determination of whether an emissions change at a given source consumes or expands increment is based on the source classification (major or minor) and the time the change occurs in relation to baseline dates. The major source baseline date for NO<sub>x</sub> is February 8, 1988, and the major source baseline for SO<sub>2</sub> and PM<sub>10</sub> is January 5, 1976. Emission changes at major sources that occur after the major source baseline dates affect Increment. In contrast, emission changes at minor sources only affect Increment after the minor source baseline date, which is set at the time when the first PSD application is completed in a given area, usually arranged on a county-by-county basis. The minor source baseline dates in Houston County have been set for PM<sub>10</sub> and SO<sub>2</sub> as August 21, 1985, and for NO<sub>2</sub> as July 13, 1993.

### Modeling Methodology

Screening and refined dispersion modeling was used for this modeling analysis. Details on the dispersion model, including meteorological data, source data, and receptors can be found in EPD's PSD Dispersion Modeling and Air Toxics Assessment Review in Appendix C of this Preliminary Determination and in Appendix C, D and J of the permit application.

### Modeling Results

Table 6-4 show that the proposed project will not cause ambient impacts of SO<sub>2</sub>, NO<sub>x</sub>, and CO above the appropriate SILs. Because the emissions increases from the proposed project result in ambient impacts less than the SILs, no further PSD analyses were conducted for these pollutants.

However, ambient impacts above the SILs were predicted for PM<sub>10</sub> for annual and 24 hour averaging periods, requiring NAAQS and Increment analyses be performed for this pollutant.

**Table 6-4: Class II Significance Analysis Results – Comparison to SILs**

Pollutant	Averaging Period	Year	UTM East (km)	UTM North (km)	Maximum Impact (ug/m <sup>3</sup> )	SIL (ug/m <sup>3</sup> )	Significant?
NO <sub>2</sub>	Annual	1991	253127	3589276	0.77	1	No
PM <sub>10</sub>	24-hour	07/21/1989	251000	3594000	5.24	5	Yes
	Annual	1989	252700	3591300	1.04	1	Yes
SO <sub>2</sub>	3-hour	05/26/1988	253170	3589454	9.70	25	No
	24-hour	02/27/1878	252600	3589100	4.47	5	No
	Annual	1991	253100	3589300	0.53234	1	No
CO	1-hour	01/17/1988	252500	3591500	48.50	2000	No
	8-hour	08/09/1989	253100	3589400	27.31	500	No

Data for worst year provided only.

As indicated in the tables above, maximum-modeled impacts were below the corresponding SILs for SO<sub>2</sub>, NO<sub>x</sub>, and CO. However, maximum-modeled impacts were above the SILs for PM<sub>10</sub>. Therefore, a Full Impact Analysis was conducted for this pollutant.

### Significant Impact Area

For any off-site pollutant impact calculated in the Significance Analysis that exceeds the SIL, a Significant Impact Area (SIA) must be determined. The SIA encompasses a circle centered on the facility being modeled with a radius extending out to the lesser of either: 1) the farthest location where the emissions increase of a pollutant from the proposed project causes a significant ambient impact, or 2) a distance of 50 kilometers. All sources of the pollutants in question within the SIA plus an additional 50 kilometers are assumed to potentially contribute to ground-level concentrations and must be evaluated for possible inclusion in the NAAQS and Increment Analysis.

Based on the results of the Significance Analysis, the distance between the facility and the furthest receptor from the facility that showed a modeled concentration exceeding the corresponding SIL was determined to be 5.06 kilometers for PM<sub>10</sub>. To be conservative, regional source inventories for both of these pollutants were prepared for sources located within 55.06 kilometers of the mill.

### NAAQS and Increment Modeling

The next step in completing the NAAQS and Increment analyses was the development of a regional source inventory. Nearby sources that have the potential to contribute significantly within the facility's SIA are ideally included in this regional inventory. HAC prepared an inventory of NAAQS and PSD Increment sources located within the 55.06-kilometer range.

Additionally, pursuant to the “20D Rule,” facilities outside the SIA but within the 55.06 km range were also excluded from the inventory if the entire facility’s emissions (expressed in tons per year) were less than 20 times the distance (expressed in kilometers) from the facility to the edge of the SIA for annual assessments, and less than 20 times the distance from the facility to the proposed source, for short term assessments.

In applying the 20D Rule, facilities in close proximity to each other (within approximately 2 kilometers of each other) were clustered and considered as one source. The regional source inventory used in the analysis is included in the permit application.

### **NAAQS Analysis**

In the NAAQS analysis, impacts within the facility’s SIA due to the potential PM<sub>10</sub> emissions from all sources at the facility and those sources included in the regional inventory were calculated. Since the modeled ambient air concentrations only reflect impacts from industrial sources, a “background” concentration was added to the modeled concentrations prior to assessing compliance with the NAAQS. The results of the NAAQS analysis are shown in Table 6-5. For the short-term averaging periods, the impacts are the highest sixth-high impacts. For the annual averaging period, the impacts are the highest impact. When the total impact at all significant receptors within the SIA are below the corresponding NAAQS, compliance is demonstrated.

**Table 6-5: NAAQS Analysis Results**

Pollutant	Averaging Period	Year	UTM East (km)	UTM North (km)	Maximum Impact (ug/m <sup>3</sup> )	Background (ug/m <sup>3</sup> )	Total Impact (ug/m <sup>3</sup> )	NAAQS (ug/m <sup>3</sup> )	Exceed NAAQS?
PM <sub>10</sub>	24-hour	01/2/1990	25250 0	3589700	38.12	38	76.12	150	No
	Annual	1989	25250 0	3589700	15.91	20	35.91	50	No

Data for worst year provided only.

As indicated in Table 6-5 above, total modeled PM<sub>10</sub> impacts at all significant receptors within the SIA are below the corresponding NAAQS.

### **Increment Analysis**

In the PSD increment analysis, impacts within the facility’s SIA due to the potential PM<sub>10</sub> emissions from all sources at the facility and those PSD increment consuming sources included in the regional inventory were calculated.

The results of the PSD increment analysis are shown in Table 6-6.

**Table 6-6: Increment Analysis Results**

Pollutant	Averaging Period	Year	UTM East (km)	UTM North (km)	Maximum Impact (ug/m <sup>3</sup> )	Increment (ug/m <sup>3</sup> )	Exceed Increment?
PM <sub>10</sub>	24-hour	04/03/1989	253478	3590144	28.15	30	No
	Annual	1989	253478	3590144	5.51	17	No

Data for worst year provided only

Table 6-6 demonstrates that the impacts are below the corresponding increments for annual and 24 hour PM<sub>10</sub> concentrations.

