TECHNICAL EVALUATION

PRELIMINARY DETERMINATION

DRAFT BACT DETERMINATIONS

CEMEX CEMENT COMPANY
BROOKSVILLE, HERNANDO COUNTY

New Portland Cement Line

DEP File No. 0530010-029-AC (PSD-FL-384)

Department of Environmental Protection
Division of Air Resources Management
Bureau of Air Regulation

April 3, 2007

I. APPLICANT NAME AND ADDRESS

CEMEX Cement, Inc.
Brooksville Cement Plant
16301 Ponce de Leon Blvd.
Brooksville, Florida 34601

Authorized Representative
Michael A. Gonzales, Plant Manager
Post Office Box 6
Brooksville, Florida 34605-0006

II. FACILITY INFORMATION

A. FACILITY LOCATION

The CEMEX Brooksville Cement Plant is located on Highway 98, northwest of Brooksville in Hernando County. The UTM coordinates referenced to the stack for a proposed new kiln are Zone 17, 356.1 km East and 3169.3 km North. The following figure shows the location of the facility, the nearby Chassahowitzka National Wildlife Refuge (NWR) and an aerial photograph of the facility.

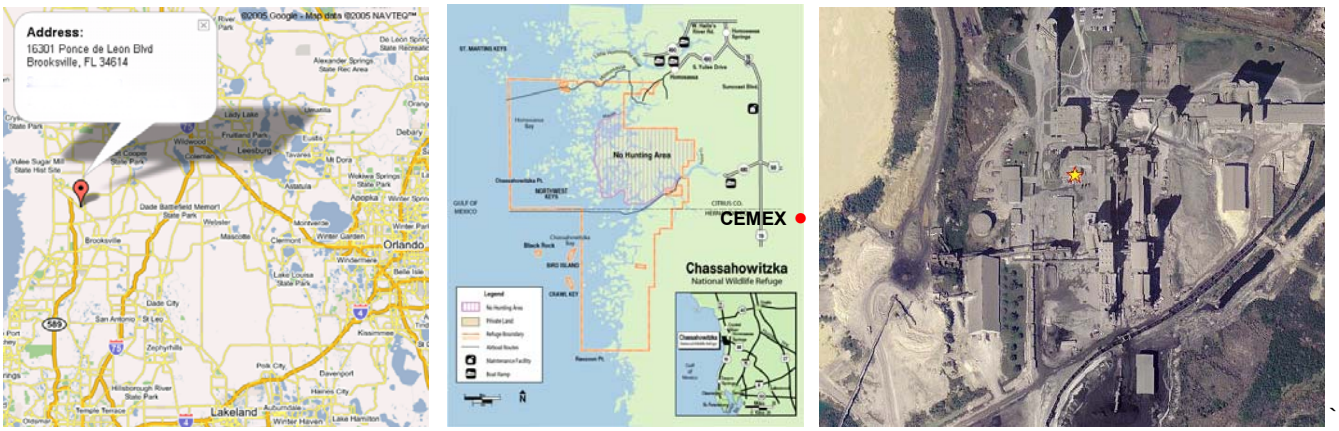


Figure 1. Location of CEMEX Brooksville Cement Plant, Chassahowitzka NWR, Aerial Photo

The proposed kiln stack reference point is less than 15 kilometers east from the Chassahowitzka NWR that is the nearest Class I Area with the respect to the Rules for the Prevention of Significant Deterioration of Air Quality (PSD).

B. FACILITY CLASSIFICATION CODE (SIC)

Major Group No. 32, Clay, Glass, and Concrete Products
Industry Group No. 324 Cement, Hydraulic
Industry No. 3241 Cement, Hydraulic

C. FACILITY CATEGORY

The following regulatory classifications apply to the subject facility:

Title I, Section 111, Clean Air Act (CAA): This facility is subject to certain Standards of Performance for New Stationary Sources. They are adopted and incorporated by reference in Rule 62-204.800, F.A.C. These include:

- 40 CFR 60, Subpart A - General Provisions.

- 40 CFR 60, Subpart F - Standards of Performance for Portland Cement Plants. Certain requirements from Subpart F are replaced by requirements from 40 CFR 63, Subpart LLL listed below.
- 40 CFR 60, Subpart Y - Standards of Performance for Coal Preparation Plants.
- 40 CFR 60, Subpart OOO - New Source Performance Standards For Nonmetallic Mineral Processing Plants.

Title I, Section 112 CAA: The facility has the potential to emit 10 tons per year or more of any one hazardous air pollutant (HAP) or 25 tons per year or more of any combination of HAPs. This facility is subject to the Major Source provisions of:

- 40 CFR 63 Subparts A - National Emission Standards for Hazardous Air Pollutants – General Provisions.
- 40 CFR 63, Subpart LLL - National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry.

Title I, Part C: The facility is located in an area designated as "attainment", "maintenance", or "unclassifiable" for each pollutant subject to a National Ambient Air Quality Standard. The facility is considered a "portland cement plant", which is one of the 28 Prevention of Significant Deterioration (PSD) source categories with the lower PSD applicability threshold of 100 tons per year. Potential emissions of at least one regulated pollutant exceed 100 tons per year. Therefore, the facility is classified as a PSD-major source of air pollution with respect to Rule 62-212.400, F.A.C., Prevention of Significant Deterioration.

Title IV, CAA: The facility does not operate any units subject to the Acid Rain provisions of the Clean Air Act.

Title V, CAA: The facility is a Title V or "Major Source" of air pollution because the potential emissions of at least one regulated pollutant exceed 100 tons per year or because it is a major source of HAPs. Regulated pollutants include pollutants such as carbon monoxide (CO), nitrogen oxides (NO_X), particulate matter (PM/PM_{10}), sulfur dioxide (SO_2), and volatile organic compounds (VOC).

State Rules: The cement plant is subject to state Rule 62-296.407, F.A.C. (Portland Cement Plants).

Given that the facility is a Major Stationary Source with respect to the PSD regulations, then project emissions greater than 40 TPY of NO_X, VOC or SO_2, 7 TPY of sulfuric acid mist (SAM), 25/15 TPY of PM/PM_{10}, 3 TPY of fluorides, 0.1 TPY of mercury (Hg) or 1200 pounds per year (lb/yr) of lead (Pb) also require review pursuant to the PSD rules. Pollutants triggering these values require a determination of Best Available Control Technology (BACT) per Rule 62-212.400, F.A.C.

III. EXISTING FACILITY DESCRIPTION

The existing Brooksville portland cement plant consists of two lines (Lines 1 and 2). Lines 1 and 2 include Polysius GEPOL preheater kilns (Kilns 1 and 2) and clinker cooler (Coolers 1 and 2). A picture of one of the kilns with preheater tower and raw meal homogenizing silo can be seen in Figure 2. Lines 1 and 2 are separately permitted with respect to preheater material feed rates and fuel heat input rates. Ancillary equipment at the plant includes a quarry, raw material handling and conveying equipment, raw mills, finish mills, cement and clinker handling equipment, coal handling equipment and silos, and particulate control/dust collection and recycling equipment.

Large, fabric filter systems (baghouses) are used to capture particulate matter (PM) from each kiln and from each clinker cooler (four total). Smaller baghouses are used to limit particulate emissions from other process emissions points. Raw material properties, chemical reactions in the kilns, absorption into the clinker, and combustion controls minimize emissions of NO_X, SO_2, CO, and VOC. Further NO_X control is provided by recently installed Pillard Low NO_X main kiln burners and selective non-catalytic reduction (SNCR) systems.

Figure 2. Preheater Kiln 1 and Homogenizing Silo. Top of Preheater for Kiln 2 in Background.

Both CEMEX Brooksville kilns are limited to 150 tons dry preheater feed per hour (30 day average) with a maximum of 165 tons preheater feed in any given hour. Both kilns are permitted to burn a variety of fuels, including coal, No. 2 fuel oil, No. 4 fuel oil, No. 5 fuel oil, No. 6 fuel oil, natural gas, and on-site generated, non-hazardous waste used oil, grease, and rags. Kiln No. 1 is also permitted to fire whole tire derived fuel (TDF) at a rate up to 20 percent of the total heat input.

IV. PROPOSED PROJECT

CEMEX proposes to construct a dry process portland cement line (Line 3, also called Kiln 3) at the existing Brooksville Cement Plant. Major equipment will include:

- Additional raw material receiving, handling, storage, proportioning and conveyance equipment;
- A pyroprocessing system with a nominal capacity of 3,850 tons per day (TPD) of clinker and consisting of a kiln with a preheater and calciner, an in-line raw mill, a homogenizing silo, and a very large (main) baghouse and stack;
- A coal and petroleum coke mill;
- A clinker cooler with a baghouse and stack;
- Product additive storage and proportioning equipment;
- A finish mill equipped with a high efficiency separator and associated equipment;
- Additional clinker and cement silos;

- An expanded cement packhouse and shipping facility;
- An ammonia injection system to reduce NO_X from the pyroprocessing system;
- Continuous emissions monitoring systems to measure NO_X, SO_2, CO, VOC and Hg; and
- Continuous opacity monitoring systems (COMS) on the main stack and clinker cooler stack.

V. CEMENT MANUFACTURING PROCESS DESCRIPTION

Some of the following description is from the Portland Cement Association and the Cement Association of Canada. The rest was developed by the Department or provided by the applicant.

A. CONCRETE AND CEMENT

Concrete is the familiar material used in construction. It is a mixture of portland cement, water and aggregates such as crushed stone, sand, and gravel. The cement and water comprise a paste that coats the surfaces of the aggregates and then hardens by chemical reaction know as hydration to form the familiar rock-like material known as concrete. The following figure depicts the proportions of the various components of concrete. Portland cement, the key ingredient, constitutes only 11 percent (%) or so of the concrete mix.

Figure 3. Components of Concrete Mix (Portland Cement Association, Cement Association of Canada)

Cement is a chemical combination of calcium, silicon, aluminum, iron and small amounts of other ingredients to which gypsum and other ingredients are added in the final grinding process. Lime and silica make up about 85% of the mass. The main raw materials for Line 3 are of quarried limestone, clay, sand, bauxite, mill scale and fly ash. Materials interground with or added to the clinker will include limestone dust, gypsum and slag.

B. HOW CEMENT IS MADE

Simply stated, the raw materials used to manufacture cement are ground, mixed, dried, heated and then sintered in a rotary kiln where temperatures reach 1500 ºC (2,732 °F). The intense heat causes chemical reactions that convert the partially molten raw materials into pellets called clinker. After adding some gypsum and other key materials, the mixture is ground to the extremely fine grey powder called portland cement.

C. RAW MATERIAL QUARRYING, CRUSHING, AND RAW MATERIAL STORAGE

Limestone rock is mined at a quarry as shown below. In Florida, the top layers (overburden) are removed and the limestone is usually mined under the water table. The rock is crushed in one or two stages to the size of gravel. It is transported by conveyor to the existing cement plant Limestone Storage Building (LSB) located west of Lines 1 and 2 where it is stored to await further processing. The present LSB will be expanded to accommodate the additional materials needed for operation of Line 3. Depending on local characteristics, the overburden is often used to provide some of the sand and clay needed in the process.

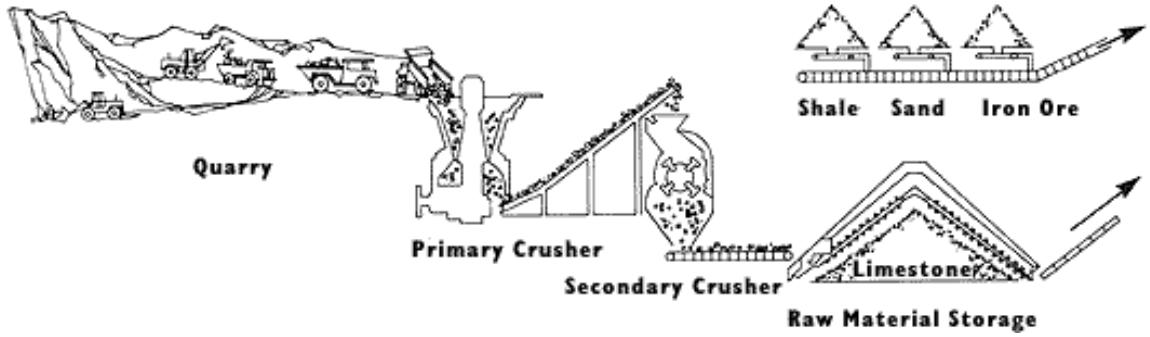
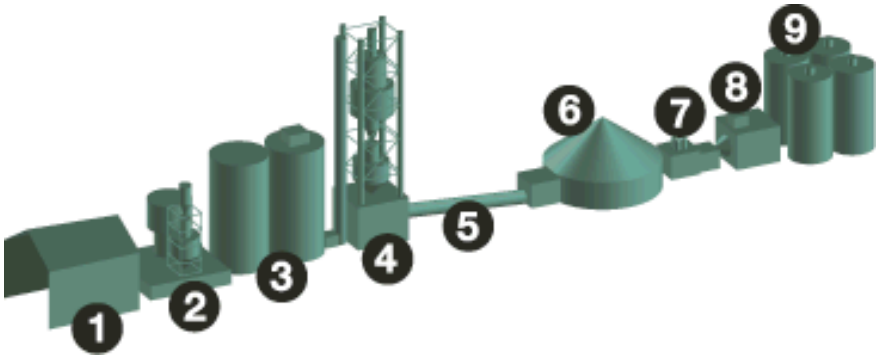


Figure 4. Diagram of Rock Quarrying, Crushing, and Storage

Limestone for Line 3 will be crushed and then will be stored in the expanded LSB. There will be two new large piles each containing approximately 30,000 tons of limestone. Clay will be processed in an existing crusher and dryer conveyed to storage silos. Additional raw material will be delivered by truck and rail. Sand, mill scale, bauxite, bottom ash and fly ash will be received and stored in expanded storage buildings located east of the existing lines and the new Line 3. Limestone dust, slag and gypsum interground with or added to the clinker will also be stored in a building to the east. Coal and petroleum coke delivered by rail or truck will be stored south of the existing plant.

D. Components and Key Operations of a Cement Plant

The following diagram represents the key components of a typical cement plant and steps involved in making Portland cement (excluding quarrying and solid fuel grinding). A virtual tour of a cement plant is available at the Portland Cement Association website: www.cement.org/basics/images/flashtour.html



1. Raw Material Storage
2. Grinding (Raw Mill)
3. Blending, Feed
4. Preheater/Calciner
5. Rotary Kiln
6. Clinker Cooler and Storage
7. Additions (e.g. Gypsum)
8. Cement Grinding (Finish Mills)
9. Bulk Storage & Loading

Figure 5. Components, Key Operations of a Cement Plant

The following figure includes the artist rendition (by Haskell) and a photograph of the Florida Rock Industries (FRI) Thompson S. Baker Cement Plant in Newberry Florida. The raw materials storage building is the gallery on the lower left hand side. The raw mill, preheater/calciner kiln and cooler are in the rear, left of center, of the layout. Clinker storage and finish grinding are in the middle of the layout. Bulk storage and loading are in the rear, right of center.

The photograph on the right hand side of the figure starts with the conveyor (left of the tower) that takes raw mix to the raw mill. Referring to the Figure 5, it also includes Components 3, 4, and 5 and another conveyor (right hand side of the photograph below) that takes the cooled clinker to Component 6 (Clinker Storage).

Figure 6. Rendition (Haskell) and Photograph (Linero) of the FRI Cement Plant in Newberry

E. Proportioning, Grinding, Blending

Stockpiled limestone at the CEMEX facility will be reclaimed inside the LSB by an existing scraper reclaimer and then transferred to the limestone silo. Clay from the dryer will also be stored in a silo. Clay and limestone will be mix onto a conveyor belt. Based on automated chemical analyses additional raw materials from bauxite, sand, mill scale and fly ash bins will proportioned and added onto the final conveyor to produce the *raw mix* that is transferred the grinding operation which occurs in the in-line raw mill.

The raw mix is ground to size in the raw mill and the moisture content is reduced. Heat for drying within the raw mill is supplied from the preheater/calciner/kiln exhaust gas and from hot air supplied from the clinker cooler. From the raw mill, the material is blown to a series of mechanical cyclones that recover most of the material. The exhaust from the cyclones passes through the main particulate matter control device (main baghouse in the case of the present project) prior to the main (kiln) stack.

The properly ground and sized raw material is conveyed to the homogenizing silo. Dust from the main baghouse is added to the homogenizing silo. The material from the homogenizing silo, known as *raw meal*, is then conveyed to and introduced near the top of the preheater tower.

The following figure is a simplified process flow diagram of a preheater/calciner kiln that is useful for discussing the details of the proposed CEMEX Brooksville Kiln No. 3 project. The figure was borrowed from an excellent study (Greer 2005 for PCA) assessing how pollution control strategies for a given pollutant's influence (increase or decrease) emissions of other pollutants. The mentioned study is available at: www.cement.org/pdf_files/SN2728.pdf

F. Pyroprocessing System

The pyroprocessing system includes the preheater, calciner, rotary kiln and clinker cooler, all of which are shown in the following diagram. An alkali bypass is shown but is not a feature of pyroprocessing at cement plants in Florida.

Coal/petcoke is fed to both the medium temperature calciner burner and the high temperature kiln burner to provide heat for the process. Hot air from the kiln hood and hottest part of the clinker cooler provides secondary combustion air to the main kiln burner and tertiary air to the calciner to support calcination and to complete burnout.