## Ambient Monitoring Requirements

**Table 6-7: Significance Analysis Results – Comparison to Monitoring De Minimis Levels**

Pollutant	Averaging Period	Year*	UTM East (km)	UTM North (km)	Monitoring De Minimis Level ( $\mu\text{g}/\text{m}^3$ )	Modeled Maximum Impact ( $\mu\text{g}/\text{m}^3$ )	Significant?
NO <sub>2</sub>	Annual	1991	253127	3589276	14	0.77	No
PM <sub>10</sub>	24-hour	07/21/1989	251000	3594000	10	5.24	No
SO <sub>2</sub>	24-hour	02/27/1987	252600	3589100	13	4.47	No
CO	8-hour	08/09/1989	253100	3589400	575	27.31	No

Data for worst year provided only

The impacts for NO<sub>x</sub>, CO, SO<sub>2</sub>, and PM<sub>10</sub> quantified in Table 6-4 of the Class I Significance Analysis are compared to the Monitoring *de minimis* concentrations, shown in Table 6-7, to determine if ambient monitoring requirements need to be considered as part of this permit action. Because all maximum modeled impacts are below the corresponding de minimis concentrations, no pre-construction monitoring is required for NO<sub>2</sub>, PM<sub>10</sub>, SO<sub>2</sub>, or CO.

As noted previously, the VOC *de minimis* concentration is mass-based (100 tpy) rather than ambient concentration-based (ppm or  $\mu\text{g}/\text{m}^3$ ). Projected VOC emissions increases resulting from the proposed modification exceed 100 tpy; however, the current Georgia EPD ozone monitoring network (which includes monitors in the City of Macon will provide sufficient ozone data such that no pre-construction or post-construction ozone monitoring is necessary.

### Class I Area Analysis

Federal Class I areas are regions of special national or regional value from a natural, scenic, recreational, or historic perspective. Class I areas are afforded the highest degree of protection among the types of areas classified under the PSD regulations. U.S. EPA has established policies and procedures that generally restrict consideration of impacts of a PSD source on Class I Increments to facilities that are located near a federal Class I area. Historically, a distance of 100 km has been used to define “near”, but more recently, a distance of 200 kilometers has been used for all facilities that do not combust coal.

One Class I area is located within approximately 200 kilometers of the proposed cement plant, this is Okefenokee National Wildlife Refuge, located approximately 196 kilometers southeast of the facility. The U.S. Fish and Wildlife Service (FWS) is the designated Federal Land Manager (FLM) responsible for oversight of this Class I area.

The Federal Land Manager (FLM) granted HAC a waiver from the Class I air quality analysis based on the calculated Q/d of 8.8 for this particular combination of facility – class I area. Therefore, only a significant impact analysis was conducted to determine if PTE emissions from HAC would cause an impact that exceeds EPA’s Significant Impact Levels (SIL).

Such analysis was done using AERMOD model (version 07026), modeling PTE emissions of PM<sub>10</sub>, NO<sub>x</sub>, and SO<sub>2</sub> from the proposed Plant with 46 receptors, spaced 1 km from each other, and located at 50 kilometers downwind in direction to Okefenokee.

**Results – Class I Significance Analysis Results**

As indicated in Table 6-8 below, the significance levels are not exceeded for any of the pollutants.

**Table 6-8: Class I Significance Analysis Results – Comparison to SILs**

Pollutant	Averaging Period	Year	UTM East (km)	UTM North (km)	Maximum Impact (ug/m <sup>3</sup> )	SIL (ug/m <sup>3</sup> )	Significant?
NO <sub>2</sub>	Annual	1987	290307	3555649	0.024	0.1	No
PM <sub>10</sub>	24-hour	10/15/1990	289585	3554890	0.056	0.3	No
	Annual	1987	290307	3555649	0.005	0.2	No
SO <sub>2</sub>	3-hour	03/19/1989	281554	3548199	0.70	1.0	No
	24-hour	10/15/1990	289585	3554890	0.14	0.2	No
	Annual	1991	297214	3565052	0.0135	0.1	No

**Ozone Ambient Air Quality Analysis**

Since no significant air quality concentration for ozone has been established, PSD permit applicants with net emissions increase of 100 tons/year or more of VOC are required to perform an ambient impact analysis that includes pre-application monitoring data to determine the current state of the ambient air conditions for Ozone. HAC's plant wide VOC emissions are 273.75 TPY and therefore falls under this category of applicants.

HAC's analysis was based on ambient air monitoring data from monitoring station 130210012 located near Macon, in Bibb county, GA, approximately 27 miles northeast of HAC's facility. This station is operated by GA EPD and therefore it complies with EPA requirements of quality assurance, and data being current.

Concerning the site being representative of the area, although the distance of the monitoring station from the proposed facility is 30 miles, it should be considered that ozone is a secondary pollutant, thus not emitted from the facility's stacks, but formed in the atmosphere by chemical reactions during transport of emissions of NO<sub>x</sub> and VOC at some distance from the source. Therefore, HAC's contribution to Ozone concentrations would have to be estimated from measurements not in the surrounding area of the facility, but at some distance from there.

The eight-hour ozone standard is met when the fourth highest measured concentration over a period of three years is less than 0.085 ppm. Review of the monitored ozone data in the above mentioned station over the last three-year period (2005 – 2007) show a fourth highest value of 0.079 ppm, which leaves a significant margin from the standard.

On the other hand, CMAQ modeling conducted by GA EPD showed that sensitivity for ozone at this monitor (Bibb County) was of 0.4 ppt/TPD of VOC. Considering that HAC is located in the adjacent Houston County, the impact of its VOC emissions on the ozone concentration in the surrounding areas can be considered negligible and not likely to cause and excess in the 8 hour standard.

## 7.0 ADDITIONAL IMPACT ANALYSES

PSD requires an analysis of impairment to visibility, soils, and vegetation that will occur as a result of a modification to the facility and an analysis of the air quality impact projected for the area as a result of the general commercial, residential, and other growth associated with the proposed project.

### Soils and Vegetation

The effect of a proposed project's emissions on local soils and vegetation is often addressed through comparison of modeled impacts to the secondary NAAQS. The secondary NAAQS were established to protect general public welfare and the environment. Impacts below the secondary NAAQS are assumed to indicate a lack of adverse impacts on soils and vegetation. As discussed in Part 6.0 of this determination, the modeled ambient impacts associated with the proposed project are below the SILs. Therefore, no negative impacts on soils and vegetation are anticipated to result from the implementation of the proposed project.

### Growth

The purpose of a growth analysis is to predict how much new growth is likely to occur as a result of the project and the resulting air quality impacts from this growth. No adverse impacts on growth are anticipated from the project since any workforce growth and associated residential and commercial growth that would be associated with the proposed project (expected to be minimal) would not cause a quantifiable impact on the air quality of the area surrounding the facility.

### Visibility

Visibility impairment is any perceptible change in visibility (visual range, contrast, atmospheric color, etc.) from that which would have existed under natural conditions. Poor visibility is caused when fine solid or liquid particles, usually in the form of volatile organics, nitrogen oxides, or sulfur oxides, absorb or scatter light. This light scattering or absorption actually reduces the amount of light received from viewed objects and scatters ambient light in the line of sight. This scattered ambient light appears as haze.

Another form of visibility impairment in the form of plume blight occurs when particles and light-absorbing gases are confined to a single elevated haze layer or coherent plume. Plume blight, a white, gray, or brown plume clearly visible against a background sky or other dark object, usually can be traced to a single source such as a smoke stack.

Georgia's SIP and Georgia *Rules for Air Quality Control* provide no specific prohibitions against visibility impairment other than regulations limiting source opacity and protecting visibility at federally protected Class I areas. To otherwise demonstrate that visibility impairment will not result from continued operation of the cement plant, the VISCREEN model was used to assess potential impacts on ambient visibility at so-called "sensitive receptors" within the SIA of HAC as listed below. Since there is no ambient visibility protection standard for Class II areas, this analysis is presented for informational purposes only and predicted impacts in excess of screening criteria are not considered "adverse impacts" nor cause further refined analyses to be conducted.

- Snow Hill Airstrip, located 23 km southwest of HAC. Coordinates are UTM Easting 237431, Northing 3573042.
- Perry Fort Valley Airport, located 17.4 km northwest of HAC. Coordinates are UTM Easting 240028, Northing 3600459

- Miami Valley Farm Airstrip, located 22.5 km northwest of HAC. Coordinates are UTM Easting 236966, Northing 3604729
- Warner Robins Air Park, located 16.8 km northwest of HAC. Coordinates are UTM Easting 248690, Northing 3605748
- Hawkinsville Airport, located 22.7 km southeast of HAC. Coordinates are UTM Easting 270512, Northing 3574472

The primary variables that affect whether a plume is visible or not at a certain location are (1) quantity of emissions, (2) types of emissions, (3) relative location of source and observer, and (4) the background visibility range. For this exhaust plume visibility analysis, a Level-1 visibility analysis was performed using the latest version of the EPA VISCREEN model according to the guidelines published in the *Workbook for Plume Visual Impact Screening and Analysis* (EPA-450/4-88-015). The VISCREEN model is designed specifically to determine whether a plume from a facility may be visible from a given vantage point. VISCREEN performs visibility calculations for two assumed plume-viewing backgrounds (horizon sky and a dark terrain object). The model assumes that the terrain object is perfectly black and located adjacent to the plume on the side of the centerline opposite the observer.

In the visibility analysis, the total project NO<sub>x</sub> and PM<sub>10</sub> emissions increases were modeled using the VISCREEN plume visibility model to determine the impacts. For both views inside and outside the Class II area, calculations are performed by the model for the two assumed plume-viewing backgrounds. The VISCREEN model output shows separate tables for inside and outside the Class II area. Each table contains several variables: theta, azi, distance, alpha, critical and actual plume delta E, and critical and actual plume contrast. These variables are defined as:

1. *Theta* – Scattering angle (the angle between direction solar radiation and the line of sight). If the observer is looking directly at the sun, theta equals zero degrees. If the observer is looking away from the sun, theta equals 180 degrees.
2. *Azi* – The azimuthal angle between the line connecting the observer and the line of sight.
3. *Alpha* – The vertical angle between the line of sight and the plume centerline.
4. *delta E* – Used to characterize the perceptibility of a plume on the basis of the color difference between the plume and a viewing background. A delta E of less than 2.0 signifies that the plume is not perceptible.
5. *Contrast* – The contrast at a given wavelength of two colored objects such as plume/sky or plume/terrain.

The analysis is generally considered satisfactory if *delta E* and *Contrast* are less than critical values of 2.0 and 0.05, respectively, both of which are Class I, not Class II, area thresholds. The Division has reviewed the VISCREEN results presented in the permit application and determined that the visual impact criteria (*delta E* and *Contrast*) at the affected sensitive receptors are exceeded less than 1% of the time during a five year period, as a result of the proposed project. Therefore, a Level II analysis is required for these receptors.

A Level II analysis refines selected Level I input parameters by using representative wind speed and atmospheric stability conditions in the region encompassing both emission source and the sensitive receptor. In contrast, the Level I analysis assumed worst-case parameters (Pasquill-Gifford stability class F and wind speed of 1.0 meters per second) that are not necessarily indicative of local weather patterns that affect visibility when winds blow emission from the HAC's cement plant toward each of these sensitive receptors. For the Level II analysis, the representative meteorological conditions were determined by creating a joint frequency distribution of atmospheric stability and wind speeds during daylight hours (i.e., 7 am to 6 pm) for the period of 1984 to 1988 made from observations at City of Macon. This analysis indicated the combination of atmospheric stability and wind speed conditions at each sensitive receptor that is most likely to occur when the wind direction is such that plume impairment would potentially occur.

As an additional refinement to the Level II analysis, the NO<sub>x</sub> emission rate was scaled by 75% following the Ambient Ration Method to account for the conversion of NO<sub>x</sub> to NO<sub>2</sub> in the atmosphere, since the latter is the specific visibility-impairing species. All other parameters were input as Level I default options. A background visual range of 25 kilometers was used for HAC.

Table 7-1 below summarizes the calculated results for each airport (distance, azimuth and worst-case conditions for each year).

**TABLE 7-1. LEVEL II VISIBILITY ANALYSIS SUMMARY**

Airport	Quadrant from source	Shortest distance from source (km)	Azimuth (Degrees)	Meteorological Conditions				
				1984	1985	1986	1987	1988
<b>Snow Hill Airstrip</b>	SW	23.08	224.31	D4	D3	D3	D3	D3
<b>Perry Fort Valley</b>	NW	16.68	307.99	F3	E3	E4	E3	F3
<b>Miami Valley Farm</b>	NW	22.10	311.77	E4	D3	D3	E4	E3
<b>Warner Robins Air Park</b>	NW	16.64	342.48	E4	D3	E5	E4	E3
<b>Hawkinsville</b>	SE	22.15	132.33	F3	F3	F3	F3	F3

VISCREEN model was run for each airport under these conditions as well as with the worst-case conditions for the concatenated 5 years of meteorological data. All of the airports show compliance with the screening threshold criteria, which means that during the five-year period, the emissions plume from HAC may be perceived as visible from those sites less than 1% of the time.