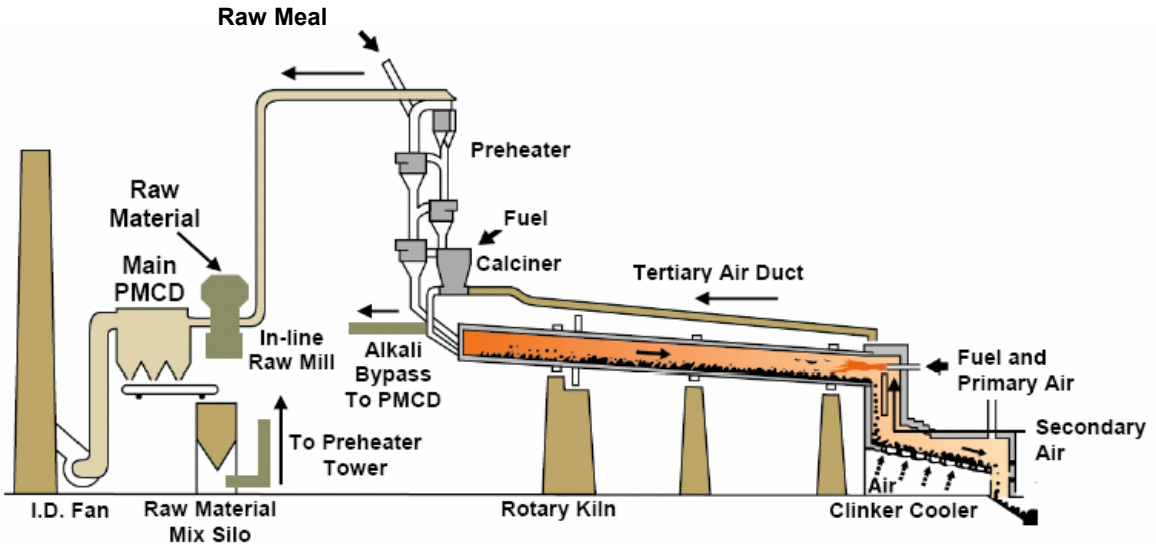


Figure 7. Process Diagram of Dry Process Preheater/Calciner Pyroprocessing System

The raw meal passes through the preheater/calciner/kiln system. Initially, fixed moisture is released from the raw meal by heat exchange with calciner/kiln exhaust gases. Then the raw meal is calcined (conversion of limestone fraction to lime) at approximately 870 °C (1,600 °F).

The calcined raw meal is fed at the gaseous exhaust side of the rotary kiln. The kiln is mounted on two or three piers with its axis inclined slightly downward towards the hot material discharge side. The material is heated to a temperature of approximately 1,500 °C (2,732 degrees F) in the large cylindrical steel rotary kilns. The kiln is lined with special firebrick. The gas temperature at the main kiln burner is necessarily even hotter (up to 1,870 °C or 3,400 °F) in order to impart the heat necessary to achieve the very high material temperature.

As the material moves through the kiln, certain elements are driven off in the form of gases. The remaining elements unite to form a new substance with new physical and chemical characteristics. The new substance, called clinker, is formed in pieces about the size of marbles.

Clinker is discharged red-hot from the lower end of the kiln and generally is brought down to handling temperature in a reciprocating clinker cooler. Most of the heated air from the cooler is returned to the kiln and raw mill. The rest is exhausted through the cooler particulate matter control device (cooler baghouse). The gases from the pyroprocessing system are drawn through the induced draft fan and discharged to the kiln stack after passing through the main baghouse.

G. Clinker Handling, Storage, Additives Addition

The cooled clinker is transferred to one of two clinker storage silos. Each clinker silo is equipped with its own baghouse for the control of PM emissions. Additional baghouses are used for the clinker conveyance and transfer operations to and from the silos. Clinker from the silos along with some gypsum and limestone are conveyed to the finish mill.

H. Finish Mill

Clinker, with gypsum and/or limestone, enters the finish mill area where the material is interground in a large ball mill. The ground product (cement) from the ball mills is transferred to cement separators for sizing of the product, using a high efficiency air separator and cyclones, then conveyed to storage.

Baghouses are used to control PM emissions from the finish mill and air separator.

I. Cement Storage, Loadout and Packing

The cement is directed via a pneumatic conveyor to one of several cement storage silos. From the storage silos, the cement is transferred to the truck loadout or to the bagging machine. PM emissions from the cement storage silos, bagging equipment, and truck loadout areas are all controlled by baghouses.

J. Coal/Petcoke Grinding

Two solid fuels, coal and petroleum coke (petcoke) will be utilized in the new cement plant. These fuels will be delivered by truck and stored under cover in separate piles. The fuels will be reclaimed by front-end loader and sent via conveyer and bucket elevator to the coal and petcoke bins. The fuels will be conveyed and combined prior to introduction into the vertical coal/petcoke mill. The fuels are then interground and dried using hot exhaust gas from the preheater taken at the downcomer duct.

The ground coal/petcoke blend is then blown to a baghouse which acts as a product separator and exhaust. The fuel is then stored in the pulverized coal/petcoke bin from where it is fed to the main burner and the calciner burner.

VI. EMISSIONS FROM CEMENT MANUFACTURING

The main pollutants emitted from cement manufacturing include nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOC), and particulate matter (PM/PM_{10}). In summary (and greatly simplified), the major mechanisms for pollutant formation are summarized in Table 1.[1] Other specifically regulated pollutants that are emitted at low levels include hydrogen chloride (HCl), mercury (Hg), and dioxin/furan (D/F).

Table 1. Primary Mechanisms and Sources of Pollutant Formation.

Pollutant	Mechanism	Source
NO_X	Thermal Formation	Kiln Burner
	Fuel Nitrogen Oxidation	Kiln, Calciner
SO_2	Oxidation of Raw Material Pyrites	Upper Preheater Stages
	Fuel Sulfur Oxidation	Kiln, Calciner, Coal/Petcoke
CO & VOC	Incomplete Combustion	Calciner
	Thermal Evolution	Raw Materials
PM/PM_{10}	Crushing, Grinding, Conveyance	Crusher, Raw Mill, Coal Mill, Belts, Silos
	Pyroprocessing	Kiln, Cooler

A. Control of Pollutants

At first glance, it appears that the most direct way to control most of the pollutants is by process and combustion controls coupled with a judicious selection of fuel and raw materials. Together with this approach there are measures that minimize fuel consumption, and incorporate "smart process control systems" to optimize production, quality, and pollution control. In summary (and again greatly simplified) the primary control measures for the main pollutants are listed in Table 2.

Table 2. Primary Pollutant Control Techniques.

Pollutant	Mechanism	Control
NO_X	Thermal	Kiln Burner Design, Indirect Firing
	Thermal and Fuel	Optimum Process and Raw Mix Control
		Fuel Choice, Staged Combustion in Calciner
SO_2	Oxidation of Pyrites	Raw Materials, Moist Limestone in Raw Mill
	Fuel	Finely Divided Lime in Calciner, Alkalis in Kiln
CO, VOC	Incomplete Combustion	Hot Excess Air, Mixing, Residence Time
	Thermal Evolution	Raw Material Selection
PM/PM_{10}	Crushing/Grinding, Convey	Wet Quarrying, Process Cyclones
	Pyroprocessing	Process Cyclones

Note that the primary control strategies given above are greatly constrained by the characteristics and availability of raw materials and fuels. Such situations give rise to various add-on control equipment technologies. Again, in greatly simplified form, these are as follows:

Table 3. Add-on Pollutant Control Techniques.

Pollutant	Control
NO_X	Selective Non-Catalytic Reduction (SNCR), Selective Catalytic Reduction (SCR)
SO_2	Hydrated Lime, Lime Slurry, Wet or Dry Scrubbers
CO and VOC	Regenerative Thermal Oxidation (both), Carbon Absorption or SCR (for VOC)
PM/PM_{10}	Electrostatic Precipitators (ESP), Baghouse Designs

These technologies are available and each is in use at one or more cement plants in the United States or Europe. Some of the technologies are necessary to meet very low emission limitations irrespective of the mentioned constraints.

There are further constraints such as clinker specifications. This frequently results in the need to include a sulfur or alkali bypass system. The purpose is to avoid accumulation of undesired chemical species in the clinker or formation of scales and rings on internal process equipment surfaces. The species thus removed via the bypass system must often be discarded. The result is that additional fuel and raw material can be required to make up the bypass losses.

B. NITROGEN OXIDES (NO_X) CONTROL

Control at Main Kiln Burner.

The starting point to control NO_X is to avoid its' formation in the high temperature environment near the main kiln burner. The key strategy is called indirect firing. The basic principle is to minimize primary air (that carries the coal to and through the burner) and to utilize more secondary air (from the kiln hood clinker cooler) as combustion air. This practice minimizes fuel consumption and thus NO_X. All manufacturers rely largely on these principles and this is now the "baseline control".

Several burners have been described that claim further NO_X reduction from the main kiln burner by promoting high momentum of the primary air to form an envelope "which generates localized reducing conditions and helps reduce NO_X".[2] Given the extreme temperature requirements and oxidizing condition needed to make clinker, there will always be significant NO_X formation even with indirect firing and special burners. A reasonable estimate would be 3 pounds NO_X per ton of clinker (lb/ton) formed in the kiln and another 1 lb NO_X/ton of clinker formed in the calciner for a "baseline" of 4 lb NO_X/ton prior to further control.

Staged Combustion in Calciner (SCC).

<u>Basic Principles of Staged Combustion in the Calciner</u>. Burning a portion of the fuel in the calciner burner instead of the main kiln burner spreads the thermal load in the pyroprocessing system. It allows much of the combustion to occur at temperatures characteristic of the calciner that are much less than the temperatures occurring near the main kiln burner. This reduces the potential for thermal NO_X formation. Significant fuel NO_X formation in the calciner is still possible.

Exhaust gas leaving the kiln and entering the calciner is characterized by relatively low excess air and high temperature that is less than required to sinter cement but greater than required to calcine raw meal. Fuel, air and raw meal introduction to the calciner can be "staged" to destroy thermal NO_X from the kiln and limit fuel NO_X formation in the calciner.

The following discussion explains the mechanism for reduction of NO_X by Staged Combustion in the Calciner (SCC).[3]

Equation 1. Calcination of limestone occurs at approximately 900 degrees Celsius (°C) and liberates carbon dioxide to produce lime according to the following endothermic reaction:

$$CaCO_3 \rightarrow CaO + CO_2$$

This reaction tends to rapidly cool the kiln exhaust gas. The additional heat supplied by the calciner burner and hot tertiary air from the kiln hood and clinker cooler sustains the reaction. Calcination tends to limit the temperature of exhaust gases in and leaving the calciner to temperatures less than 900 °C. Combustion in the calciner proceeds as follows.

Equation 2. Fuel, such as a volatile coal, is heated and pyrolyzed releasing hydrocarbon radicals. These, in turn, catalytically react with NO to form hydrogen cyanide according to:[4]

$$CHi^* + NO \rightarrow HCN + ...$$

Where:

i = 1, 2, 3

Equation 3. Ammonia-like radicals are also released during pyrolysis. Under reducing conditions and in the presence of raw meal they catalytically destroy NO according to:[5]

$$NHi^* + NO \rightarrow N_2 + ...$$

This mechanism suppresses formation of NO by the pyrolyzed fuel nitrogen and employs that nitrogen to further reduce NO_X in reactions that at first glance look much like SNCR or SCR.

Other reactions involving carbon monoxide (CO) or hydrogen (H_2) are also catalytically driven and destroy NO_X in this reducing atmosphere. In the subsequent burning of soot and char, the NO_X reducing reactions proceed much more slowly and some of the remaining fuel nitrogen can still form significant amounts of additional NO_X.

There are numerous approaches available that employ the principles discussed above. Following are discussions of two of them including the approach planned for the present project.

F.L. Smidth (FLS) Low NO_X Calciner. In the FLS design *all* calciner fuel is injected at a single level in the riser between the kiln and calciner to create the desired reducing atmosphere. Their theory is that the greatest NO_X reduction will occur when the most aggressive reducing conditions and highest temperature persist just long enough to drive the NO_X destruction reactions.[6] Then *all* air is added via the tertiary air duct from the kiln hood and clinker cooler to a single level near the bottom of the calciner.

The tertiary air supply duct is readily visible in the following photograph and the point where it enters the calciner is shown in the diagram. Another feature not fully appreciated is that raw meal is split to several sections of the calciner. Three meal splits are visible in the diagram. Effective SCC designs typically incorporate *meal staging* for numerous reasons. One key reason is to take advantage of the *catalytically* enhanced dissociation in the preheater of nitrogen oxide (NO) formed in the kiln.[7] Another important reason is as a temperature control stratagem.

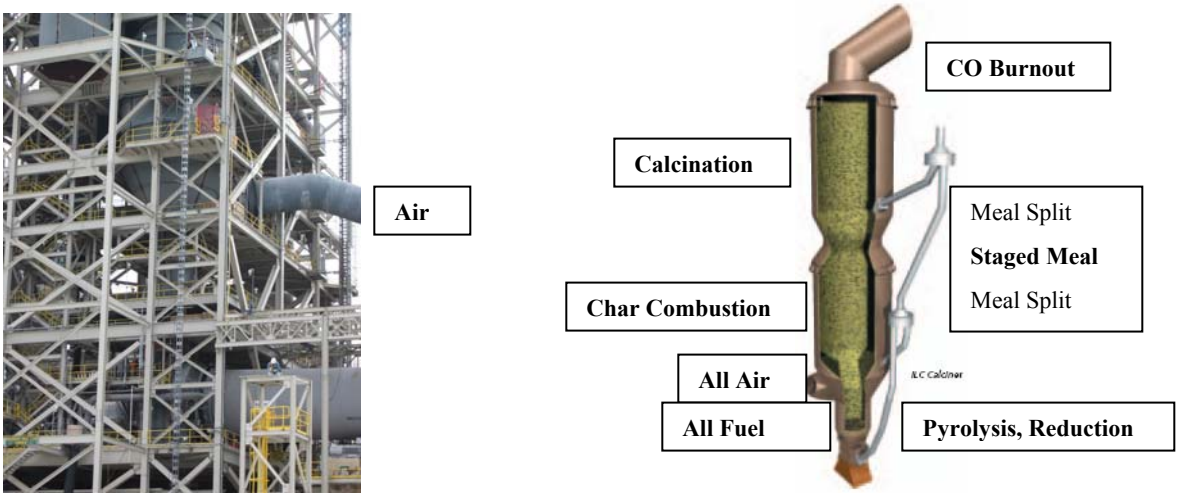


Figure 8. Titan Florida Pennsuco Cement Plant Calciner, Diagram of SCC Strategy

The degree of CO "burnout" depends upon the length and turbulence in the upper duct leaving the calciner. The described version of SCC was demonstrated in the U.S. at the CEMEX Santa Cruz, California plant by 1997. A value of approximately 2 pounds NO_X per ton of clinker (lb/ton) is routinely achieved at the Titan Florida Pennsuco Cement Plant. The same calciner is also characterized by low CO emissions (routinely between 0.75 and 1.25 lb CO/ton on a 30-day basis) based on the most recent data from continuous emission monitoring system (CEMS) located in the stack.[8] The emission limits are 2.17 lb NO_X/ton (12-month rolled monthly) and 2.0 lb CO/ton (30-day rolling average).[9]

KHD Humboldt-Wedag Pyroclon Low NO_X Calciner. The Pyroclon Low NO_X design shown below relies on the principle of *fuel and air staging*. The version on the left incorporates a relatively small "Low NO_X" burner, the purpose of which is the effect the necessary reducing conditions. The second "Calciner" burner operates in an oxidizing atmosphere and provides most of the fuel for calcination. The diagram on the right hand side shows an updated Pyroclon design that includes a top air duct for additional air staging as planned for the CEMEX Brooksville project.

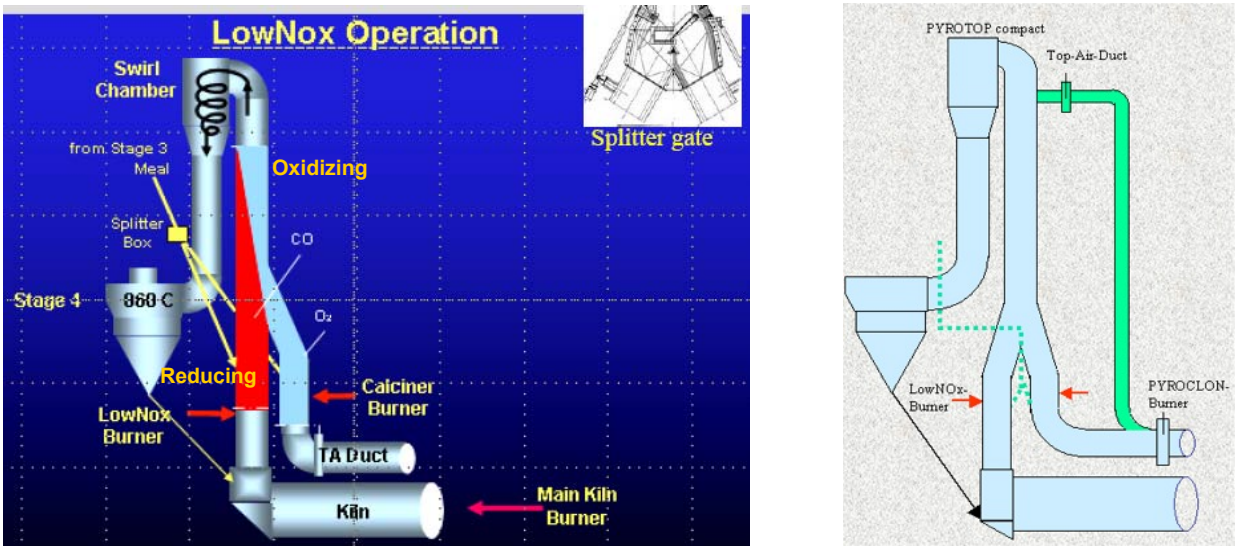


Figure 9. Pyroclon Calciner with Pyrotop Swirl Chamber, Updated Version with Top Air Duct

The recent CEMEX Kosmosdale project in Kentucky included the Pyrotop swirl chamber but did not include the Top Air Duct. The system was guaranteed to achieve 3.3 and 1.5 lb/ton of NO_X and CO respectively. The performance tests indicated emissions of 2.3 lb NO_X/ton and 0.8 lb CO/ton.[10] According to the cited reference, "the Low NO_X burner reduces the NO_X produced in the kiln to near zero, limited only by the maximum allowable CO emissions" (underline added).

The LaFarge Roberta, Alabama project included the Pyrotop and the Top Air Duct. It was guaranteed to achieve 2.4 and 0.8 lb/ton of NO_X and CO respectively. The performance tests indicated emissions of 1.8 lb NO_X/ton and 0.3 lb CO/ton.[11]

The more recent CEMEX Victorville, California Kiln 3 project included the Pyrotop and Top Air Duct. Based on continuous emission monitoring system (CEMS) data, the 30-day rolling averages ranged from 2.2 to 3.0 lb NO_X/ton and 0.07 to 0.23 lb CO/ton during 2004.

Conclusion Regarding SCC. Based on the performance of the FLS and KHD Low NO_X calciners, the Department concludes that NO_X levels less than 3 lb NO_X/ton and 2 lb CO/ton will be comfortably achieved by SCC alone before consideration of add-on control equipment.

Selective Non-Catalytic Reduction.