The results of the Level II VISCREEN analysis show that the screening criteria are not exceeded at any of the sensitive receptors when evaluated using the Level II input parameters. Therefore, the proposed modifications to facility are not anticipated to cause adverse impacts on visibility at the sensitive receptors in the area surrounding the mill as listed in column one of Table 7-1.

Moreover, an analysis of the Class II increment inventory at the HAC's cement plant indicates that, since 1975, decreases in actual emissions of visibility-affecting pollutants from the facility far exceed any corresponding increases in potential emissions of these pollutants. Because the perception of industrial plumes has not been an issue in the past, this indicates there is little reason to expect visible industrial plumes from this site will be a substantial future issue.

### **Georgia Toxic Air Pollutant Modeling Analysis**

Georgia EPD regulates the emissions of toxic air pollutant (TAP) through a program covered by the provisions of *Georgia Rules for Air Quality Control*, 391-3-1-.02(2)(a)3.(ii). A TAP is defined as any substance that may have an adverse effect on public health, excluding any specific substance that is covered by a State or Federal ambient air quality standard. Procedures governing the Georgia EPD's review of TAP emissions as part of air permit reviews are contained in the agency's "*Guideline for Ambient Impact Assessment of Toxic Air Pollutant Emissions (Revised)*."

#### **Selection of Toxic Air Pollutants for Modeling**

For projects with quantifiable increases in TAP emissions, an air dispersion modeling analysis is generally performed to demonstrate that off-property impacts are less than the established Acceptable Ambient Concentration (AAC) values. The TAP evaluated are restricted to those that may increase due to the proposed project. Thus, the TAP analysis would generally be an assessment of off-property impacts due to facility-wide emissions of any TAP emitted by a facility. To conduct a facility-wide TAP impact evaluation for any pollutant that could conceivably be emitted by the facility is impractical. A literature review would suggest that at least one molecule of hundreds of organic and inorganic chemical compounds could be emitted from the various combustion units. This is understandable given the nature of the fuels (natural gas, coal, oils, wood wastes, spent tires, pet cokes, etc.) fed to the combustion sources, and the fact that there are complex chemical reactions and combustion of fuel taking place in some. The vast majority of compounds potentially emitted however are emitted in only trace amounts that are not reasonably quantifiable.

In the particular case of HAC, the main kiln stack controlled by a single baghouse was the single emission source of the following toxic air pollutants: Ag, As, Ba, Be, Cd, Cr, HCl, Cu, Hg, Ammonia, Pb, Se, Tl, Zn, Benzene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Formaldehyde, Phenanthrene, Pyrene, Naphthalene, and Chlorine. Emissions were calculated for each pollutant using appropriate AP-42 emission factors. In the particular case of HAC, the cement kiln using a fabric filter control system was the single emission source of the following toxic air pollutants: Ag, As, Ba, Be, Cd, Cr, HCl, Cu, Hg, Ammonia, Pb, Se, Tl, Zn, Benzene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Formaldehyde, Phenanthrene, Pyrene, Naphthalene, and Chlorine. Emissions were calculated for each pollutant using AP-42 emission factors with a fabric filter control system.

For each TAP identified for further analysis, both the short-term and long-term AAC were calculated following the procedures given in Georgia EPD's *Guideline*. Figure 8-3 of Georgia EPD's *Guideline* contains a flow chart of the process for determining long-term and short-term ambient thresholds. HAC referenced the resources previously detailed to determine the long-term (i.e., annual average) and short-term AAC (i.e., 24-hour or 15-minute). The AACs were verified by the EPD.

#### **Determination of Toxic Air Pollutant Impact**

The Georgia EPD *Guideline* recommends a tiered approach to model TAP impacts, beginning with screening analyses using SCREEN3, followed by refined modeling, if necessary, with ISCST3 or ISCLT3. For the refined modeling completed, the infrastructure setup for the SIA analyses was relied upon with appropriate sources added for the TAP modeling. Note that per the Georgia EPD's *Guideline*, downwash was not considered in the TAP assessment.

### Initial Screening Analysis Technique

Generally, an initial screening analysis is performed in which the total TAP emission rate is modeled from the stack with the lowest effective release height to obtain the maximum ground level concentration (MGLC). Note the MGLC could occur within the facility boundary for this evaluation method. The individual MGLC is obtained and compared to the smallest AAC. Due to the likelihood that this screening would result in the need for further analysis for most TAP, the analyses were initiated with the secondary screening technique.

Modeling was conducted using a generic emission rate of 1 g/sec for which a hypothetical predicted concentration was found. The Modeled Ground Level Concentration (MGLC) for each pollutant was then calculated multiplying the hypothetical predicted concentration by the ratio of the emission rates. SCREEN3 V96043 dispersion model was used for such analysis.

MGLCs calculated by SCREEN3 are 1-hour concentrations and therefore results were converted to annual, 24 hour, and 15 minutes averages in order to compare them to the corresponding acceptable ambient concentration (AAC) which were obtained from the following sources:

- EPA's Integrated Risk Information System (IRIS) as an inhalation reference concentration (RfC) or calculated as a risk based ambient concentration (RBAC).
- OSHA's Permissible Exposure Limits as timed weighted averages (TWA) or Ceiling limit.
- American Conference of Governmental and Industrial Hygienists (ACGIH) as short-term exposure limits (STEL).
- National Institute for Occupational Safety and Health (NIOSH) as STEL values.

The review process shows that emissions calculations, estimation of AACs, air dispersion modeling, and further calculation of MGLCs for each pollutant and averaging period, were properly done according to EPD's guidelines.

Comparison of MGLCs with their respective AAC show that the former are always below the latter and therefore in compliance with EPD's Guideline for Ambient Impact Assessment of Toxic Air Pollutant Emissions. Table 7-2 summarizes the results.

**TABLE 7-2. PROJECTED IMPACTS – AIR TOXICS**

POLLUTANT	CHRONIC (LONG TERM)			ACUTE (SHORT TERM) Averaging period of 15 minutes	
	Averaging Period	MGLC ( $\mu\text{g}/\text{m}^3$ )	AAC ( $\mu\text{g}/\text{m}^3$ )	MGLC ( $\mu\text{g}/\text{m}^3$ )	AAC ( $\mu\text{g}/\text{m}^3$ )
Ag	24 hour	1.44E-6	2.37E-2	NA	NA
As	Annual	2.83E-5	2.4E-4	3.8E-4	2.0E-1
Ba	24 hour	1.09E-3	1.19	NA	NA
Be	Annual	6.25E-7	4.0E-4	8.39E-6	5.0E-2
Cd	Annual	5.19E-6	6.0E-4	6.97E-5	30
Cr	24 hour	3.3E-4	2.37	NA	NA
HCl	Annual	3.3E-1	20	4.44	298
Cu	24 hour	1.25E-2	2.37	NA	NA
Hg	Annual	2.83E-4	3.0E-1	3.8E-3	10
Ammonia	Annual	2.36E-2	100	3.17E-1	2400
Pb	24 hour	1.77E-4	1.19E-1	NA	NA
Se	24 hour	4.72E-4	4.75E-1	NA	NA
Tl	24 hour	1.27E-5	2.37E-1	NA	NA
Zn	24 hour	8.02E-4	11.9	1.08E-2	1000
Chlorine	24 hour	2.026E-2	3.6	6.69E-2	300

POLLUTANT	CHRONIC (LONG TERM)			ACUTE (SHORT TERM) Averaging period of 15 minutes	
	Averaging Period	MGLC ( $\mu\text{g}/\text{m}^3$ )	AAC ( $\mu\text{g}/\text{m}^3$ )	MGLC ( $\mu\text{g}/\text{m}^3$ )	AAC ( $\mu\text{g}/\text{m}^3$ )
Benzene	Annual	3.77E-2	1.3E-1	5.07E-1	320
Benzo(a)pyrene	24 hour	3.07E-7	4.75E-1	NA	NA
Benzo(b)fluoranthene	24 hour	1.32E-6	4.75E-1	NA	NA
Benzo(g,h,i)perylene	24 hour	1.84E-7	4.75E-1	NA	NA
Benzo(k)fluoranthene	24 hour	3.54E-7	4.75E-1	NA	NA
Chrysene	24 hour	3.77E-7	4.75E-1	NA	NA
Formaldehyde	Annual	1.09E-3	8.0E-2	1.46E-2	37
Phenanthrene	24 hour	9.2E-4	4.75E-1	NA	NA
Pyrene	24 hour	1.04E-5	4.75E-1	NA	NA
Naphthalene	Annual	4.01E-3	3.0	5.39E-2	7500

## **8.0 EXPLANATION OF DRAFT PERMIT CONDITIONS**

The permit requirements for this proposed facility are included in draft Georgia Air Quality Permit No. 3241-153-0056-P-01-0.

### **Section 1.0: Facility Description**

This greenfield/new source is a dry process Portland cement plant capable of producing 1,095,000 short tons of clinker and 1,171,650 short tons of cement per year. The plant consists mainly of an on-site limestone-clay quarry, raw material handling and storage, kiln feed preparation with a raw mill, a dry process rotary kiln coupled with a preheater/precalciner and a calciner, a clinker cooler, a coal mill, a finish mill, and cement storage, packaging and shipping operations. The production process begins with quarrying of limestone and clay, and crushing of the limestone. Then the raw materials such as limestone, clay, fly ash and other additives are mixed according to specification, grinded and dried in the raw mill. The powdery material produced by the raw mill, referred to as dry/kiln feed, is then conveyed into the preheater/precalciner, calciner, and kiln in turn for pyroprocessing into cement clinker nodules. The clinker nodules are cooled in the clinker cooler and then mixed and grinded with limestone, gypsum and/or other additives as necessary in the finish mill to formulate Portland cement. The kiln system has a capacity of 229 short tons per hour of dry feed input to the preheater/precalciner, and 125 short tons per hour of clinker output from the kiln. The finish mill can produce 150 short tons per hour of Portland cement. Cement produced is stored or packaged as necessary, and distributed by both truck and rail.

Raw materials for the kiln system include limestone, clay, iron ore/mill scale (or other iron sources) and bauxite/fly ash (or other alumina sources), gypsum, either quarried on-site (limestone and clay) or brought in by both truck and freight train.

Fuel authorized for the kiln include natural gas, coal, petroleum coke, fuel oils, landfill gas, and other non-hazardous liquid and solid fuels such as “on-specification” used oil fuels, plastic, filter fluff and wood wastes. A coal mill grinds up to 205,618 short tons of coal and petroleum coke annually for firing the kiln. Emissions of regulated air pollutants from combustion of each fuel are evaluated via performance tests before the fuel authorization.

The facility uses NH<sub>3</sub> solution-injection based SNCR in combination with SCC and low NO<sub>x</sub> burners to minimize NO<sub>x</sub> emissions from the in-line kiln/raw mill. Fabric filters/baghouses are employed to capture PM emitted from exhaust stacks serving various process units in the plant. Wet suppression/water spray and other precautions are utilized as necessary to reduce fugitive emissions from the quarry operations and the material handling processes. An hydrated lime injection system is used as necessary to comply with SO<sub>2</sub> emission limits. The in-line kiln/raw mill system is also designed and operated to minimize emissions of CO and VOC via controlled combustion, and SO<sub>2</sub> via raw material management and hydrated lime injection.

### **Section 2.0: Requirements Pertaining to the Entire Facility**

Conditions 2.1.1 through 2.1.6 are standard SIP facility-wide general requirement permit conditions for good work practice to minimize emissions, prevention of emission dilution, application submittal, permit amendment, condition governances, and facility ownership change.

The ambient impacts of the criteria and gaseous toxic air pollutants emitted from this facility were assessed using atmospheric dispersion models and determined to be acceptable under pertinent NSR/PSD and SIP rules. Condition 2.1.7 ensures these impacts remain acceptable to the Division.

Condition 2.1.8 requires the Permittee to obtain a Title V permit. Conditions 2.1.9 explains mainly the circumstances for permit expiration and permit extension under NSR/PSD rule. Please note that the BACT determination(s) in this permit may have time limit.

Condition 2.1.10 remind the Permittee to comply with the most current rule(s) in effect after the issuance of this permit.

Conditions 2.2.1 through 2.2.5 establish facility-wide annual/rolling 12-month emission limits for CO, PM/PM<sub>10</sub>, NO<sub>x</sub>, SO<sub>2</sub>, and VOC. All are PSD/BACT limits and have acceptable ambient impacts.