In addition to or in lieu of SCC, Selective Non-Catalytic Reduction (SNCR) and Selective Catalytic Reduction (SCR) are available for consideration.

Principle of SNCR. SNCR technology involves injection of ammonia (NH_3) at a point in the process characterized by a temperature window between 850 and 1050 °C. Residence time, turbulence, oxygen content, and a number of other factors specific to the given gas stream are also important. SNCR destroys NO_X by a two-step process as follows:

Equation 4. Ammonia reacts with available hydroxyl radicals to form amine radicals and water per the following theoretical equation:

$$NH_3 + OH^* \rightarrow NH_2{}^* + H_2O$$

Equation 5. Amine radicals combine with nitrogen oxides to form nitrogen and water.

$$NH_2{}^* + NO \rightarrow N_2 + H_2O$$

Equation 6. The two steps are typically expressed as a single "global reaction".

$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$

The simplified equation does not convey the kinetics. But it suggests that, theoretically, SNCR will function best in an oxidizing atmosphere.

Equation 7. In a reducing atmosphere, CO competes with ammonia for available OH radicals

$$CO + OH^* \rightarrow CO_2 + H^*$$

Per the following figure, the necessary temperature window exists at least between the kiln inlet and the bottom cyclone of the preheater that receives the exhaust from a calciner that employs air staging. The physical extent of the window for oxidizing conditions depends on the damper positions for the tertiary air branches for the shown calciner design. In selecting a level (or levels) for ammonia injection there must be some optimization of temperature and oxygen.

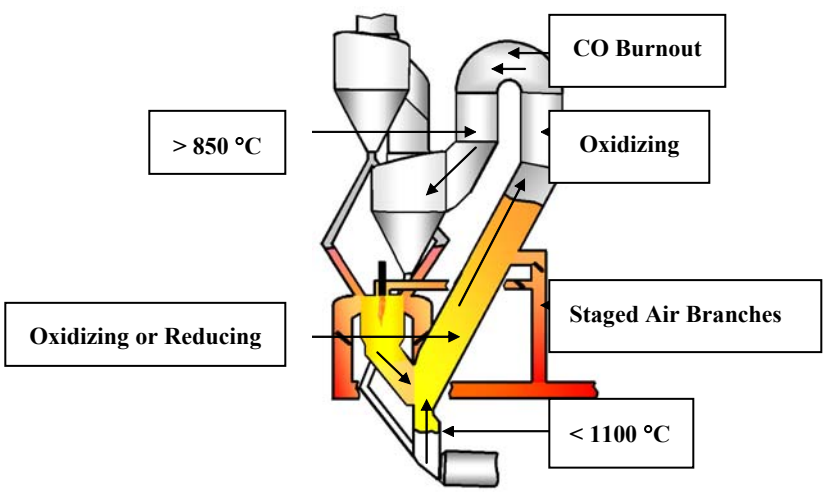


Figure 10. Temperature and Oxidizing Windows for SNCR in an Air Staged Calciner

Based on the foregoing, ammonia should be injected after introduction of tertiary air and preferably after completion of CO burnout. Some of the equipment used during an SNCR demonstration at Suwannee American Cement (SAC) in Branford, Florida is shown in the following figure.

Figure 11. Aqueous Ammonia Supply Truck, Compressed Air, One of Four Ports, Injector

Not shown is the metering system or the additional continuous emission monitoring equipment. Four ports were installed after the bend in the duct work following the top air injection branch for tertiary air. It is noteworthy that it sufficed for treatment of all of the exhaust gas from the calciner and not just a slip stream. In fact at times a single injector sufficed for adequate NO_X control.

The trials conducted showed that it was possible to achieve emissions as low as 1 lb/ton whether or not SNCR was combined with SCC.[12] Similar tests were conducted at the Florida Rock Industries (FRI) Cement Plant in Newberry, Florida. These tests were conducted by Polysius during the period December 6-11, 2004. The summary report prepared by Koogler and Associates is available at: www.dep.state.fl.us/Air/permitting/construction/flrock.htm

The Department reviewed the report and summarized the performance of the SNCR system in the graphs shown in the figure below. The graph on the left hand side represents the performance of the SNCR system while burning tires and maintaining mildly reducing or mildly oxidizing conditions in the calciner. A basic molar ratio (NH_3 in/NO_X baseline) a little greater than 0.5 was sufficient to reduce emissions to around 1.5 lb/ton.

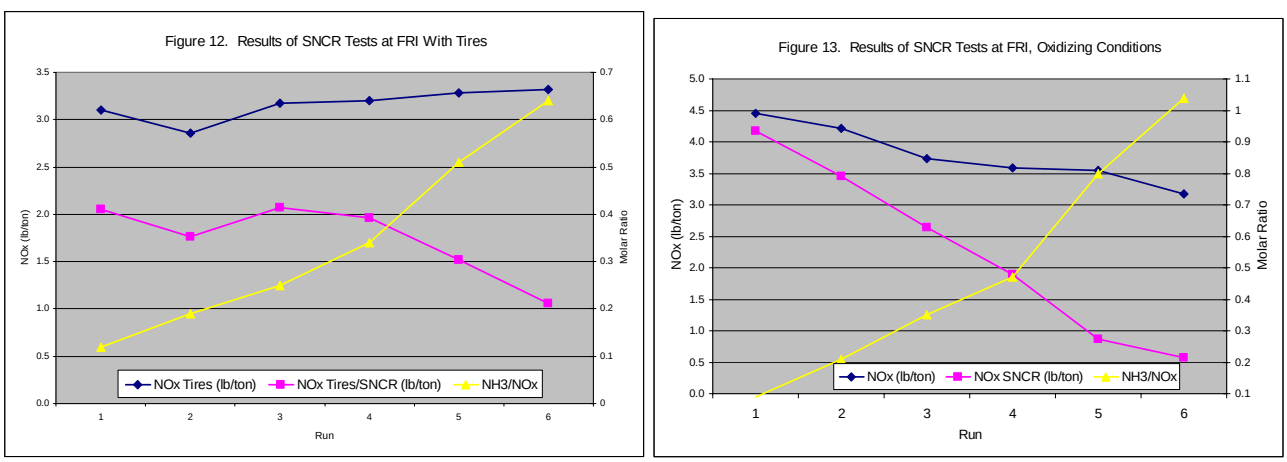


Figure 12. NO_X Emissions (middle lines) vs. Molar Ratio (lower lines) during Testing at FRI.

Following experiments carried out at SAC and Florida Rock Industries (FRI), a permanent SNCR unit was installed at the existing SAC plant. The limit is 2.4 lb/ton on a 30-day basis. The data are continuously available at: www.suwanneecement.com/liveemissions.html . A SNCR system is under construction at the existing FRI kiln.

In 2005 CEMEX installed an SNCR system at their Brooksville Cement Plant Kilns 1 and 2 and will comply with a recently issued permit limit equivalent to 2.0 lb/ton of clinker.

Limitations to SNCR. One of the arguments against SNCR is the possibility of increased opacity due to the formation of ammoniated sulfate and sulfite species in detached plumes.[13] Unreacted ammonia from the SNCR process or from raw materials reacts with SO_2 and SO_3 at temperatures prevalent in the upper preheater, pollution control equipment, and outside the stack.

Equation 8. Ammonium bisulfate is formed in accordance with the following reaction.

$$NH_3 + SO_3 + H_2O \rightarrow NH_4HSO_4$$

Equation 9. Ammonium sulfate is formed per the following reaction.

$$2NH_3 + SO_3 + H_2O \rightarrow (NH_4)_2SO_4$$

Equation 10. Finally, ammonium bisulfite is formed as follows.

$$NH_3 + SO_2 + H_2O \rightarrow NH_4HSO_3$$

When a PH/C kiln is operated with the raw mill on line, these compounds condense. They go back into the feed system and to the preheater, where they vaporize again. They subsequently condense again in the raw mill. When the raw mill is taken off line, the volatile salts are no longer captured in the raw mill, and go to the dust collector. Since the dust collector cannot efficiently capture these species, the plume could become visible. When the raw mill is put back into operation, the plume would cease again. This cycle continues indefinitely, unless something is done to break it.[14]

This detached or visible plume phenomenon did not present itself during the Florida tests because the raw materials are (with few exceptions) very low in sulfur as explained in following sections. If a plant has a persistent detached plume that is attributable to $(NH_4)_2SO_4$ it is necessary to get rid of one of the two reactants that ultimately form $(NH_4)_2SO_4$ - either the NH_3 or the SO_2.[15] One method of avoiding the plumes when using SNCR is by minimizing ammonia slip when SO_2 emissions are likely.

European SNCR Experience. As of 2000, there were at least 18 kilns in Europe that had installed SNCR.[16] By 2004, there were approximately 32 SNCR installations in Germany alone.[17] Most of these SNCR installations were designed and operated for NO_X reduction rates of 10 – 50 percent with NH_3 /NO_2 molar ratios of 0.5-0.9 and emissions of 500-800 mg NO_X/m^3 (~2.3 to 3.6 lb/ton). The Scancem Skövde and Slite Plants in Sweden are limited to 200 mg NO_X/m^3 and achieve the limit with SNCR.[18] This equates to approximately 0.9 lb NO_X/ton and is believed to be the lowest limit in Europe.

The emissions and ammonia consumption profiles for the Skövde and Slite Plants are shown in the following figure. Clearly, both plants exhibited high emissions on the order of 1,100 mg NO_X/m^3 (~ 5 lb/ton) prior to installation of SNCR systems and much lower emissions thereafter.

The Department reviewed the more detailed data provided by the Swedish Environmental Agency and found that in 1995, before installation of the SNCR, the 2,100 tons per day Skövde Preheater Kiln achieved approximately 5 lb NO_X/ton clinker.[19] Between 1997 and 2004, after installation of SNCR, the kiln achieved monthly averaged values between 0.44 and 1.1 lb NO_X/ton. In 2001 the basic molar ratio (NH_3/NO_X present) was 1.0-1.2. The corrected molar ratio (NH_3/NO_X actually removed) is 1.2 to 1.4. Therefore the overall NO_X reduction is greater than 80% while the reagent utilization efficiency is on the order of 70 to 80%.

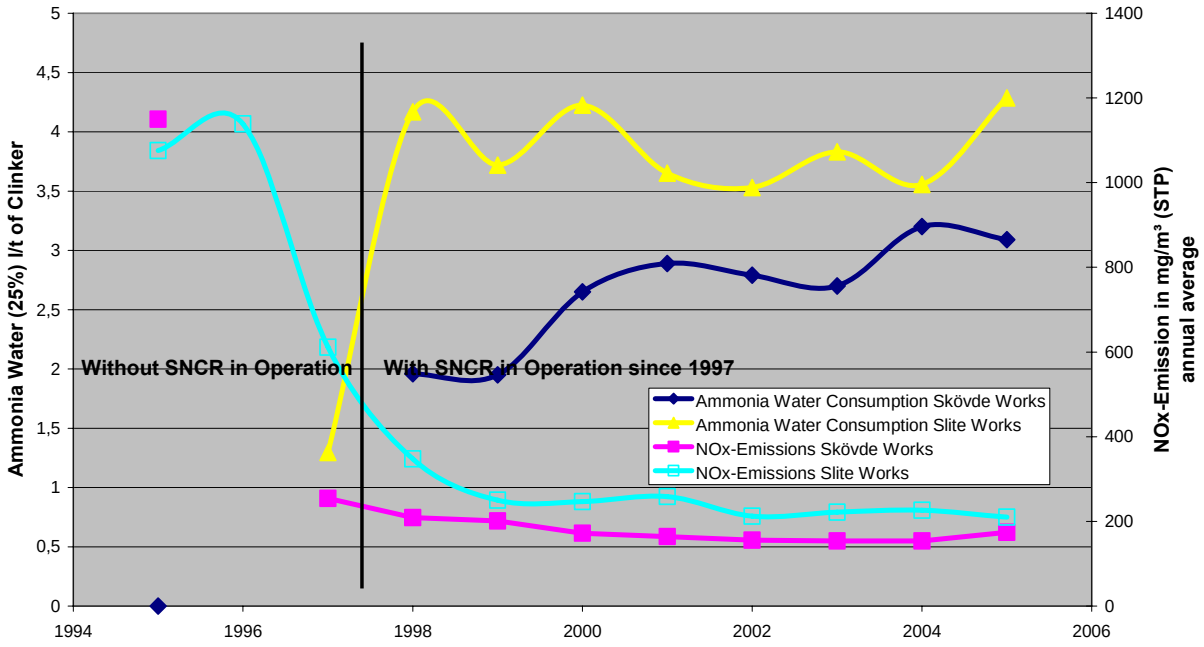


Figure 13. NH_3 Use and NH_3, NO_X Emissions - Skövde (no Scrubber) and Slite (Scrubber)

The 6,400 TPD Slite Preheater/Calciner Kiln No. 8 exhibited similar NO_X reduction efficiency. At Slite the basic and corrected molar ratio were in the ranges of 1.2 to 1.4 and 1.5 to 1.8 respectively. The reagent utilization efficiency ranges between 56 and 67%. Ammonia consumption and emission values are shown in the following figure.

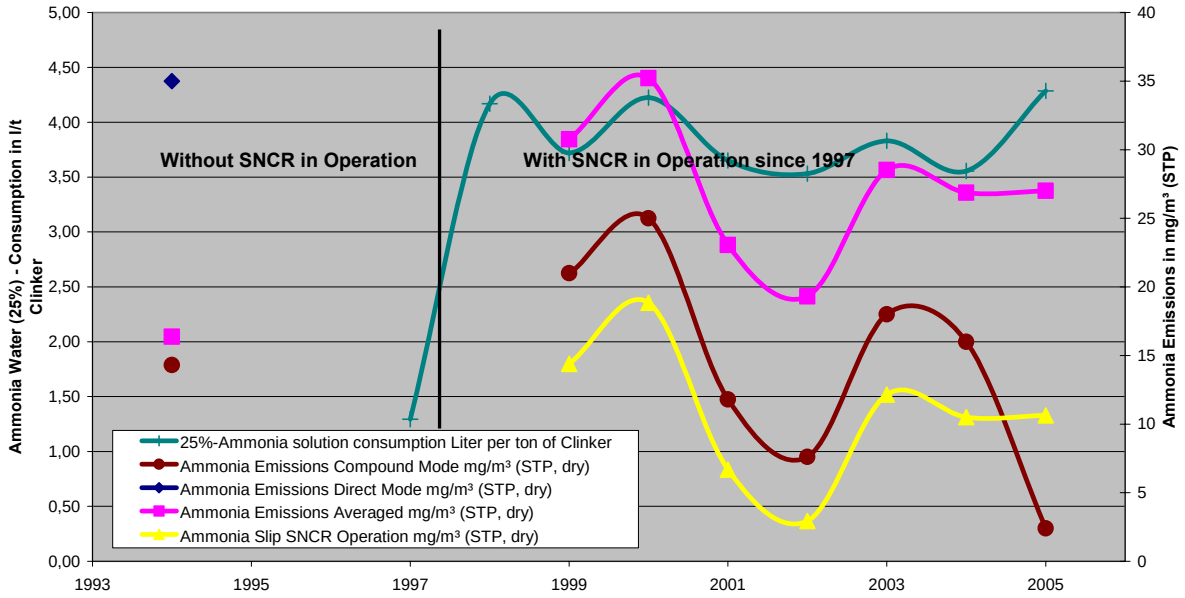


Figure 14. Ammonia Emissions and Consumption for Slite Kilns 7 and 8 after Scrubber

It presently takes approximately 3 to 4.5 liters of 25% ammonia solution per ton of clinker to achieve the necessary 80% NO_X reduction at the two plants. Both plants have raw mills that absorb ammonia when operating. In Skövde the raw mill operates approximately 98% of the time.

The Slite Plant has an SO_2 scrubber that tends to equalize and average out NH_3 emissions over time. Skövde has no scrubber. Measurements in 2003 indicated less than 5 mg/m³ ammonia emission without SNCR and 20 mg/m³ with the SNCR system in operation.

Märker Cement operates a preheater kiln in Harburg, Bavaria. In 2005 they were subject to a limit of 500 mg/m^3 and achieved, on average, 385 mg/m^3 by SNCR.[20] However, the German Waste Incineration Ordinance requires adherence to values between 200 mg/m^3 and 320 mg/m^3 (~0.9 to 1.5 lb/ton) by the end of 2007 from kilns burning significant amounts of waste fuel.

The SNCR system at Märker Cement was recently upgraded to a *high-efficiency* SNCR installation with multi-level reagent injection. The Department examined recent data taken over several months provided by the Bavarian Environmental Agency that indicate NO_X emissions of 200 mg/m^3 or roughly 0.9 lb/ton.[21] The data also indicate substantial NH_3 emissions when the raw mill is down. However, the high efficiency SNCR installation is new and is undergoing optimization of the multi-level injection system. No detached plume is expected during periods of high NH_3 emissions because SO_2 emissions at Märker are low.

Conclusion regarding SNCR. Based on the foregoing discussion, it is possible to achieve NO_X emissions of 1 lb/ton by SNCR even with relatively high baseline emissions. The consequences can be substantial NH_3 emissions when trying to achieve very low NO_X emissions or a detached plume when SO_2 emissions are also high. Therefore it is important to balance NO_X, NH_3 and SO_2 emissions or consider selective catalytic reduction (SCR) when very low NO_X emissions are required.

Selective Catalytic Reduction (SCR)

Principle of Selective Catalytic Reduction (SCR). The key to SCR is the catalyst, over which the exhaust gas and reducing reagent are contacted at temperatures between 170 and 400°C in contrast with the SNCR temperature window (850 to 1050 °C). High conversion can be realized by the catalyst with short retention times.

The principle of the SCR process is shown in the following figure.