The facility-wide annual/rolling 12-month emission limit for Hg in Condition 2.2.6 confirms that the Hg emissions are below the NSR/PSD significant level and thus not subject to BPSD/BACT review.

### **Section 3.0: Requirements for Emission Units**

Because most of the PSD/BACT emission standards in this permit are based on quantity of clinker produced, Condition 3.2.1 limits the hourly and annual clinker production rates to establish the potential capacity of the cement plant during this initial PSD permitting. Any production rate increases above these limits will be subject to a EPD review.

The ambient impacts of the criteria and toxic gaseous air pollutants emitted from this cement plant have been assessed using atmospheric dispersion models and determined to be acceptable under pertinent NSR/PSD and SIP rules. Condition 3.2.2 ensures these impacts to remain acceptable to the Division by fixing the stack exiting conditions because this stack accounts for all the emissions of the criteria and toxic gaseous air pollutants and approximately half of the PM/PM<sub>10</sub> emissions from this cement plant.

Emissions from the kiln system are affected by the various fuel combustion processes occurring at different locations of the kiln system. Condition 3.2.3 contains detailed firing requirements which are designed to minimize emissions from the kiln. These requirements intend to maintain the kiln combustion conditions the same as those utilized during the performance testing and thus the levels and/or characteristics of the emissions. The condition limits the use of used oil as fuel to "on-specification" used oil fuel which is not regulated as hazardous waste and shall meet the content limits as specified. The annual usage limit for the "on-specification" used oil fuels ensures the emissions of heavy metals and toxic compounds involved to stay below the applicable significant levels under pertinent NSR and/or NESHAP rules. HAC shall conduct performance testing on any new fuels which may affect any emissions adversely and demonstrate to the Division that the effect on the emissions is within the acceptable level.

Condition 3.2.4 incorporates operating and process and control equipment requirements for compliance with the BACT emission limits in this permit. These requirements are considered as part of the BACT for the emission control devices involved. The requirements also include O&M and work practice plans to ensure proper function of the process and control equipment involved and the normal operation.

Condition 3.2.5 requires the continuous monitoring of the pressure drops across the large baghouses with air flow rate greater than 10,000 acfm. This requirement ensures the pressure drops to be maintained at the levels or inside the ranges established during the most recent Division-approved performance testing, or HAC shall report any deviation as an excursion. This requirement ensure the maintenance of the capture efficiencies of the baghouses at or greater than the testing levels.

Without an alkali bypass, HAC's kiln will not be subject to certain NSR/PSD and NESHAP requirements and/or standards. Condition 3.2.6 requires permit amendment to add conditions containing the applicable requirements and/or standards when HAC decides to add the alkali bypass.

Condition 3.2.7 ensures the proper function and quick repair of the pollution systems. To reduce emissions and thus to comply with pertinent emission limits, Conditions 3.2.10 through 3.2.13 establish the pollution control and prevention requirements for the on-site quarry and associated activities. Recent permits issued by the Division to similar sources contain same requirements.

Conditions 3.2.14 through 3.2.22 incorporate mainly the applicable operating requirements and limitations under 40 CFR Part 63, Subpart LLL, i.e., the NESHAP MACT standard for Portland cement industry. As a new source, HAC shall comply with all the applicable emission standards and other requirements under Subpart LLL on and after initial startup, as specified in Condition 3.2.15. Condition 3.2.16 identifies affected operations/process units subject to Subpart LLL. Condition 3.2.17 prohibits the use of hazardous wastes as kiln fuels and thus allow the kiln to avoid being subject to 40 CFR Part 63, Subpart EEE, the NESHAP MACT standards for hazardous waste combustors. Because high temperature would increase D/F emissions, Condition 3.2.18 limits the temperature at the main kiln stack to ensure compliance with the D/F emission limit. Condition 3.2.19 ensure the compliance with the Hg emission limits by prohibiting the use as a raw material or fuel of Hg-rich fly ash generated by activated carbon Hg control systems employed by boilers.

Conditions 3.2.23 through 3.2.25 incorporate applicable operating requirements and limitations for the 750 kW emergency stationary diesel engine/generator under 40 CFR Part 60, Subpart IIII, the NSPS standard for stationary compression ignition internal combustion engines. HAC shall purchase the engine certified for compliance with all the applicable emission standards.

Conditions 3.2.26 and 3.2.27 contain applicable operating and notification requirements for the emergency stationary diesel engine/generator under 40 CFR Part 63, Subpart ZZZZ, the NESHAP MACT standard for stationary reciprocating internal combustion engines.

Condition 3.3.1 establishes the equipment/source and/or emission-specific BACT emission standards, and corresponding compliance methods and data average time if applicable. Please note that the main kiln stack (stack No. ST35) accounts for all the CO, NO<sub>x</sub>, SO<sub>2</sub>, and VOC and approximately half of the PM/PM<sub>10</sub> emissions from the entire plant, and consequently is required to be equipped with CEM for CO, NO<sub>x</sub>, SO<sub>2</sub>, and VOC (as THC) emissions and COM for visible emissions. The CEM and COM greatly enhance the emission monitoring and compliance by continuously providing relatively accurate real time emission data. The constant emission data feedback also allow timely optimization or adjustment of the operation of the kiln system to minimize the emissions involved.

Because it takes time to shakedown and optimize the complicated operation of the kiln system and the SNCR, Condition 3.3.1 allows a relative high NO<sub>x</sub> emission limit during the initial startup period as defined in the condition, a provision contained in the PSD permits issued recently to similar cement plants by the State of Florida. All the limits for criteria pollutants emitted from the main kiln stack are based on pounds of the pollutant per ton of clinker, the most common unit for the standards involved among permits issued to cement plants. PM/PM<sub>10</sub> emission from other point sources/stacks have identical emission limits in the unit of grain loading/concentration, which is also the most common among permits issued to cement plants or similar sources.

Other applicable SIP emission standards for PM, sulfur dioxide and fugitive emissions are subsumed by more stringent BACT limits in Condition 3.3.1.

Conditions 3.3.2 and 3.3.3 specifies respectively the affected sources at HAC and the applicable emission limit under 40 CFR Part 60, Subpart Y, the NSPS standard for coal preparation plants. Except the 20% opacity visible limit, the coal mill stack is also subject to the more stringent PM/PM<sub>10</sub> and visible emissions limits under BACT. Because a small portion of exhaust gas stream from the clinker cooler is routed the coal mill for drying the coal, this unit is also subject to the Subpart LLL.