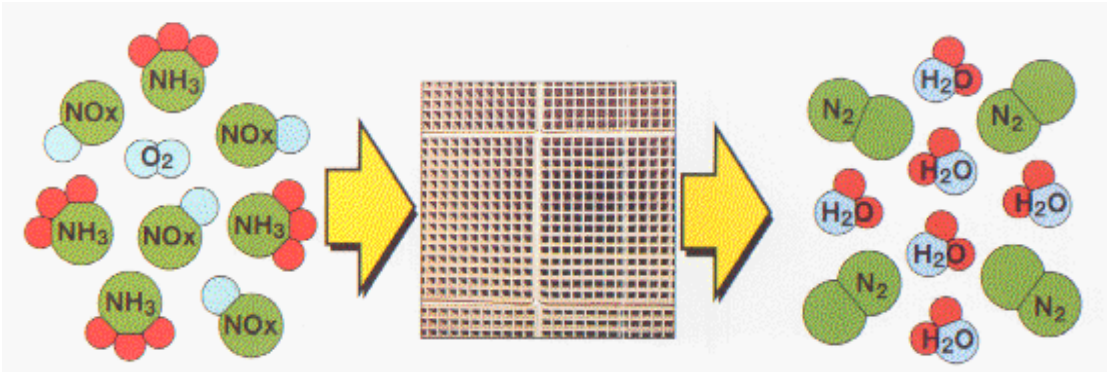


Figure 15. Raw Gas with NO_X and NH_3. Reaction over Catalyst. Yields Nitrogen and Water

The catalyst elements store ammonia in their micro-pores to a certain extent and ammonia is not necessarily consumed immediately upon injection. Conversely the reaction can proceed for some time after discontinuing injection. This partly explains why NO_X-removal efficiencies by SCR can be greater than 90% with practically no ammonia slip. The catalyst is not a reactant and is not consumed in the process.

The catalyst consists of active metals and substrates. The combination of V_2O_5 as active component and TiO_2 as a ceramic base and formed as a honeycomb structure has shown the best results so far for cement kiln applications. Other known active components consist of tungsten, iron, chromium, nickel or copper; precious metals (e.g.: platinum, palladium, rhodium, ruthenium); zeolites; and activated carbon (Haug et al., 2002).[22] Other known catalyst structures are plate, molded wire, pellets or dust.

The basic requirements of an SCR catalyst for cement kiln application are:

- Suitable to handle gas with dust on the order of 100 g/m^3;
- High activity and selectivity;
- Low oxidation rate of SO_2 to SO_3;
- Chemical and mechanical stability; and
- Small pressure loss.

Referring to the following figure, the appropriate SCR temperature window exists from the upper stages of the preheater through the gas conditioning tower (CT) and raw mill (RMM). These possible locations are characterized by high dust loadings. Therefore the key concerns for a high-dust SCR system at a PH or PH/C cement kiln are additional equipment to prevent catalyst pluggage and to keep the gas passages clean and catalyst design to resist abrasion and loss of activity.

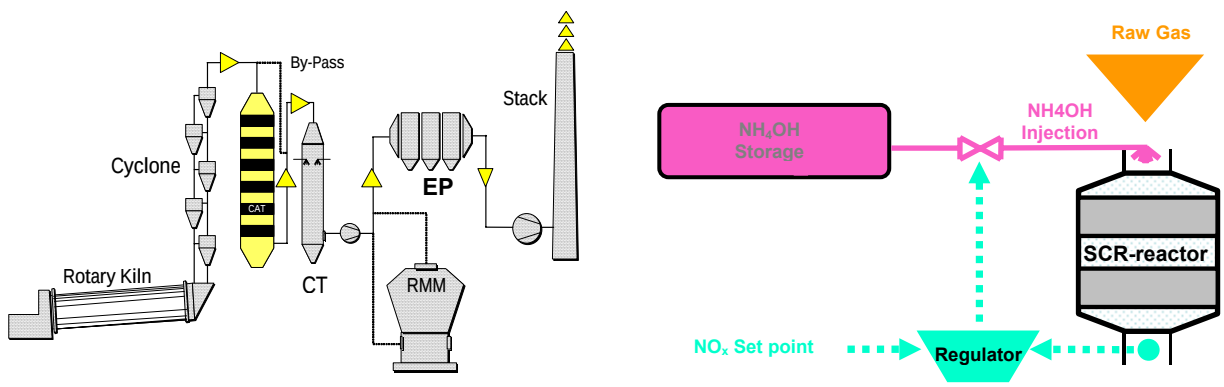


Figure 16. SCR Reactor Location in Preheater Kiln. Simplified Diagram of SCR Components

Until recently the only known full scale installation of SCR at a cement plant was at the Solnhofer Portland Zementwerke in Bavaria, Germany. It was built with financial assistance from the German Federal Environmental Office. The first known self-funded commercial installation of SCR at a cement plant is located at the Radici Cementeria di Monselice (CM) in Italy.

There is much debate in the industry regarding the relative merits of SNCR versus SCR. Very low NO_X emissions are possible with either technology. The most interesting details regarding the installation at CM relate to the NH_3 consumption and slip. Use of SCR directly minimizes detached plume formation potential and fine particulate precursor emissions.

According to the following figure, the data for the SCR system at CM indicate that less than one mole of ammonia is required to destroy one mole of NO_X. All the data from CM lie to the left of the ideal "unity" line (moles NH_3 injected/mole of NO_X prior to treatment = 1). The reason for the "better than theoretical" performance is that raw materials used at the plant contain some ammonia. The catalyst utilizes that ammonia to destroy approximately 25-30% of the NO_X before any reagent is required.

Performance ranges for different classes of SNCR systems reviewed by the SCR system manufacturer are also shown in the graph for comparison. [23] It is clear that more NH_3 is required when using SNCR than when using SCR for a given NO_X removal objective. In that respect (minimizing NH_3 consumption and emissions) the CM system is clearly superior to the performance of the various classes of SNCR data that comprise even the "excellent SNCR Systems".

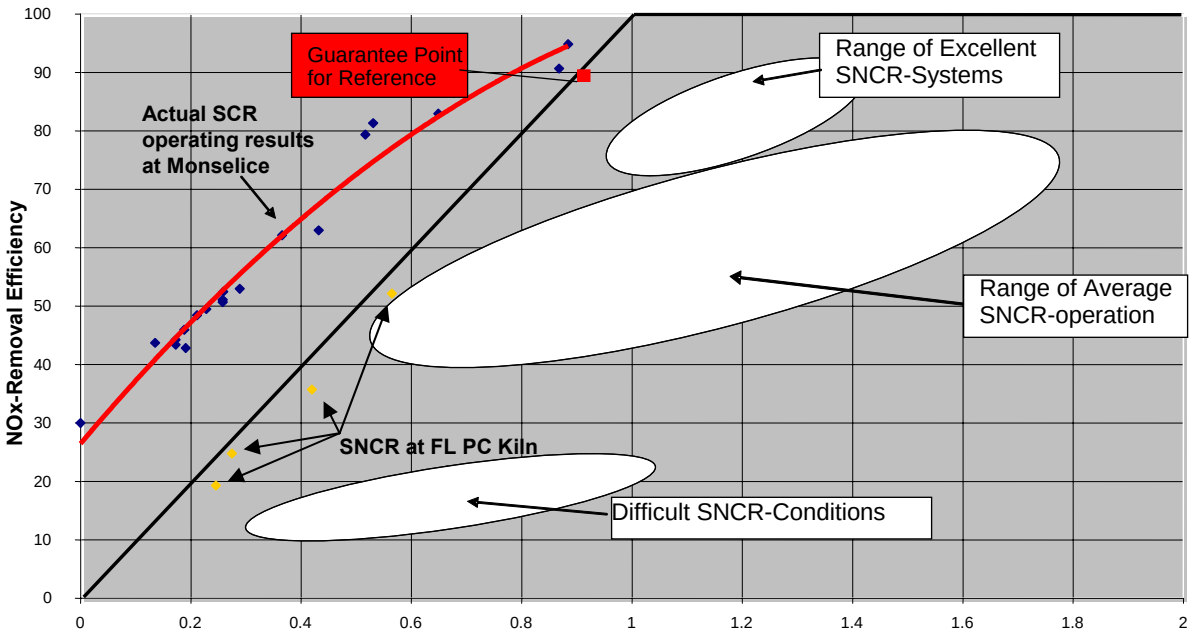


Figure 17. SCR Efficiency at Cementeria di Monselice compared with SNCR Systems

During February and March 2007, ammonia emissions based on continuous emission monitoring data averaged 2 mg NH_3/m^3 at CM compared to emissions as high as 150 mg/m^3 before installation of the SCR system. An SNCR system on the CM kiln would increase rather than reduce the pre-control NH_3 emissions.

SNCR tests conducted at one Florida preheater/calciner kiln yielded the data points that fall just to the right of the unity line, at least for molar ratios up to 0.55. Beyond that level, the characteristic line will tend to curve to the right and towards the long axis of the ellipse describing the "excellent SNCR systems".

Because the raw materials in Florida do not contain much NH_3, the performance of an SCR system on a Florida kiln would also be just to the right of the unity line (rather than on the left as in CM). The points would, in contrast to the SNCR system, continue to "hug" the line even at high molar ratios. Overall for modest NO_X reductions (~50%) at Florida cement kilns, SNCR is likely to be almost as efficient as SCR.

For greater NO_X removal efficiency requirements, the kilns in Florida (excellent SNCR conditions) using SNCR would require more NH_3 reagent and would exhibit greater slip than they would if they were outfitted with SCR. In many other parts of the country, the trends towards greater reagent consumption, greater slip and possible plume formation at even moderate NO_X removal targets can be more pronounced (difficult SNCR conditions).

SCR can be beneficial as well in areas where VOC reductions are also necessary or as a dioxin/furan control strategy.

Equations 11 and 12. Hydrocarbons can be oxidized on the catalyst. As a specific example, the equations for the proven oxidation of dioxin and furan on the catalyst are given below:

$$C_{12}H_nCl_{8-n}O_2 + (9+0.5n)O_2 \rightarrow (n-4)H_2O + 12CO_2 + (8-n)HCl$$

$$C_{12}H_xCl_{8-n}O + (9.5+0.5n)O_2 \rightarrow (n-4)H_2O + 12CO_2 + (8-n)HCl$$

Conclusion regarding SCR. Based on the foregoing, SCR has been demonstrated and is available for the cement industry. SCR can achieve low NO_X reductions with lower NH_3 emissions than SNCR. It can also achieve reductions in VOC and D/F.

C. SULFUR DIOXIDE CONTROL

Inherent Scrubbing of Fuel Sulfur Dioxide. Sulfur dioxide (SO_2) formed by burning fuel in the main kiln burner can be efficiently scrubbed out by reactions with alkali species (Na and K) in the kiln to form stable sulfate compounds that are incorporated into the clinker.

Equation 13. Kiln SO_2 reaching the calciner and all SO_2 from burning fuel in the calciner are completely scrubbed out at the temperatures prevailing in the calciner as follows: [24]

$$CaO + SO_2 \leftrightarrow CaSO_3 \text{ or } CaO + SO_2 + 0.5O_2 \leftrightarrow CaSO_4$$

At 1,045°C, the formation and decomposition reactions for $CaSO_4$ are at equilibrium at normal excess oxygen levels. As materials move through the high temperature regime in the kiln, the $CaSO_4$ can break down per the above reaction releasing the SO_2 or it can fuse/react with the alkali sulfates and other species to form stable compounds that depart with the clinker.

In summary, the control of fuel SO_2 is not an issue in modern kilns. Limiting fuel sulfur makes little or no difference in emissions. Generally severe operational problems such as coating formation and blockages will occur due to use of high sulfur fuels before significant SO_2 emissions occur. [25]

Control of Raw Material SO_2. Sulfide or elemental sulfur contained in raw materials may be "roasted" or oxidized to SO_2 in areas of the pyroprocessing system where sufficient oxygen is present and the material temperature is in the range of 300-600°C.[26,27] SO_2 emissions are very low at Florida PH/C kilns because there are only minute amounts of sulfur in most of the available limestone, with the exception of random pockets in northernmost Florida.

Uncontrolled SO_2 emissions can be very significant when pyritic sulfur is present in the raw materials and much greater than the very minimal emissions caused by fuel sulfur.

Operating the raw mill promotes raw material lime SO_2 removal by limestone scrubbing under humid conditions, due in part to freshly generated limestone surface produced by grinding. Some of the SO_2 generated in the top preheater stages is also scrubbed out by small amounts of free CaO that are carried back from hotter zones by combustion flue gases.

Another SO_2 removal technique is to extend the inherent self-scrubbing (by CaO) that occurs in the calciner to the upper sections of the preheater where pyrite-derived SO_2 is evolved. This involves conveyance of lime from the calciner (by differential pressure) to the upper stages of the preheater. The system consists of a cyclone and some ductwork and involves no moving parts.[28]

A very fine suspension of slaked lime can be introduced into the gas-conditioning tower to remove SO_2, particularly when the raw mill does not operate. The droplets react, dry, and are captured by the particulate control equipment where excess lime (from the dried droplets) continues to remove remaining SO_2.[29]

If the control measures mentioned above are insufficient to achieve permitted SO_2 requirements, then conventional wet or dry scrubbers can be considered. The TXI Midlothian scrubber system was estimated to cost $13,000,000. Emissions of SO_2 from the new kiln were still permitted at over 1,300 tons per year and 1.33 lb/ton of clinker but are likely much lower.[30]

The inherently low SO_2 emissions from cement kilns in Florida do not warrant serious consideration of add-on control equipment or any of the described procedures. The exception is in parts of the state where some limestone deposits contain pyrites or chert. In such cases, SO_2 emissions are minimized by selective mining or intermittent hydrated lime injection.

D. Carbon Monoxide (CO) and Volatile Organic Compounds (VOC) Control

CO and VOC are pollutants formed by the incomplete combustion of the fuels fired during pyroprocessing or by evolution of carbonaceous or hydrocarbon fractions in raw materials (such as fly ash and mill scale) in the preheater. Emissions of CO and VOC are controlled by:

1. Relatively low carbonaceous matter and hydrocarbons in the raw materials;
2. Good combustion at the main kiln burner and calciner;
3. Addition of tertiary air from the kiln hood and clinker cooler; and
4. Varying degrees of calciner sizes and duct lengths to complete burnout.

Referring back to Figure 7, it is easy to appreciate that CO and VOC evolved by carbonaceous and oily material entering the top of the preheater will not be exposed to sufficiently high temperatures to completely oxidize these pollutants. It is also easy to appreciate that fuel in the kiln and calciner can be completely combusted given the prevailing temperature regime, turbulence, and excess air.

Both of the SCC designs in Figures 8 and 9 provide for very hot excess air from the kiln hood and clinker cooler and it is only a matter of holding the relatively high temperature during adequate residence time to minimize CO and VOC from fuel combustion as described in Table 2. Most of the recently approved kilns have incorporated designs with relatively low residence time. These include Polysius kilns at Suwannee American Cement, Florida Rock and Rinker/Florida Crushed Stone.

The design proposed by CEMEX and the one installed at Titan Pennsuco are characterized by high residence times on the order of 7 seconds. Therefore very low CO emissions are expected and have actually been measured using CO CEMS as shown in the following figure.

The graph on the left side of the figure shows the emission characteristics of the CEMEX Victorville Kiln 3 that has a KHD Humboldt Wedag design similar to the one proposed for CEMEX Brooksville. The graph on the right shows the characteristics of the Titan Pennsuco Kiln that uses the F.L. Smidth design. Both have long residence times. With respect to CO, the CEMEX Victorville KHD calciner appears to perform better than the Titan Pennsuco F.L. Smidth calciner. With regard to NO_X, the Titan Pennsuco F.L. Smidth version appears to perform better.

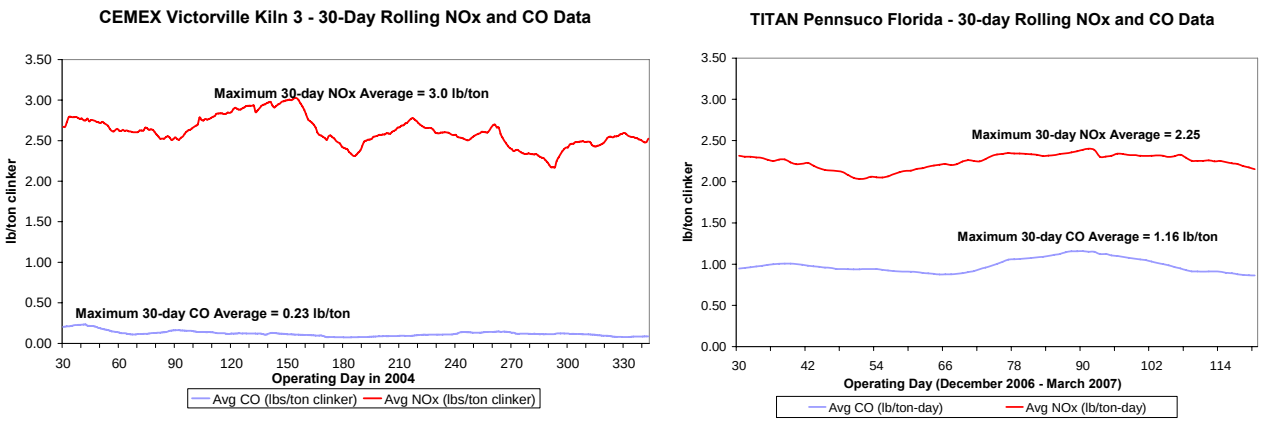


Figure 18. CO and NO_X Emissions from CEMEX Victorville and Titan Pennsuco Kilns

VOC and CO from raw materials can be controlled by judicious selection of the raw materials. This is not a simple task if the origin is native limestone, clay, and sand. If the source is additives such as mill scale or coal ash (such as with high LOI), there are some options. These include accessing different mill scale sources[31] (or coal ash) or grinding and metering directly into the kiln.[32] Presumably the Titan Pennsuco kiln uses some raw materials that have a greater contribution to total CO emissions than the CEMEX Victorville Kiln 3.

Extremely high levels of CO and VOC emanating from native raw materials can be controlled by a regenerative thermal oxidation system (RTO). Such a system was installed at the Holcim Dundee Michigan Plant to combat odor problems. A $17,500,000 RTO system was installed at the TXI Midlothian Plant to deal with inherently and unusually high carbonaceous matter in the limestone and to avoid PSD for both CO and VOC. The system consists of 11 RTO modules and covers an area equal to a "football field". Natural gas is used to heat the system.

An expensive alternative to RTO is a carbon/coke filter such as included in the Polvitec system installed at the Holcim Siggenthal Cement Plant.[33, 34] The unit was installed in conjunction with a program to burn pelletized sewage sludge from the City of Zurich.

The native limestone in Florida does not contain high levels of carbonaceous material or oily substances such as kerogen. Therefore controls such as RTO and Polvitec are not necessary to achieve low VOC and CO levels. Judicious selection of the raw materials, proper combustion in the calciner and sufficient burnout residence time are sufficient controls to achieve low CO and VOC values.

E. Particulate Matter (PM and PM_{10})

Particulate matter, or PM, is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. PM_{10} represents particles with an aerodynamic diameter of less than 10 microns (µm) which represent the cut-off size for particles that can enter into the pulmonary system. $PM_{2.5}$ represents particles less than 2.5 µm in aerodynamic diameter and considered to be "fine" particles. Because of their small size, fine particles can lodge deeply into the lungs. PM consists of all generated particulate matter and includes PM_{10} as well as $PM_{2.5}$.

PM can be directly emitted by fuel combustion and processes that lead to material abrasion. PM, especially the $PM_{2.5}$ fraction, can also be by atmospheric reaction of precursors such as SO_2, NO_X, VOC and ammonia emitted from traffic, industry, fuel combustion and even agriculture.

For reference, all of the precursors can be emitted from cement plants. This is the reason that a complete program of PM control includes minimization of PM and its precursors.

PM is emitted from all of the operations at cement plants including quarrying, crushing, material transfer and storage, grinding and blending, pyroprocessing, finish grinding, and packaging and loading. Quarrying and crushing are not potentially large generators of dust at the proposed project site because the basic limestone is mined under the water table without the need for blasting, etc. Even after some dewatering and drying the material generally contains a large fraction of fixed moisture.

Operations between the quarry and raw material transport are less of a concern because the PM tends to be large and falls out locally. Also it is typically much like naturally occurring dust. In contrast, emissions from pyroprocessing include the $PM_{2.5}$ precursors. Intermediate and final products such as clinker, cement and baghouse dust are alkaline and can be corrosive to human tissue.

At this facility, all dust generated in the pyroprocessing operation constitutes raw material and is returned to the process. Dust from the new line will be similarly handled. At the most modern plants, material and emissions from the kiln, raw mill and clinker cooler are controlled by a single very large fabric filter baghouse. The proposed project will have separate baghouses for the kiln system (including the raw mill) and for the cooler.

Electrostatic precipitators (ESPs) are an alternative to large baghouse and have been used in some of the earlier projects. Both control strategies achieve PM control on the order of 99% or better and each has its benefits. One main benefit of a baghouse is that it is less affected by power trips. For example, ESPs are depowered whenever CO concentrations rise above a certain level and present an explosive threat.

The other key strategy towards control of PM emissions (especially $PM_{2.5}$) from pyroprocessing is the minimization of SO_2, NO_X, VOC, and ammonia (NH_3) such as from the SNCR system.

The single baghouse arrangement (for the kiln, raw mill and cooler) at the recently modernized Titan Florida Pennsuco Cement Plant is shown in the following figure.

Figure 19. Titan's Main Baghouse, Lower Preheater Raw Mill Cyclones to Main Baghouse.

The raw mill, cyclones and duct work to the kiln baghouse are on the far right of the figure. The arrangement at CEMEX Line 3 will include separate baghouses for the kiln and the clinker cooler. Existing Lines 1 and 2 also have separate kiln and clinker cooler baghouses.

Emission control from operations after pyroprocessing is also very important because of the caustic nature of the product. However, there is every incentive to prevent these emissions as they would otherwise represent loss of valuable product. Material transfer, grinding, storage, packing, and shipping operations are controlled by baghouses in conjunction with inertial separators, internal storage in silos, operation under negative pressure, etc.

Common controls to limit particulate emissions from fugitive sources (such as roadways, stockpiles, and material processing and conveying equipment) include application of water for dust suppression, removal of dust, application of other dust suppressants, paving of roads and covering of stockpiles to reduce wind erosion.

A well controlled plant usually has a "clean look" that comes from application of BACT controls from key emission units and reasonable precautions to minimize fugitive emissions. The following figure contains photographs that were taken at the Suwannee American Cement Plant in Branford, Florida.

Figure 20. Mining, Materials Delivery, Pyroprocessing Area, Product Storage and Shipping

VII. RULE APPLICABILITY

A. State Regulations

This project shall comply with all applicable provisions of the Florida Administrative Code (including applicable portions of the Code of Federal Regulations incorporated therein) and, specifically, the following Chapters and Rules:

Table 5. State Regulations Applicable to Portland Cement Plants.

Chapter 62-4	Permits.
Rule 62-204.220	Ambient Air Quality Protection
Rule 62-204.240	Ambient Air Quality Standards
Rule 62-204.260	Prevention of Significant Deterioration Increments
Rule 62-204.360	Designation of Prevention of Significant Deterioration Areas
Rule 62-204.800	Federal Regulations Adopted by Reference
Rule 62-210.300	Permits Required
Rule 62-210.350	Public Notice and Comments
Rule 62-210.370	Reports
Rule 62-210.550	Stack Height Policy

Rule 62-210.650	Circumvention
Rule 62-210.700	Excess Emissions
Rule 62-210.900	Forms and Instructions
Rule 62-212.300	General Preconstruction Review Requirements
Rule 62-212.400	Prevention of Significant Deterioration
Chapter 62-213	Operation Permits for Major Sources of Air Pollution
Rule 62-296.320	General Pollutant Emission Limiting Standards
Rule 62-297.310	General Test Requirements
Rule 62-297.401	Compliance Test Methods
Rule 62-297.570	Test Reports
Rule 62-297.520	EPA Continuous Monitor Performance Specifications
Rule 62-297.701	Portland Cement Plants

B. Federal Regulations

This project shall comply with all applicable provisions of the following regulations:

Table 6. Federal Regulations Applicable to Portland Cement Plants.

40 CFR 50	National Primary and Secondary Ambient Air Quality Standards
40 CFR 60, Subpart A	General Provisions
40 CFR 60, Subpart Y	Standards of Performance for Coal Preparation Plants
40 CFR 60, Subpart OOO	Standards of Performance for Nonmetallic Mineral Processing Plants
40 CFR 63, Subpart A	General Provisions
40 CFR 63 Subpart LLL	National Emissions Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry – Major Sources

C. PSD Applicability and Preconstruction Review

The Department regulates "major" air pollution facilities in accordance with Florida's Prevention of Significant Deterioration (PSD) program, in accordance with Rule 62-212.400, F.A.C. PSD preconstruction review is required in areas that are in attainment with the state and federal Ambient Air Quality Standards (AAQS) for each regulated pollutant, or areas designated as "unclassifiable" for these pollutants. A facility is considered "major" with respect to PSD if it emits or has the potential to emit 250 or more tons per year of any regulated pollutant, or emits 100 or more tons per year of any regulated pollutant and belongs to one of 28 "PSD major facility categories", or emits 5 or more tons per year of lead.

Once a new facility is considered "major", each regulated pollutant is reviewed for PSD applicability based on the Significant Emission Rates (SERs) defined in Rule 62-210.200 (Definitions), F.A.C. Any pollutant emissions expected to be above the listed SERs are considered to be "significant" and are subject to PSD preconstruction review which includes a Best Available Control Technology (BACT) determination and ambient air quality impact analysis. A facility can be "major" for only one regulated pollutant, and still be subject to preconstruction review for several PSD-significant pollutants.

This project is located in Hernando County, which is an area presently in attainment for all criteria pollutants in accordance with Rule 62-204.360, F.A.C, therefore a PSD preconstruction review is required. Because CEMEX Brooksville is a portland cement plant belonging to one of the 28 "PSD major facility categories" and has the potential to emit 100 tons per year of at least one of the regulated pollutants, the facility is considered "major" with respect to PSD. The following table summarizes the applicant's PSD applicability analysis based on a comparison of potential emissions of the project to the SERs.

Table 7. Summary of PSD Applicability

Pollutant	PSD SER's (TPY)	Project Emissions (TPY)	Subject to PSD?
Carbon Monoxide (CO)	100	3,088	Yes
Nitrogen Oxides (NO_X)	40	1,675	Yes
Particulate Matter (PM/PM_{10})	25/15	438/323	Yes
Sulfur Dioxide (SO_2)	40	232	Yes
Sulfuric Acid Mist (SAM)	7		No
Volatile Organic Compounds (VOC)	40	98.7	Yes
Fluorides (F)	3	0.8	No
Lead (Pb)	0.6	0.06	No
Mercury (Hg)	0.1 (200 lb)	0.092 (184 lb)	No

As shown in the table, the project is subject to PSD preconstruction review for emissions of carbon monoxide (CO), nitrogen oxides (NO_X), particulate matter (PM/PM_{10}), sulfur dioxide (SO_2), and volatile organic compounds (VOC). Therefore, the applicant must provide a supporting air quality analysis and the Department must determine the (BACT) for each PSD-significant pollutant.

D. NESHAP Requirements

This facility is subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP) at 40 CFR 63, Subpart LLL applicable to portland cement plants. Subpart LLL contains Maximum Achievable Control Technology (MACT) requirements for Hazardous Air Pollutants (HAPs). These include limits on PM/PM_{10}, dioxin/furan, Hg, and total hydrocarbon (THC).[35]

E. BACT Determination procedure

Best Available Control Technology or "BACT" is defined in Rule 62-210.200 (Definitions), F.A.C. as:

a. *An emission limitation, including a visible emissions standard, based on the maximum degree of reduction of each pollutant emitted which the Department, on a case by case basis, taking into account:*

   1. *Energy, environmental and economic impacts, and other costs;*
   2. *All scientific, engineering, and technical material and other information available to the Department; and*
   3. *The emission limiting standards or BACT determinations of Florida and any other state; determines is achievable through application of production processes and*

available methods, systems and techniques (including fuel cleaning or treatment or innovative fuel combustion techniques) for control of each such pollutant.

b. *If the Department determines that technological or economic limitations on the application of measurement methodology to a particular part of an emissions unit or facility would make the imposition of an emission standard infeasible, a design, equipment, work practice, operational standard or combination thereof, may be prescribed instead to satisfy the requirement for the application of BACT. Such standard shall, to the degree possible, set forth the emissions reductions achievable by implementation of such design, equipment, work practice or operation.*

c. *Each BACT determination shall include applicable test methods or shall provide for determining compliance with the standard(s) by means which achieve equivalent results.*

d. *In no event shall application of best available control technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 40 CFR Parts 60, 61, and 63.*

For reference, the U.S. EPA requires that BACT determinations conducted by its own offices and by states delegated to conduct BACT determinations under its PSD rules at 40 CFR 52.21 must be determined using the "top-down" approach. The Department is not required to use this methodology because it has an EPA-approved State Implementation Plan (SIP) at 40 CFR 52, Subpart K that includes the BACT definition and procedure described above. However the Department's BACT definition and determination process generally achieve the same outcome and do not preclude top/down methodology.

Under the top/down approach, available control technologies are ranked in order of control effectiveness for the emissions unit under review. The most stringent alternative is evaluated first. That alternative is selected as BACT unless the alternative is found to not be achievable based on technical considerations or energy, environmental or economic impacts. If this alternative is eliminated for these reasons, the next most stringent alternative is considered. This Top/Down approach is continued until BACT is determined. In general EPA has identified five key steps in the top/down BACT process:

1. Identify alternative control technologies;
2. Eliminate technically infeasible options;
3. Rank remaining control technologies by control effectiveness;
4. Evaluate most effective controls; and
5. Select BACT.

F. Department's BACT review

It is important to note that no NSPS or NESHAP limits were set by EPA for NO_X, SO_2, CO, or VOC. These two rules set limits on PM. The NESHAP also sets limits on total hydrocarbons (THC – similar to VOC), Hg, and dioxin/furan.

<u>Nitrogen Oxides</u>. CEMEX proposes an emission limit of 1.95 pounds per ton of clinker (lb NO_X/ton) by a combination of staged combustion (SCC) in the calciner and SNCR. The principle of SCC was discussed in Section B above including the example of the FLS calciner wherein levels near 2 lb NO_X/ton are achieved, for example at CEMEX Santa Cruz, TXI Midlothian and Titan Pennsuco.

The "top" technology based on permitted limits is 200 milligrams per dry standard cubic meter, dry, and at 10 percent oxygen (mg/m^3) at the Heidelberger Cement Skövde and Slite Plants in Sweden. This value equates to approximately 0.9 lb NO_X/ton and is accomplished by high efficiency SNCR. Maerker Cement in Germany meets the same value based on the amount of waste used.

The lowest value for any permitted kiln in the United States is 95 lb NO_X/hour ton on a 24-hour basis for the proposed Drake Cement Plant in Arizona. This value is equivalent to 1.14 lb/ton. The low limit is necessary due to proximity to a number of Class I areas such as the Grand Canyon. The BACT limit within the same permit is 1.95 lb/ton on a 30-day basis.[36]

In 2005 and early 2006, the Department issued permits with BACT determinations for additional kilns at three cement plants and two greenfield plants. These include Suwannee American Cement, Florida Rock, Rinker/Florida Crushed Stone, Sumter Cement, and American Cement. BACT was determined to be 1.95 lb NO_X/ton by a combination of Low NO_X Kiln Burner, Indirect Firing, SCC and SNCR. These determinations were made before the Department obtained more detailed data for the European SNCR and SCR installations than previously available.

According to the initial application for the CEMEX Brooksville Line 3, the costs to achieve 1.95 lb NO_X/ton (starting from 3.5 lb/ton) by SNCR were estimated to be approximately $500 per ton NO_X removed, while the costs to achieve the same value by SCR estimated at approximately $2,000 per ton NO_X removed. The costs were subsequently revised upward and were calculated for several target emission rates. The applicant's estimated costs to achieve 1.5 lb NO_X/ton values are $1,027 and 2,362 by SNCR and SCR respectively.

A cost comparison between SNCR and SCR technologies was given in a recently published paper by the Research Institute of the German Cement Works Association (VDZ) and an operator in Germany.[37] The costs developed are for reduction of NO_X from 850 mg/m^3 to 250 mg/m^3 (3.9 to 1.15 lb/ton clinker) or 70%. The first three rows of the following table are from that paper.

Table 8. Cost Calculation by the VDZ "NO_X Abatement" Working Group for a Kiln with 3,500 metric tonnes per day Clinker Capacity. (NO_X Abatement Rate: 850 → 250 mg/m^3).

Cost Type	Unit	SNCR Process	SCR Process
Capital Costs	€	~ 880,000	~ 6,400,000
Specific Operating Costs	€/tonne clinker	0.40	0.70
Specific Total Costs	€/tonne clinker	0.54	1.43
Capital Costs	$	~ 1,153,000	~ 8,320,000
Specific Operating Costs	$/ton clinker	0.47	0.83
Specific Total Costs	$/ton clinker	0.64	1.69
Cost Effectiveness	$/ton NO_X removed	465	1,230

The last four rows were added by the Department assuming a conversion rate of $1.30/€ and a reduction of 2.75 lb/ton of clinker (i.e. from 3.9 – to 1.15 lb/ton clinker). Note that "tonne" means a metric tonne and "ton" means a short ton.

The cost-effectiveness estimates by VDZ for a European application are roughly one-half of the values estimated by CEMEX for the Brooksville installation. Coincidentally, the proposed CEMEX Brooksville Kiln 3 will have a capacity of 3,850 tons per day of clinker. This equates to approximately 3,500 metric tones per day as given in the VDZ analysis.

According to the previously cited Swedish government source, the cost effectiveness of NO_X abatement at the Slite facility by SNCR is 250 €/tonne of NO_X removed or approximately $300/ton of NO_X removed (to achieve 0.9 lb/ton). According to the German Federal Environmental Office, the abatement costs to achieve 200 mg/m^3 are approximately 450 and 470 €/tonne NO_X removed by SNCR and SCR respectively. These values equate to approximately $540 and $565/ton NO_X removed by SNCR and SCR respectively to achieve 0.9 lb/ton.[38]

The abatement costs by SCR at the Cementeria di Monselice (CM) are estimated at 1 to 1.30 €/tonne clinker at the 90 percent removal level. This would equate to less than $500/ton of NO_X removed. In the case of CM the total reduction in terms of lb NO_X/ton is significantly greater because of the high baseline (pre-control) emissions so the cost-effectiveness is very favorable. By comparison with the European estimates the CEMEX cost-effectiveness for both the SNCR and SCR cases appear high. However even at the values estimated by CEMEX, both technologies are cost-effective.

The Department believes that the proposed CEMEX Kiln No. 3 can easily achieve less than 3.5 lb NO_X/ton by its SCC strategy alone given the performance of the KHD Humboldt Wedag PYROCLON calciners installed at LaFarge Roberta (AL) Alabama, CEMEX Kosmosdale (KY) and CEMEX Victorville (CA). Even lower values by SCC alone could be achieved using the FLS calciner such as used at CEMEX Santa Cruz (CA), Titan Pennsuco (FL), and Phoenix Cement (AZ).

Reduction to 1.50 lb/ton from either CEMEX' estimated pre-control value of 3.5 lb/ton or a typical FLS value of 2.0 would be cost-effective and relatively easy to accomplish with reasonable molar ratios and minimal slip using SNCR.

The limit at the older preheater kilns located at CEMEX Brooksville is approximately 2 lb/ton and is achieved through SNCR by injecting much more ammonia per ton of NO_X removed than it would take to treat emissions from the new kiln to 1.50 lb NO_X/ton.

The Department concludes that BACT for the present project is 1.50 lb/ton on a 30-day averaging time and achievable by a combination of SCC, SNCR or SCR, indirect firing and a Low NO_X main kiln burner. The value is the lowest BACT issued to-date in the United States and the second lowest NO_X limit to-date. It is also a reasonable value considering the proximity of the source to the Class I Chassahowitzka NWR. The value of 1.50 lb NO_X/ton will insure BACT for NO_X can be accomplished without causing excessive reagent usage or NH_3 emissions and without necessarily installing a large SCR system.

The applicant has the option to install an SNCR system or an SCR system or a combination of the two. According to news stories, CEMEX is considering an SCR system for its Lyons Plant in Colorado.[39]

Sulfur Dioxide. SCC proposes an emission limit of 0.20 lb SO_2/ton. This is a much lower emissions rate than achieved at most cement plants throughout the country where raw material sulfur is a large contributor to emissions even when the latter kilns include wet scrubbers. The Department considers the "top technology" to be the self scrubbing of fuel sulfur in the kiln and calciner coupled with use of raw materials that are very low in sulfur.

In 2005-2006, the Department issued five BACT SO_2 determinations for new kilns. These ranged from 0.20 to 0.28 lb SO_2/ton. At very low emission rates, further add-on control is not cost-effective. The Department has determined that 0.20 lb SO_2/ton on a 30-day basis is BACT for the CEMEX Brooksville project and has reasonable assurance that this value can be met by: use of low sulfur raw materials; self scrubbing of fuel SO_2 by finely divided lime in the calciner; removal by moisture and finely divided limestone in the raw mill; and ultimate incorporation into the clinker within the kiln.