Conditions 3.3.4 through 3.3.6 incorporate applicable emission limits under 40 CFR Part 63, Subpart LLL, the NESHAP MACT standards for Portland cement manufacturing industry. Because the kiln and the clinker share a single stack, i.e., the main kiln stack, this stack assumes the more stringent PM and visible emissions of the clinker cooler. The coal mill stack No. ST38 is subject to the same PM and visible emission limits as applicable to the main kiln stack No. ST35 because a small portion of exhaust gas stream from the clinker cooler is routed the coal mill for drying the coal. The coal mill stack only has PM/PM<sub>10</sub> and no D/F, Hg or VOC emissions and thus is not subject to the emissions limits for D/F, Hg or VOC emissions under Subpart LLL.

Condition 3.3.7 establishes the applicable emission limits for HAC's process units/operations which are subject to the 40 CFR Part 60, Subpart OOO, the NSPS standard for nonmetallic mineral processing plants. This is one of the standard conditions in EPD's condition vault. Please notice that according to HAC's application, the on-site quarry and associated material storage and conveying operations only have fugitive emissions. Therefore, Condition 3.3.7b and 3.3.7e do not apply.

Conditions 3.3.8 and 3.3.9 incorporate the applicable emission and fuel standards for the emergency stationary diesel engine/generator under 40 CFR Part 60, Subpart IIII, the NSPS standard for stationary compression ignition internal engines. The manufacturer of the engine is required to certify with EPA that the engine is in compliance with applicable emission limits before selling the engine. Please note that the diesel to be used by the engine is subject to sulfur and cetane index or aromatic content standards which become more and more stringent with later compliance date.

Condition 3.4.1 incorporate applicable operating requirement for reducing or preventing fugitive emissions from HAC's cement manufacturing plant. Other applicable state emission standards for PM, sulfur dioxide and fugitive emissions are subsumed by the more stringent BACT limits in Condition 3.3.1.

#### Section 4.0: Requirements for Testing

Condition 4.1.1 lists applicable methods for performance testing and monitoring of the emissions from this facility. Conditions 4.1.2 through 4.1.5 contain standard requirements with regard to the continuous monitoring system(s) to be used during the testing, the production rate during the testing, the notification of the testing, and the reporting of the testing results.

Conditions 4.2.1 through 4.2.13 incorporate the applicable testing requirements and/or procedures under 40 CFR part 63, Subpart LLL. The initial performance tests for PM, D/F and VOC/THC emissions shall be conducted separately while the raw mill is in normal operation and shutdown because the operating status of the raw mill may affect such emissions. Certified and calibrated CEM and COM shall be used in the testing wherever equipped with. Method 5 testing and visible emission testing with COM shall be conducted simultaneously on the main kiln stack and the finish mill stack, as required in Condition 4.2.3. Method 9 shall be used for other affected sources. Conditions 4.2.5, 4.2.6 and 4.2.7 require separate performance testing for the D/F, VOC/THC and Hg emissions on the main kiln stack, the only source for such emissions. Conditions 4.2.8 and 4.2.9 require for follow up testing on the PM and visible emission (every 5 years) and Hg emission (every 30 months) respectively. Conditions 4.2.10 through 4.2.13 establishes the retesting requirements for the similar emission from similar source whenever a source modification may adversely affect compliance with the applicable emission limit(s). HAC shall notify the Division of the retesting of the D/F emissions 60 days in advance and complete the retesting within 360 hours after the planned modification period begins. Condition 4.2.13 exempt HAC from the applicable PM and visible emission standards or operating requirements when conducting PM CEM correlation tests to prepare for the use of the PM CEM.

Condition 4.2.14 requires HAC to use Method 9 to conduct initial performance testing on the visible emissions from the sources subject to 40 CFR Part 60, Subpart Y.

Conditions 4.2.15 through 4.2.19 incorporate applicable testing requirements for the visible and fugitive emissions from the sources subject to 40 CFR Part 60, Subpart OOO. Condition 4.2.16 and 4.2.17 allow shortened testing when the emission meet certain conditions. Condition 4.2.18 allow an alternative testing procedure when the fugitive emissions from two or more sources continuously interfere with each other.

Conditions 4.2.20 through 4.2.22 establish the initial performance testing requirements for sources and/or emissions subject to PSD/BACT emission standards. No such testing is required when a testing pursuant to Subpart LLL has already been conducted for the same emissions from the same source under the same operating conditions. Testing using Method 201 or 201A in conjunction with Method 202 may be required when the PM emission rate(s) from Method 5 exceed the PM<sub>10</sub> emission limit from the same source(s). Condition 4.2.21 requires initial performance testing on CO, NO<sub>x</sub> and SO<sub>2</sub> emissions from the main kiln stack No. ST35, the only stack discharging such emission. Affected by the operating status of the raw mill, the SO<sub>2</sub> emissions shall be tested when the raw mill is in normal operation and when it is shutdown respectively. HAC shall record all operating parameters and other production information and/or data affecting the emissions and/or required in the determination of emissions involved in the same units as the relevant PSD/BACT emission limits.

Firing of new fuels may have adverse effects on the emissions from the kiln system. Condition 4.2.22 requires performance testing for firing any new fuel before the fuel use authorization. A permit amendment may be required to establish new or revised operating and, if necessary, emission requirements for the use of the new fuel(s). A Part 70 permit amendment issued recently to a similar cement plant by the Division contains similar testing requirements for the use of new fuels.

#### Section 5.0: Requirements for Monitoring

Condition 5.1.1 contain general requirements for the operation of CEM. Conditions 5.2.1 through 5.2.9 incorporate applicable monitoring requirements under NESHAP MACT Standard 40 CFR Part 63, Subpart LLL. The daily visible emission test/observation required by Condition 5.2.1d.i and Condition 5.2.3 may substitute the daily VE check in Condition 5.2.12 for that day. Condition 5.2.4 requires continuous monitoring of the exhaust gas temperature at the main kiln stack as the surrogate of the D/F emissions. The hourly average THC emission data generated by the THC CEM will be used to demonstrate compliance with the THC/VOC limit in Condition 3.3.4, and as basis to calculate the THC/VOC emissions to demonstrate compliance with other BACT THC/VOC emission limits in this permit.

Condition 5.2.10 incorporates the applicable monitoring requirement under NSPS 40 CFR Part 60, Subpart IIII for the use of a non-resettable hour meter installed on the emergency stationary diesel generator/engine to track the operating time of the generator. HAC shall record the time of operation of the generator/engine and the nature of the operation during that time.