Although the limit will be 0.20 lb/ton, the Department expects day-in/day-out emissions on the order of 0.01 to 0.05 lb/ton. The reader is referred to the SAC website for typical CEMS based readings at: www.suwanneecement.com/liveemissions.html .

Carbon Monoxide and Volatile Organic Compounds. CEMEX proposes emission limits of 2.9 lb CO/ton and 0.115 lb VOC/ton. The VOC proposal is very low and equates to about 1/3 of the applicable MACT standard for greenfield cement kilns.

The Department considers a regenerative thermal oxidizer to be the "top technology". As previously mentioned, an RTO was installed at TXI that cost $17,500,000. It was installed to avoid PSD during a plant expansion and was not a BACT determination. TXI recently applied to the Texas Environmental Quality Board to turn off the RTO system outside of the ozone season. A settlement was reached with petitioners opposed to the TXI request and requires that the RTO system be used year-round. The revised CO and THC/VOC limits at TXI are given in the following table.

According to the agreement, the effective CO limits at the TXI project will be equivalent to 1.56 lb CO/ton clinker at an annual tonnage factor (2,190 TPY) rather than a technological limit. The VOC limit (as total hydrocarbons – THC) is equivalent to 0.06 lb VOC/ton.

Table 9. Agreement Regarding RTO and CO, VOC/THC Limits at TXI Midlothian Plant

ELEMENTS OF AGREEMENT			
	Existing permit	**TXI's Request**	**Agreed-upon permit**
Total Hydrocarbons	44 TPY	603 TPY	< 84 TPY
Carbon Monoxide	370 TPY	7,743 TPY	2,190 TPY
SOURCE: Mediated agreement with TXI, Blue Skies Alliance, Downwinders At Risk and 22 Midlothian residents			

In contrast to the native raw materials available in parts of Michigan, Texas and Colorado, the raw materials in Florida do not cause high CO or VOC formation. For example, without the RTO emissions from the TXI plant would be over 15,000 TPY of CO and more than 1000 TPY of VOC. By contrast CEMEX's estimates of controlled emissions of 2,037 and 84 TPY of CO and VOC respectively from the planned Brooksville Line 3 project are much lower and are approximately equal to the permitted emissions from the TXI (with RTO).

An RTO system at the CEMEX Brooksville project would be too costly on the basis of total capital costs and cost per ton of CO removed. It is less expensive to implement controls on fuels, selection of raw material additives such as mill scale and power plant ash as well as combustion controls.

Recently, the Department issued permits for new kilns to be constructed at SAC, FRI, and Rinker/Florida Crushed Stone, American Cement, Sumter Cement and for production increases at the existing kilns at SAC, FRI, and Titan Florida. The determinations have ranged from 2 to 3.6 lb CO/ton and 0.11 to 0.12 lb VOC/ton. The recently noticed Ash Grove project in Nevada includes a CO BACT limit of 1.05 lb/ton. The existing preheater kilns at CEMEX Brooksville are limited to 1.2 lb/ton of feed (< 2 lb/ton of clinker)

According to CEMS data analyzed and shown in Figure 18 above, the relatively new CEMEX Victorville Kiln 3 never exceeded 0.23 lb CO/ton on a 30-day basis in 2004, while the Titan Pennsuco Kiln has not exceeded 1.16 lb/ton on a 30-day basis since a new in-stack CEMS was installed in 2006.

Based on the long residence time planned for the new CEMEX Brooksville Kiln 3, it should easily be possible to achieve emissions of 2.0 lb CO/ton on a 30-day basis. It is especially prudent to set a limit that will discourage use of certain raw materials, in particular certain fly ash, with properties that can cause dioxin/furan formation or that contain mercury (Hg) removed from power plants under various state and federal programs. This potential phenomenon is discussed in the section on mercury below.

The Department's BACT determinations for CO and VOC are 2.0 and 0.115 lb/ton, respectively based on kiln/calciner design, characteristics of primary raw materials, and judicious selection and procurement of additives.

Particulate Matter ($PM/PM_{10}/PM_{2.5}$). PM represents all particles emitted from a source. PM_{10} consists of coarse "inhalable particles" as well as "fine particles" ($PM_{2.5}$). Coarse inhalable particles comprise the category of PM_{10} that includes those particles with aerodynamic diameters between 2.5 and 10 microns (μm). This class of particles includes dust resuspended by traffic dust, tire and brake wear, crushing, grinding, silica, fly ash, construction/demolition, disturbed soils, industrial fugitive emissions, and biological sources.

$PM_{2.5}$ is also inhalable and is emitted directly, such as in smoke from a fire. It can also form from chemical reactions of gases such as sulfur dioxide, nitrogen dioxide and some organic gases. Sources of $PM_{2.5}$ and its precursors include power plants, gasoline and diesel engines, wood combustion, high-temperature industrial processes such as smelters and steel mills, and forest fires.[40]

CEMEX proposes PM/PM_{10} emission limits of 0.153 lb/ton of clinker for the pyroprocessing system (kiln/preheater/calciner/in-line raw mill) and 0.08 lb/ton from the clinker cooler. The total from the two systems equals 0.23 lb PM/PM_{10}/ton of clinker. CEMEX proposes a visible emissions limitation of 10% opacity from the pyroprocessing system and from the clinker cooler.

For reference the applicable NSPS and NESHAP MACT emissions limits is 0.3 lb PM/ton of feed from the kiln and 0.1 lb/ton of feed from the clinker cooler for a total of 0.4 lb PM/ton of feed. After conversion to lb/ton of clinker, the BACT values are equivalent to approximately 1/4th of the NSPS/NESHAP limits. Similarly, there are separate NSPS/NESHAP opacity limits for the kiln and clinker cooler of 10 and 20% respectively. By complying with the more stringent 10% limit, CEMEX's proposal is more stringent than the NSPS/NESHAP opacity limits.

The Department reviewed recent emission limit determinations for PM/PM_{10}. The sum of emissions limits from the pyroprocessing and cooler are shown in the PM_{10} column in the table below. The limits ranged from 0.095 to 0.28 lb/ton of clinker. The range of values is given in the following table

that also includes the Department's proposed BACT determinations for all pollutants including PM/PM_{10}.

Table 10. Emission Limits for in Recent Cement Plant Permits in lb/ton of Clinker.

Project	NO_X (lb/ton)	SO_2 (lb/ton)	CO (lb/ton)	VOC (lb/ton)	PM_{10} (lb/ton)	Total[a] (lb/ton)
CEMEX Brooksville (Application)	1.95	0.20	2.9	0.12	0.23	2.50
CEMEX Brooksville (Determination)	1.50	0.20	2.0	0.115	0.15	1.97
Drake Cement LLC, AZ	1.14/1.95	0.06	3.6	0.12	0.21	1.53
Ash Grove/Moapa, Nevada (Draft)	1.95	0.42	1.05	0.0625	0.095	2.53
Sumter Cement, Center Hill	1.95	0.20	2.9	0.115	0.15	2.42
American Cement, Sumterville	1.95	0.20	2.9	0.12	0.15	2.42
Suwannee American, Branford Kiln 2	1.95	0.20	2.9	0.12	0.17	2.44
Florida Rock, Newberry Kiln 2	1.95	0.28	3.6	0.12	0.28	2.63
Rinker/FCS, Brooksville Kiln 2	1.95	0.23	3.6	0.12	0.20	2.50
Holcim Lee, Missouri (2004)	2.4	1.26	6.0	0.33	0.35	4.34
CEMEX Brooksville Kiln 2 (rev. 2007)[b]	2.0	0.20	2.0	0.115	0.15	2.47
Titan Florida Medley (1999, rev. 2006)[c]	2.17	0.50	2.0	0.14	0.10	2.91

a. Total for $PM_{2.5}$ surrogates and potential precursors. Total does not include CO.
b. Only the NO_X Limit at existing CEMEX Brooksville Kilns is Recent.
c. Only the CO Limit at Titan is BACT. The rest were set to avoid PSD. SNCR is not practiced at Titan.

The Department's BACT determinations for PM/PM_{10} are 0.10 and 0.05 lb PM_{10}/ton of clinker from the pyroprocessing system and the clinker cooler respectively. The total value for comparison with the other projects is 0.15 lb/ton. The main kiln and cooler baghouses will be designed with particulate removal efficiency on the order of 99.9%. This is sufficient to limit hourly emissions to 24 lb/hour of PM/PM_{10}. The Department accepts CEMEX's proposal for visible emissions of 10 percent opacity for the pyroprocessing and cooler systems as BACT.

One strategy towards control of $PM_{2.5}$ is to minimize emissions of its surrogates and precursors including PM_{10}, SO_2, NO_X, VOC, and NH_3. The aggregate of $PM_{2.5}$ surrogates and precursors (NO_X+SO_2+VOC+PM_{10}) based on the Department's BACT determination CEMEX project is the second lowest among the listed projects. While this parameter is not a recognized PM2.5 measurement system, it is a very useful indicator of PM2.5 formation potential. Similarly, the Department's BACT determination in each category of $PM_{2.5}$ surrogate or precursor is the second lowest among those shown in the table.

There are no NH_3 emission limits for the above projects although do include maximum molar ratios of NH_3/NO_X. Relatively low NH_3 emissions are expected from CEMEX Line 3 because the NO_X reduction objective by SNCR or SCR (~57% with the KHD calciner) is not very high. Where precontrolled NO_X (or natural NH_3) emissions are high or when very low NO_X emissions are required, SCR can be an effective $PM_{2.5}$ control strategy by reducing NH_3, NO_X, VOC and SO_2.

The characteristics of other baghouses in the proposed Line 3 project are shown in the following table.

Table 11. Baghouse Characteristics and PM_{10} Emissions for Enclosed Emissions Sources.

Point	Point Description	acfm	°F	Opacity	dscfm	gr/dscf	TPY
Emissions Unit 033 - Raw Materials Handling and Storage							
PS61	Sand/mill scale reception hopper	4,875	120	5%	4,352	0.007	1.13
PS62	Bottom Ash reception hopper	4,875	120	5%	4,352	0.007	1.13
PS63	Ash/mill scale/sand bins	5,000	122	5%	4,448	0.007	1.18
PS65	Limestone silo and Clay Silo	5,000	120	5%	4,463	0.007	1.18
Emissions Unit 034 - Raw Mill System							
PS64	Additive Bins- Feeders	5,000	120	5%	4,463	0.007	1.18
PS64A	Additive Transfer Point	2,000	120	5%	1,785	0.007	0.44
PS64AA3	Additive Transfer Point	2,000	122	5%	1,785	0.007	0.44
PS61	Hoppers to mill transfer (1 of 2)	2,000	120	5%	1,785	0.007	0.44
PS62A	Hoppers to mill transfer (2 of 2)	7,915	120	5%	7,095	0.007	1.86
PS66	Cyclones to feeding silo	5,000	120	5%	4,463	0.007	1.18
PS69	Bottom of bucket elevator to blending silo	5,000	156	5%	4,202	0.007	1.10
PS70	Blending silo	10,000	156	5%	8,405	0.007	2.20
PS71	Weigh Hopper after blending silo	1,500	122	5%	1,334	0.007	0.35
PS72	Air slide after weigh hopper to bucket elevator (1 of 2)	1,500	122	5%	1,334	0.007	0.35
PS72A	Air slide after weigh hopper to bucket elevator (2 of 2)	1,500	122	5%	1,334	0.007	0.35
PS73	Air slide after bucket elevator to preheater	2,500	122	5%	2,224	0.007	0.56
PS68	Filter dust hopper	15,000	122	5%	1,334	0.007	0.35
Emissions Unit 037 - Clinker Handling and Silo							
PS75	Clinker Transfer deep pan conveyor	5,000	156	5%	4,202	0.007	1.10
PS76	Clinker Silo	5,000	120	5%	4,462	0.007	1.10
PS77	Truck unload clinker buffer	5,000	156	5%	4,202	0.007	1.10
Emissions Unit 038 and 039 – Finish Mills Feed and Finish Mill System							
PS78	Finish Mill Feed	7,916	120	5%	7,066	0.007	1.83
PS78G	Gypsum silo	2,500	120	5%	2,232	0.007	0.56
PS78S	Slag Silo	2,500	120	5%	2,232	0.007	0.56
PS78L	Limestone dust silo	2,500	120	5%	2,232	0.007	0.56
PS78GO	Gypsum transfer from silo	1,500	120	5%	1,339	0.007	0.35
PS78SO	Slag transfer from silo	1,500	120	5%	1,339	0.007	0.35
PS78LO	Limestone dust transfer from silo	1,500	120	5%	1,339	0.007	0.35
PS79	Finish Mill	400,233	203	5%	312,518	0.007	82.1

Emissions Unit 040 Cement Silos and Loadout							
PS80	Cement Transfer	2,500	156	5%	2101	0.007	0.55
PS81	Cement form Bucket Elevator to belt Conveyor	3,000	120	5%	2,677	0.007	0.7
PS82A	Quadrate Silo #8	2,500	120	5%	2,231	0.007	0.58
PS83A	Quadrate Silo #9	2,500	120	5%	2,231	0.007	0.58
PS82	Loadout Spout #8	2,800	120	5%	2,499	0.007	0.65
PS83	Loadout Spout #9	2,800	120	5%	2,499	0.007	0.65
Emissions Unit 041 Coal/Coke Mill							
PS84	Coke/coal transfer to mill	1,650	120	5%	1,473	0.007	0.39
PS84A	Coke/coal transfer to mill	1,650	120	5%	1,473	0.007	0.39
PS87	Coke/coal mill	69,356	183	5%	55,841	0.007	14.6
PS88	Pulverized fuel bin (1 of 2)	1,500	122	5%	1,334	0.007	0.35
PS89	Pulverized fuel bin (2 of 2)	1,500	122	5%	1,334	0.007	0.35
PS85	Coke/coal bin	1,500	122	5%	1,334	0.007	0.35
PS86	Coke/coal bin	1,500	122	5%	1,334	0.007	0.35

BACT for the enclosed emission sources shown in the table served by baghouses will be an opacity limitation of 5%. This will be achieved by baghouses designed to meet respective PM and PM_{10} emissions characteristics of 0.01 and 0.007 grains per dry standard cubic foot (gr/dscf). Visible emissions from any transfer point on belt conveyors or from any other affected facility shall not exceed 10% opacity. Because of its large size and significant potential to emit (84 TPY), the main finish Mill baghouse will also be limited to a corresponding emission rate of 18.8 pounds PM/PM_{10} per hour (lb/hr).

BACT for unenclosed sources is generally control of particulate matter emissions by inherent or applied moisture. Material and fuel storage piles will be stored under roof or in enclosed vessels. Storage piles shall be shaped, compacted and oriented to minimize wind erosion. Storage piles shall be wetted with devices located near such piles when visual inspection determines wetting is needed. Water spray bars shall be located at each unenclosed conveyor and used for wetting of materials and fuel if inherent or previously-applied moisture is insufficient to prevent unconfined PM emissions. Paving of the new area and access roadways is required.

The key emissions unit for basic raw materials is the Raw Material Quarrying, Crushing and Storage System. The existing primary crusher that is presently used for Lines 1 and 2 will be replaced whether or not Line 3 is constructed with a new jaw crusher under Permit No. 0530010-027-AC issued on January 18, 2007. The same jaw crusher will be used for Line 3. The secondary crusher presently used for Lines 1 and 2 will also meet the requirements of Line 3. Improvements including installation of a Gamma metric cross belt analyzer and a Neutron source limestone correction system were included under the mentioned permit.

Quarrying in Florida is usually conducted beneath the water table rather than by blasting and mining of open pits. Therefore dust emissions are inherently less than encountered in other parts of the country. The Raw Material Quarrying, Crushing and Storage System was not shown in earlier permits as a unit subject to 40 CFR 60, Subpart A – General Provision and 40 CFR 60 Subpart OOO - Nonmetallic

Mineral Processing Plants. The Department included the Subpart A and Subpart OOO requirements in Permit No. 0530010-027-AC.

The existing Limestone Storage Building will be expanded under the Line 3 project to accommodate two additional limestone piles to meet the requirements for Line 3. The crushers will not be further modified but their usage will increase due to the Line 3 project. The measures in Subpart OOO together with the wet processing of raw materials and the Department's Reasonable Precautions in Rule 62-296.320(4)(c), F.A.C. will insure that emissions from the Raw Material Quarrying, Crushing and Storage System are minimized. These measures are also sufficient as BACT for the additional quarrying, use of the crushers, expansion of the Limestone Storage Building and operation of the additional storage piles related to the Line 3 project.

Mercury (Hg). A BACT determination was not required for Hg because emissions will be less than 200 lb/year. The applicant has proposed a limit on Hg emissions of 190 lb/yr. However due to the concerns about Hg emissions from industrial sources, it is still necessary to evaluate the possible contribution of Line 3 to overall Hg loadings to the environment.

The following diagram was developed from a diagram in a CEMBUREAU report that was modified by the Department to show what happens to Hg within a cement pyroprocessing system. The following paraphrased abstract is from a paper by the Forschungsinstitut der Verein Deutscher Zementindustrie (VDZ) regarding operational factors that affected Hg emissions from two German cement kilns.[41]

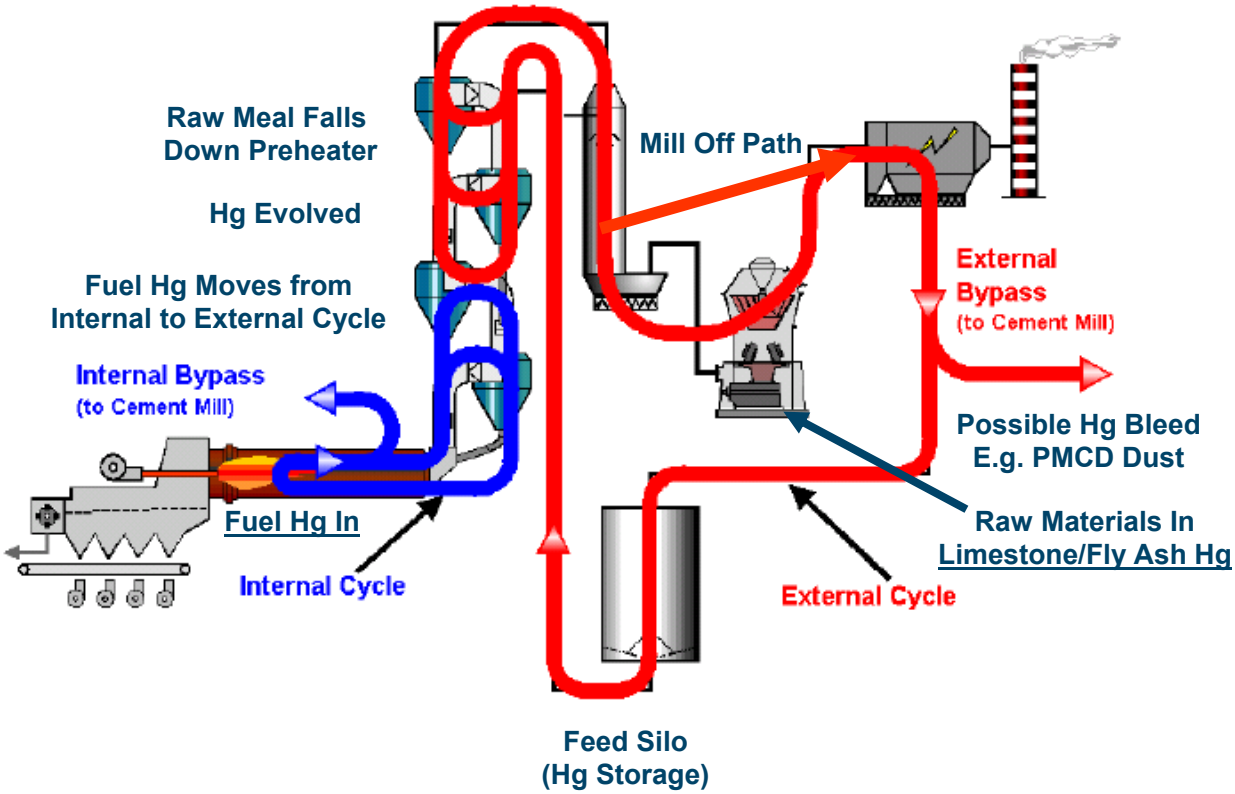


Figure 21. The Behavior of Hg in a Cement Kiln and Possible Bypass Stream.

Because of its vapor pressure characteristics, the Hg is not retained in the kiln or preheater. Depending on exhaust gas temperature it passes with the raw gas into the downstream systems. The Hg which has been introduced builds up in the external recirculation system between the preheater, particulate matter control device (PMCD) and raw mill. The feed silo serves as a temporary buffer

which feeds the Hg back into the preheater after a time delay. To limit the external Hg recirculating system and to minimize the Hg emissions it is expedient to remove some of the meal (actually dust) from the PMCD especially during periods of direct (raw mill down) operation.

Not only the temperature regime in the exhaust gas but also the extent and nature of removal of raw material from the exhaust gas cleaning system are of considerable importance for possible buildup of Hg in external recirculating systems in cement plants. The comparison between continuous and discontinuous measurement of the Hg emission concentration showed substantial discrepancies in some cases, especially in direct operation. There was better agreement between the measured results in interconnected (raw mill up) operation.

The abstract also states that the Hg input via the fuels is significantly less than the input via raw materials. Following is a graphic representation of the manner by which samples of the Hg inputs are collected by most operators of cement kilns in Florida that are subject to annual mass emission limits.[42]

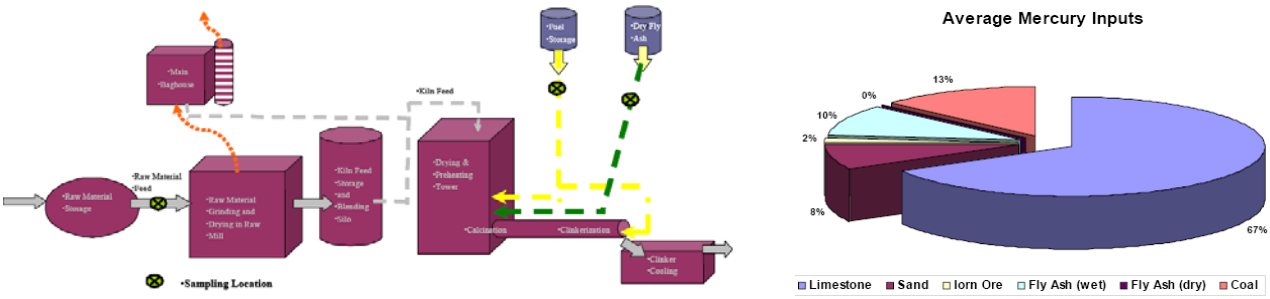


Figure 22. Hg Monitoring Sampling Locations. Sources of Hg into Cement Process

Several samples are collected on a daily basis from all of the material inputs to the process and then made into a daily composite. The daily composites are made into monthly composites. These monthly composites are then analyzed for the mercury concentrations.

If a monthly sample is below the detection limit, the operator assumes the detection limit which <u>overestimates</u> the amount of Hg input. By assuming that all inputted mercury exits via the stack and no mercury exits via the clinker, conservative estimates of emissions are made that insure annual emissions will be less than the permitted annual Hg limit. According to operators who rely on this method of compliance, the limestone is the primary source of Hg inputs to the system and comprises about 2/3 of the total.

The contribution from power plant fly ash shown in the above diagram is on the order of 23 percent (%) of total Hg input. Because of the control to be implemented at power plants pursuant to the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR) there is reason to believe that fly ash available as raw material or even as fuel to the cement industry can become further enriched in Hg.

EPA recently set Hg limits through the MACT process under Section 112 of the Clean Air Act. In its most recent rulemaking (40 CFR 63, Subpart LLL) that was noticed in the Federal Register on December 20, 2006, EPA set a limit of 41 micrograms per dry standard cubic meter at 7 percent oxygen ($\mu g/m^3$).

Within the rule, EPA recognized the possibility of Hg enriched fly ash and the Final Rule includes a ban only on fly ash derived from power plants that use activated carbon to reduce Hg emissions (unless shown to not impact cement plant emissions). The need was described by the Clean Air Task Force (CATF) in its comments dated April 18, 2006 (EPA-HQ-OAR-2002-0051-0156) that state:

If EPA allows fly ash to be used as a feed material, captured particulate matter from the kilns (cement kiln dust) will contain increased mercury and must be managed accordingly. For example, the practice of recycling the captured dust back through the kiln must not be allowed as this practice would allow for the re-release of mercury from the activated carbon. Etc.

The Department indicated similar but more generalized concerns to EPA regarding fly ash containing Hg whether or not the originating power plant uses activated carbon to control Hg. Fly ash can become enriched with Hg simply due to measures taken in the furnace to reduce nitrogen oxides (NO_X). The measures include installation of Low NO_X burners (LNBs) with Separate Overfire Air (SOFA) and also reburn. These are basically staged combustion processes.

In either case there will be less complete carbon burnout at the power plant. Carbon monoxide (CO) emissions increase as well as carbon in the fly ash contributing to high "loss on ignition" (LOI) fly ash that (unless remediated) is not useful for direct use in concrete and becomes more attractive for cement pyroprocessing. The additional carbon in the power plant furnace exhaust is not as effective as activated carbon in capturing Hg, but there is much more of it. Therefore the overall effect on fly ash can be as significant as described by CATF for the activated carbon scenario.

The following figure shows how this phenomenon can occur and cause additional Hg to be captured in the power plant PMCD.

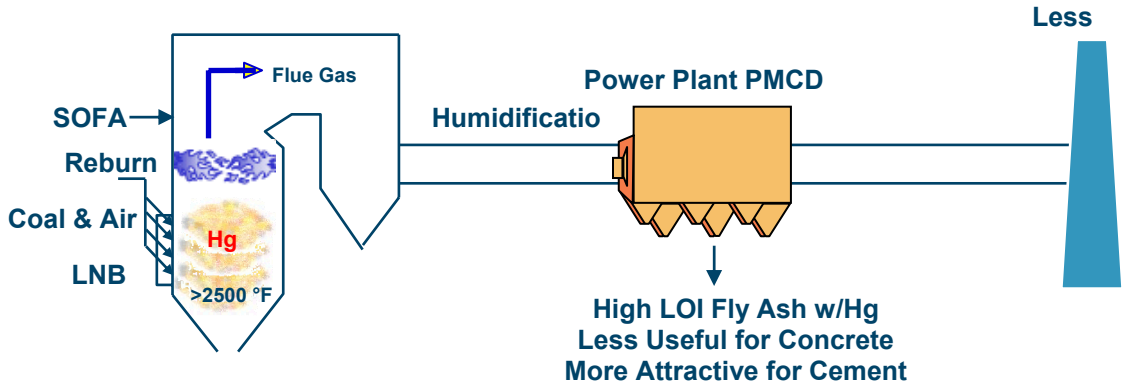


Figure 23. Combustion Controls for NO_X Including LNBs, Reburn, SOFA

The Department acquired data from two out of state power plants that practice NO_X control consisting of one or more of the methods described above. The concentration of Hg in the fly ash was on the order of 0.5 parts per million by weight (ppmw). Fortunately the fly ash was remediated such that it was rendered useful for concrete. According to tests conducted by the Department on the product, the Hg stayed in the concrete quality fly ash and was not available for re-emission. According to 40 CFR 63, Subpart LLL:

No owner or operator of a reconstructed or new kiln or reconstructed or new inline kiln/raw mill located at a facility which is a major source subject to the provisions of this subpart shall cause to be discharged into the atmosphere from these affected sources any gases which: (5) Contain mercury from the main exhaust of the kiln, or main exhaust of the in-line kiln/raw mill, or the alkali bypass in excess of 41µg/dscm if the source is a new or reconstructed source that commenced construction after December 2, 2005. As an alternative to meeting the 41 µg/dscm standard you may route the emissions through a packed bed or spray tower wet scrubber with a liquid-to-gas (l/g) ratio of 30 gallons per 1000 actual cubic feet per minute (acfm) or more and meet a site specific emissions limit based on the measured performance of the wet scrubber.

New and reconstructed kilns and in-line kilns/raw mills must not exceed the average hourly CKD recycle rate measured during mercury performance testing. Any exceedance of this average hourly rate is considered a violation of the standard.

While the limit of 41 µg/dscm would allow annual Hg emissions of 265 lb/yr, the requirement to meet the standard during the raw mill up and raw mill off condition suggests that actual emissions will be much less than this value and likely much less than 190 lb/yr as proposed by CEMEX.

The requirement thereafter to limit dust recycling to pyroprocessing at the values practiced during the testing will further insure low annual emissions. The weakness in the standard is that a single annual stack test is required for each condition (raw mill on/off). There can be very substantial discrepancies in measured emissions during each of the described conditions depending upon the timing of the tests with respect to the timing of the raw mill operation. Further analysis is beyond the scope of this assessment and the reader is referred to the referenced paper.

The Department will require compliance demonstration with the annual limits by fuel and raw material sampling and testing as previously described. The sum of any 12 month period of the total inputted mercury in the described manner will be less then the requested Hg limit of 190 lb/yr. Data from existing cement plants that follow the same or similar procedures suggest that emissions will be significantly less than the limit requested.

The Department will also rely on a combination of the emission limit of 41 µg Hg/dscm and the measures given in 40 CFR 63, Subpart LLL to further insure substantially lower Hg emissions than the annual limit of 190 lb/yr. Because of concerns about Hg emissions to the environment, the Department believes it is important to measure emissions accurately and continuously rather than just conservatively and in a discontinuous manner.

CAMR requires installation of recently developed or improved (3rd Generation) continuous emission monitoring system for Hg (Hg-CEMS) at power plants for the purpose of accurately measuring and trading Hg allowances in such a manner that total statewide Hg emissions will be reduced.

The Department concluded that the 3rd generation CEMS will be available and reasonably accurate by the time the recently approved Sumter Cement and American Cement projects start operation. The Department will require CEMEX to install a Hg-CEMS as part of this project. Such systems are routinely used in Germany. The following figure shows pictures of the Hg-CEMS, principle of operation, monitoring screen and plant setting at the Solnhofer Cement Plant in Bavaria.

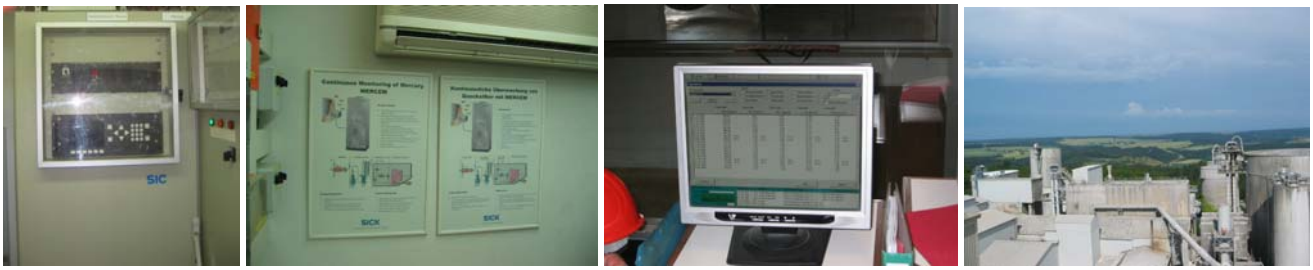


Figure 24. Hg-CEMS, Hg-CEMS Principle, Monitoring Screen, Solnhofer Plant Setting (Linero)

While promulgating 40 CFR 63, LLL as a Final Rule, the EPA noticed its possible Reconsideration on the same date. If EPA subsequently makes changes in Subpart LLL that impinge on the foregoing analysis, the Department reserves the right to review how changes may affect the emissions of Hg from CEMEX Line 3 and after public notice take measures to preserve the stringency of the assumed Hg control measures and practices.

The final issue relates to the fate of dust withdrawn in accordance with the practices described in 40 CFR 63, Subpart LLL. The Department believes that CEMEX can store the dust and introduce it to the product cement without unduly affecting the product suitability for Type I/II cement. The Department initiated discussions with the Florida State Department of Transportation experts and with CEMEX and will continue to expand those discussions on an ongoing basis to avoid possible waste generation.

VIII. AIR QUALITY ANALYSIS REVIEW

A. Introduction

The proposed project will increase emissions of five pollutants at levels in excess of PSD significant amounts: PM/PM_{10}, CO, NO_X, SO_2 and VOC. PM_{10}, SO_2 and NO_X are criteria pollutants and have national and state ambient air quality standards (NAAQS or AAQS), PSD increments, significant impact levels and de minimis monitoring levels defined for them. CO is a criteria pollutant and has only AAQS, significant impact levels and de minimis monitoring levels defined for it. There are no applicable PSD increments, AAQS, significant impact or de minimis monitoring levels for VOC. However, VOC is a precursor to the criteria pollutant, ozone; and any net increase of 100 tons per year of VOC requires an ambient impact analysis including the gathering of preconstruction ambient air quality data.

The air quality impact analyses required by the PSD regulations for this project include:

- An analysis of existing air quality for PM_{10}, SO_2, NO_X, CO and VOC;
- A significant impact analysis for PM_{10}, SO_2, NO_X and CO;
- A PSD Class II increment analysis for PM_{10} and a Class I increment analysis for PM_{10} and NO_X;
- An Ambient Air Quality Standards (AAQS) analysis for PM_{10}; and
- An analysis of impacts on soils, vegetation, visibility and growth-related air quality impacts.

The analysis of existing air quality generally relies on preconstruction monitoring data collected with EPA-approved methods. The significant impact, PSD increment, and AAQS analyses depend on air quality dispersion modeling carried out in accordance with EPA guidelines. Based on the required analyses, the Department has reasonable assurance that the proposed project, as described in this report and subject to the conditions of approval proposed herein, will not cause or significantly contribute to a violation of any AAQS or PSD increment. A discussion of the required analyses follows.

B. Analysis of Existing Air Quality in the Vicinity of the Project

Sources of Air Pollution in Hernando and Contiguous Counties

The following table includes reported emissions from the existing cement kilns in Hernando County and the applicant's estimated emissions for the Line 3 project.

Table 12. Annual Emissions (TPY) from some Key Sources in Hernando, Contiguous Counties.

Plant	NO_X	SO_2	CO	VOC	PM
CEMEX Cement, Hernando (Proposed Line 3)	**1,370**	**141**	**2,037**	**84**	**358**
CEMEX Cement, Hernando (Line 1 and 2)	1,371	14	499	82	265
Rinker/Central Power & Lime, Hernando	5,277	3,420	?	?	398
Center Hill Cement Plant, Sumter (Proposed)	1,675	232	3,088	99	438
Progress Crystal River Power Plant, Citrus	35,000	94,000	?	?	13,000
Progress Anclote Power Plant, Pasco	10,700	33,000	?	?	4,300

One existing or planned source from each of the contiguous counties is included in the table to provide a sense of proportion to additional load from the proposed CEMEX Line 3 project. Power plant emissions are the most substantial contributors to the regional stationary source pollution loading. General traffic contributions are not shown, but provide the greatest contributions to VOC and CO as well as considerable emissions of NO_X.

Air Quality and Monitoring in Hernando and Adjacent Counties

The State of Florida operates a large ambient air quality monitoring network. Monitors are located to characterize background ambient air quality, air quality in populated areas, and air quality at areas of greatest impact from industrial activities.

The following map shows the location of the monitors nearest to the proposed project site.

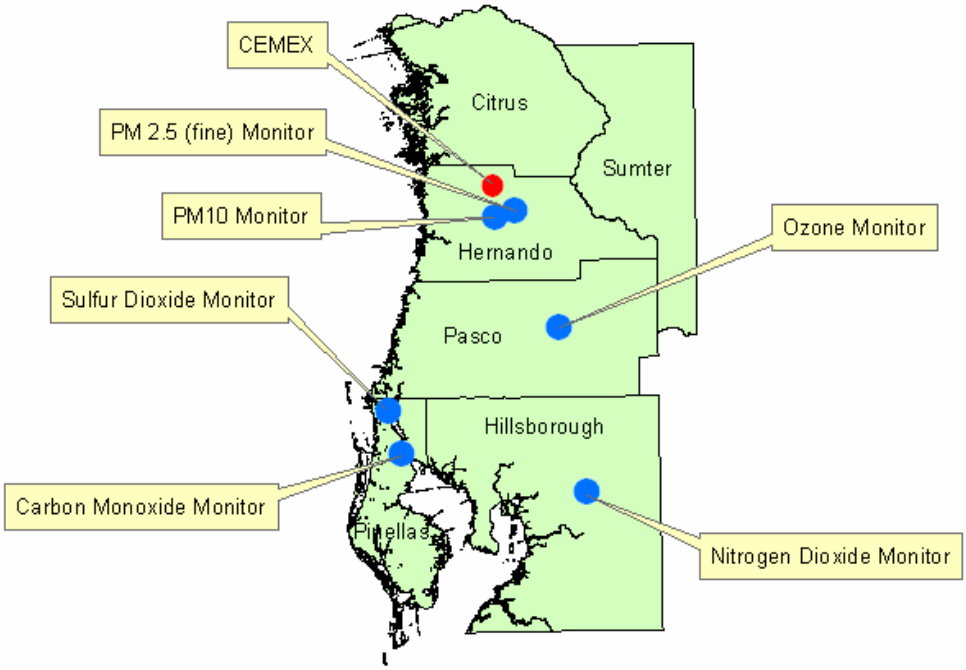


Figure 25. Monitor Locations Nearest to the CEMEX Cement Plant.