Condition 5.2.11 assumes some appropriate monitoring requirements for PM, THC, and visible emissions as PSD/BACT monitoring requirements for the same emissions to reduce redundant monitoring work.

Conditions 5.2.12 and 5.2.13 establish daily visible emission (VE) check requirements for point/stack sources with visible emissions and for sources with fugitive emissions. Representing a BACT requirement, Condition 5.2.12 is more stringent than the similar VE daily check condition in SIP standard condition vault.

Condition 5.2.14 establishes PSD/BACT monitoring requirements for CO, NO<sub>x</sub>, SO<sub>2</sub> and THC/VOC emissions from the main kiln stack, the only source for these emissions at this cement plant. The operating, instrumental and data processing requirements are extracted from pertinent SIP and/or Federal rules or procedures, and by no means to substitute the original rules or procedures. Please refer to the original documents for details.

Condition 5.2.15 establishes monitoring requirements for a number of operating parameters and mass inputs for certain process and pollution control systems which are either needed in the emission calculations for demonstration of compliance with applicable emission limits, or necessary to maintain compliance with the emission limits.

Condition 5.2.16 incorporates the applicable maintenance requirements for the CEM used. These requirements are extracted from pertinent SIP and Federal rules or procedures, and by no means substitute the original rules or procedures. Please refer to the original documents for details.

Based on Condition 5.2.17 specifies the manual reading requirements when CO, NO<sub>x</sub>, SO<sub>2</sub> or THC/VOC CEM is not available during the breakdowns, repairs, calibration checks, and zero and span adjustments. These requirements are extracted from pertinent SIP and Federal rules or procedures, and by no means substitute the original rules or procedures. Please refer to the original documents for details.

Condition 5.2.18 establishes the monitoring requirements for the dust/fugitive emission suppression systems, as contained in permits issued to similar sources.

Condition 5.2.19 establishes the monitoring and route inspection and maintenance requirements for baghouses not required to have continuous monitoring system for pressure drop across the baghouse. These are relatively small baghouses with air flow rates less than 10,000 acfm.

#### Section 6.0: Other Recordkeeping and Reporting Requirements

Conditions 6.1.1 through 6.1.6 contain respectively general requirements for the record keeping type and duration, reporting of deviations, excess emissions, exceedances, or excursions, quarterly report, sampling records, and record keeping of measurements for monitoring systems (monitoring, calibration, adjustment and maintenance) and performance testing.

Condition 6.1.7 incorporates the applicable reporting requirements for excess emissions, exceedances, excursions or additional information to be included in the PSD/BACT quarterly reports required by Condition 6.1.4. The reporting levels of the emissions specified in Condition 6.1.7d serve as an “early warning” system to facilitate emission compliance.

Conditions 6.2.1 through 6.2.7 incorporate the applicable record keeping, notification, compliance demonstration and reporting requirements for affected cement manufacturing processes/units under 40 CFR Part 63, Subpart LLL. If necessary and/or appropriate, these requirements could be considered also as PSD/BACT requirements for the same sources and/or emissions, unless there is specific PSD/BACT requirement(s).

Conditions 6.2.8 and 6.2.9 incorporate respectively the record keeping, compliance demonstration, reporting and notification requirements for the on-site quarry operations under 40 CFR Part 60, Subpart OOO. The facility startup notification establishes the time frames for requirements such as compliance, testing, record keeping, and/or reporting.

Conditions 6.2.10 and 6.2.15 incorporate respectively the record keeping, compliance demonstration, reporting and notification requirements for the emergency stationary diesel generator/engine under 40 CFR Part 60, Subpart IIII. The facility startup notification establishes the time frames for requirements such as compliance, testing, record keeping, and/or reporting.

Conditions 6.2.16 through 6.2.19 establish respectively the record keeping, emission calculation/compliance demonstration, reporting and notification requirements for the cement manufacturing processes/units subject to the PSD/BACT emission limits under pertinent NSR/PSD rules. The reporting levels of the emissions specified in Condition 6.2.17 serve as an “early warning” system to facilitate emission compliance.

Please note that the control efficiency of a well designed, maintained and operated baghouse is largely insensitive to the physical characteristics of the gas and dust and to the inlet dust loading.<sup>2</sup> Therefore, the actual PM/PM<sub>10</sub> emissions obtained by multiplying the emission factors (lbs./ton of clinker) from performance testing with the actual tonnage of clinker produced during averaging period may be less or more conservative when the clinker production rate is below or above that used during the performance testing, assuming a steady exhaust flow rate. Nevertheless, this is the most common approach for emission estimation, as seen in many chapters of AP-42, including that for cement manufacturing industry. Another approach is to assume that during normal operation of the process units and control systems involved, the PM/PM<sub>10</sub> emission concentrations (gr/dscf) in the exhaust gas stream is constant and equal to that during the performance testing under the similar operating conditions. Therefore, the actual PM and PM<sub>10</sub> emission rates in lbs/ton of clinker could be estimated by dividing respectively the total emissions of PM and PM<sub>10</sub> with the total clinker produced during the same averaging period. This approach is more in line with the characteristic of the baghouses. For the purpose of compliance demonstration, the more conservative between the two approaches should be considered first. Once deployed, the PM CEM should generate the most accurate PM emission data among all via continuous real time analysis of the PM emissions.

For emissions of CO, NO<sub>x</sub>, SO<sub>2</sub>, and THC as monitored continuously by the respective CEM, the actual emission rates for these pollutants shall be calculated respectively by using the actual concentration of each pollutant in the exhaust gas and the corresponding exhaust gas flow rate and clinker production rate during the averaging period interested.

Condition 6.2.20 require HAC to keep records of water truck usage, a provision contained in permits issued to similar sources by the Division.

The fuel records required by Condition 6.2.21 ensure the compliance with the fuel use limit for the air heater specified in Condition 3.2.3f.

The emission and fuel usage data and combustion system inspection information required by Condition 6.2.22 facilitate the Division to examine mainly the emissions periodically or track the emissions on a route basis. Similar requirements are included in the permit issued to an existing similar cement plant by the Division.

The facility startup notification requirement in Condition 6.2.23 establishes the time frames for PED/BACT requirements such as compliance, testing, record keeping, and/or reporting.

APPENDIX A

Draft Construction Permit  
Houston American Cement Plant  
Perry (Houston County), Georgia

## APPENDIX B

### Houston American Cement Company PSD Permit Application and Supporting Data

#### Contents Include:

1. PSD Permit Application No. 17509, dated June 25, 2007

## APPENDIX C

EPD'S PSD Dispersion Modeling and Air Toxics Assessment Review