The ozone monitor in Pasco County is representative of the entire rural region because ozone formation is a wide scale phenomenon. The "fine PM" and PM_{10} monitors are located by cement facilities and are operated by private industry. The nearest State-operated PM fine and PM_{10} monitors are located in Citrus and Pinellas counties respectively. The NO_2, CO and SO_2 monitors are located at points of maximum expected impacts from air pollutant sources and traffic in the urban Tampa Bay area.

Measured ambient air quality information from nearest monitors to the CEMEX site is summarized in the following table. All except the PM_{10} and $PM_{2.5}$ monitors are operated by the Department and adhere to its quality assurance (QA) requirements. The latter stations are operated by a consultant for Rinker Materials who operate the nearby Florida Crushed Stone Cement Plant in Brooksville. While the QA requirements are not necessarily identical to those of the Department, the proximity of those monitors to the proposed site makes the data invaluable in this assessment.

Table 13. Ambient Air Quality Measurements Nearest to Project Site (2005)

Pollutant	Location	Averaging Period	Ambient Concentration				
			High	2nd High	Mean	Standard	Units
Ozone	Dade City	1-hour	0.099	0.093		0.12 [a]	ppm
		8-hour	0.082	0.081		0.08 [a]	ppm
PM_{10}	Tarpon Springs	24-hour	30	25		150 [b]	$\mu g/m^3$
		Annual			16	50 [c]	$\mu g/m^3$
PM_{10}	Hernando Co.	24-hour	30	24		150 [b]	$\mu g/m^3$
		Annual			15	50 [c]	$\mu g/m^3$
$PM_{2.5}$	Hernando Co.	24-hour	37	22		35 [d]	$\mu g/m^3$
		Annual			10	15[d]	$\mu g/m^3$
SO_2	Tarpon Springs	3-hour	58	54		500 [b]	ppb
		24-hour	13	11		100 [b]	ppb
		Annual			2	20 [c]	ppb
NO_2	Plant City	Annual			7	53 [c]	ppb
CO	Clearwater	1-hour	3	3		35 [b]	ppm
		8-hour	1	1		9 [b]	ppm

a. Not to be exceeded (i.e. > 125 or > 85 ppb) on more than an average of 1 day per year over a 3-year period.
b. Not to be exceeded more than once per year.
c. Arithmetic mean.
d. 3-year average of the 98th percentile of 24-hour concentrations.
e. 3-year average of the weighted annual mean

The monitoring locations are all in attainment with the respect to the AAQS. Although the 8-hour ozone AAQS is 0.08 parts per million (ppm), the highest reported values of 0.081 and 0.082 ppm in Pasco County do not constitute exceedances. An exceedance would be a value of 0.085 ppm or greater.

Ozone is formed from precursors that are clearly available (NO_X and VOC) from nearby industry and traffic. Ozone at times approaches one of the NAAQS in nearby Pasco County. However, the 1 and 8-hour ozone concentration never exceeded 0.12 or 0.08 ppm (125 or 85 ppb) respectively.

The tendency to form ozone is accentuated by hot ambient temperature, high pressure, and relatively low wind speed. These factors are accentuated during drought years. The exact profile is not certain in Hernando County. The figure that follows the table contains plots of the "running" 1-hour and 8-hour average ozone concentrations in parts per billion (ppb) measured in nearby Pasco County during the two months in 2005 when the highest concentrations were recorded.

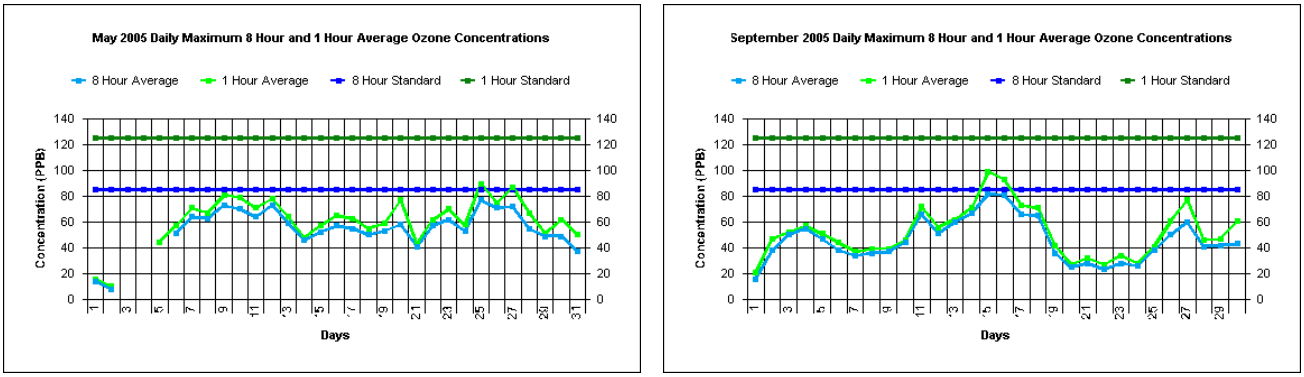


Figure 26. 1 and 8-hour ozone concentrations in Pasco County during May and September 2005

While Pasco County is influenced by the sources in the highly populated Tampa Bay area, Hernando County is closer to the large Crystal River Power Plant that is the largest NO_X source (ozone precursor) in the state.

The nearest PM_{10} monitors are in Hernando and Pinellas Counties respectively. These sites report PM_{10} concentrations significantly less than the NAAQS. Notably the results in terms of highest and average values from the state-operated PM_{10} monitor in Pinellas County are approximately equal to those from the Rinker-operated PM_{10} monitor in Hernando County. This suggests that the State Tarpon Springs monitor is a good reference for adjacent counties and that the Rinker monitor is also adequate despite uncertain QA procedures.

Examples are shown in the following figure together with a map indicating areas that are not in attainment with the new $PM_{2.5}$ standard. None are in Florida.

Figure 27. Sources of Inhalable Coarse and Fine Particles. Counties Exceeding PM $_{2.5}$ AAQS.

According to Rinker ambient levels of particulate matter are much less than the ambient standards (including the pre-2006 $PM_{2.5}$ limit of 65 µm).[43] The Rinker $PM_{2.5}$ monitoring data given above from 2005 support an overall conclusion that Hernando County is also in attainment with the recently promulgated AAQS. Although the highest daily measurement was greater than 35 µg/m^3, the value that exceeded 98 percent of daily measurements was 21.3 µg/m^3, which is approximately two-thirds (2/3) of the present limit.

The final observation regarding particulate matter is that *most* of the PM_{10} consists of fine particles rather than inhalable coarse particles. Based on the average values, $PM_{2.5}$ comprises approximately 2/3 of PM_{10}.

Values of CO, SO_2 and NO_2 are much less than the respective AAQS. However SO_2 and NO_X are precursors of $PM_{2.5}$ or ozone; pollutants that are present at levels relatively much closer to their respective limits.

Preconstruction Ambient Monitoring and Modeling Requirements

A preconstruction monitoring analysis is done for those pollutants with listed de minimis impact levels. This monitoring requirement may be satisfied by using previously existing representative monitoring data, if available. An exemption to the monitoring requirement shall be granted by rule if either of the following conditions is met:

- The maximum predicted air quality impact resulting from the projected emissions increase, as determined by air quality modeling using emissions at worst load conditions as inputs to the models, is less than a pollutant-specific de minimis ambient concentration; or
- The existing ambient concentrations are less than a pollutant-specific de minimis ambient concentration.

If preconstruction ambient monitoring is exempted, determination of background concentrations for PSD significant pollutants with established AAQS may still be necessary for use in any required AAQS analysis. These concentrations may be established from the required preconstruction ambient air quality monitoring analysis or from the existing representative monitoring data. The background ambient air quality concentrations are added to pollutant impacts predicted by modeling and represent the air quality impacts of sources not included in the modeling.

The table below shows project air quality impacts for comparison to de minimis ambient concentrations.

Table 14. Maximum Air Quality Impacts Compared with De Minimis Impact Levels.

Pollutant	Averaging Time	Max Predicted Impact (ug/m^3)	De Minimis Level (ug/m^3)	Baseline (ug/m^3)	Impact Greater Than De Minimis?
PM_{10}	24-hour	23	10	~30	YES
NO_2	Annual	0.7	14	~13	NO
SO_2	24-hour	1	13	~34	NO
CO	8-hour	35	575	~1150	NO

SO_2, NO_2 and CO impacts from the project are predicted to be less than the de minimis levels and preconstruction monitoring is not indicated for these pollutants. Similarly, CO, SO_2 and NO_2 emissions are not predicted to have significant impacts and no further modeling or monitoring is required.

PM_{10} impacts from the project are predicted to be greater than the corresponding de minimis level. Therefore, the applicant is not exempt from preconstruction monitoring for PM_{10}. As previously mentioned, most of the PM_{10} is actually in the form of $PM_{2.5}$. The Department believes that a $PM_{2.5}$ monitor for the purposes of pre and post construction monitoring is indicated closer to CEMEX and the nearby Chassahowitzka Class I area and will require one as a permit condition.

The Hernando PM_{10} data are approximately equal to data from Tarpon Springs. However the latter data cover a longer period of time and fulfill the Department's QA requirements. Therefore the Tarpon Springs data were used to specify the background upon which to overlay the project impacts.

Table 15. PM_{10} Monitor Data for Background Concentrations.

Years	Monitor Location	Concentration (µg/m^3) High, 1st high 24-hour average	Arithmetic Mean Concentration (ug/m^3) Annual Average
2001 – 2005	Pinellas County	54	20

VOC emissions are predicted to be less than the de minimis emission rate of 100 tons per year (TPY) that could otherwise require *ozone* modeling or further measurement. While the applicant's proposed NO_X emissions are 1,370 TPY, the ozone ambient impact evaluation requirement for sources greater than 100 TPY of NO_X has not yet been incorporated into Department rules and do not yet apply. However, the topic is of concern given the near ozone exceedances detailed in previous discussion and the issue is discussed in the section below on "Impact on Ozone, Visibility and Regional Haze".

C. Significant Impact, PSD Increment and AAQS Analyses

Models and Meteorological Data

The air quality models used are those listed in the "Guideline on Air Quality Models" in Appendix W of 40 CFR Part 51 at the time when the initial application for the proposed project was received by the Department.

PSD Class II Area

The EPA-approved Industrial Source Complex Short-Term (ISCST3) dispersion model was used to evaluate the pollutant emissions from the proposed project in the surrounding Class II Area. This model determines ground-level concentrations of inert gases or small particles emitted into the atmosphere by point, area, and volume sources. It incorporates elements for plume rise, transport by the mean wind, Gaussian dispersion, and pollutant removal mechanisms such as deposition.

The ISCST3 model allows for the separation of sources, building wake downwash, and various other input/output parameters. A series of specific model features, recommended by the EPA, are referred to as the regulatory options. The applicant used the EPA recommended regulatory options. Direction-specific downwash parameters were used for all sources for which downwash was considered. The stacks associated with this project all satisfied the good engineering practice (GEP) stack height criteria.

Meteorological data used in the ISCST3 model consisted of a concurrent 5-year period of hourly surface weather observations and twice-daily upper air soundings from Tampa and Ruskin Airports, respectively. The 5-year period of meteorological data was from 1991 through 1995. These National Weather Service stations were selected for use in this study because they are the closest primary weather stations to the study area and are most representative of the project site. The surface observations included wind direction, wind speed, temperature, cloud cover, and cloud ceiling.

The modeling source inputs consisted of point and volume sources. The 137 volume sources were used to model the truck traffic on paved roads by which the facility raw materials and cement are received and delivered respectively. These volume sources are the road segments for the whole facility whose emission rates are based on the truck/raw materials characteristics, i.e. weight. Including the volume sources ensure that the predicted air impacts for particulate matter are determined by not only the kiln itself but by all of the process-related fugitive or dust emissions that may occur within a cement facility. Typically, as the case with CEMEX, truck impacts are the greatest on the property line of the facility and decrease with distance.

The building configuration at the plant consists of multiple building complexes and many out-buildings used for storage, maintenance, etc. The dimensions of these buildings and structures were used in the modeling to determine downwash impacts. The applicant provided the Department with plot plans and electronic files representing the property and all sources, buildings, and fence line used in the modeling.

The Department has determined that the application complies with the applicable provisions of the stack height regulations as revised by EPA on July 8, 1985 (50 FR 27892). Portions of the regulations have been remanded by a panel of the U.S. Court of Appeals for the D.C. Circuit in NRDC v. Thomas, 838 F. 2d 1224 (D.C. Cir. 1988). Consequently, this permit may be subject to modification should EPA revise the regulation in response to the court decision. This may result in revised emission limitations or may affect other actions taken by the source owners or operators.

PSD Class I Area

The nearest distance of this site from the Class I Chassahowitzka National Wilderness Area (CNWA) is 15 kilometers. Since the PSD Class I area evaluated for impacts is less than 50 km from the proposed facility, the long-range transport model, CALPUFF, will not be appropriate for this Class I impact assessment. The ISCST3 model, as explained above for the Class II analysis, will also be used for the Class I analysis. ISCST3 will also measure nitrogen deposition impacts, an Air Quality Related Value (AQRV) for the Class I area CNWA. The other AQRV, visibility, was analyzed by using the models VISCREEN and PLUVUE II. VISCREEN and PLUVUE II are steady state, Gaussian-based plume dispersion models that analyzes plumes viewed against a background.

Significant Impact Analyses

Significant Impact Levels (SILs) are defined for PM/PM_{10}, CO, NO_X and SO_2. A significant impact analysis is performed on each of these pollutants to determine if a project can even cause an increase in ground level concentration greater than the SIL for each pollutant. In order to conduct a significant impact analysis, the applicant uses the proposed project's emissions at worst load conditions as inputs to the models. The highest predicted short-term concentrations and the highest predicted annual averages predicted by this modeling are compared to the appropriate SILs for the PSD Class I (CNWA) and PSD Class II Area (everywhere except the Class I areas).

If this modeling at worst-load conditions shows ground-level increases less than the SILs, the applicant is exempted from conducting any further modeling. If the modeled concentrations from the project exceed the SILs, then additional modeling including emissions from all facilities or projects in the area (multi-source modeling) is required to determine the proposed project's impacts compared to the AAQS and PSD increment.

Modeling to determine significance in the PSD Class II area in the vicinity of the project was conducted using a fence-line and polar receptor grid. The polar grid consisted of 20 radial rings using 10 degree spacing extending out to 10 km, a total of 720 receptors. The fence-line grid consisted of 224 receptors spaced at 100-meters apart.

The applicant's initial PM/PM_{10}, CO, NO_X, and SO_2 air quality impact analyses for this project indicated that maximum predicted impacts from all pollutants are less than the applicable SILs for the Class II area except for PM_{10}.

These values are tabulated in the following table and compared with existing ambient air quality measurements from the regional monitoring network. Clearly the maximum predicted impacts from the project are much less than the respective AAQS. PM_{10} was determined to have greater than significant impacts in the Class II area, therefore multi-source modeling is required.

Table 16. Maximum Projected Air Quality Impacts from CEMEX Kiln No. 3 Cement Project for Comparison to the PSD Class II Significant Impact Levels.

Pollutant	Averaging Time	Max Predicted Impact (ug/m^3)	Significant Impact Level (ug/m^3)	Baseline Concentrations (ug/m^3)	Ambient Air Standards (ug/m^3)	Significant Impact?
SO_2	Annual	0.06	1	~5	60	NO
	24-Hour	1	5	~34	260	NO
	3-Hour	4	25	~151	1300	NO
PM_{10}	Annual	3	1	~20	50	YES
	24-Hour	23	5	~54	150	YES
CO	8-Hour	35	500	~1150	10,000	NO
	1-Hour	114	2000	~3450	40,000	NO
NO_2	Annual	0.7	1	~13	100	NO

In the Class II area, the significant impact distance is the critical distance and determines the Significant Impact Area (SIA) over which additional multi-source modeling is required. The SIA is defined as a circular area centered on the proposed source with a radius equal to the critical distance. The SIA was established for the annual and 24-hour averaging period for PM_{10} for every year of meteorological data. The SIA over which AAQS and increment compliance modeling is performed, is the largest of these areas. The SIA based on maximum predicted ambient air concentrations of PM_{10} for all short-term and long-term periods was 4.6 km.

The nearest PSD Class I area is the CWNA located about 15 km from the project site. Maximum air quality impacts from the proposed project are summarized in the table on the following page.

The results of the initial PM/PM_{10}, NO_X and SO_2 air quality impact analyses for this project indicated that maximum predicted impacts from SO_2 and annual PM_{10} are less than the applicable SILs for the Class I areas. The results also indicate that the 24-hour PM_{10} and NO_2 are greater than the applicable SILs for the Class I areas, therefore further detailed modeling efforts is required.

Table 17. Maximum Air Quality Impacts from the CEMEX Kiln No. 3 Project for Comparison to the PSD Class I SILs at CWNA.

Pollutant	Averaging Time	Max. Predicted Impact at Class I Area (ug/m^3)	Class I Significant Impact Level (ug/m^3)	Significant Impact?
PM_{10}	Annual	0.1	0.2	NO
	24-hour	1.6	0.3	YES
NO_2	Annual	0.2	0.1	YES
SO_2	Annual	0.02	0.1	NO
	24-hour	0.19	0.2	NO
	3-hour	0.8	1	NO

PSD Increment Analysis

The PSD increment represents the amount that new sources in an area may increase ambient ground level concentrations of a pollutant over a baseline level set in 1977. Refined Class I and II Increment compliance modeling is performed only if the Significant Impact Analysis indicates that the project would have a significant impact on air quality. The purpose of this increment compliance modeling is to demonstrate that the new sources will not significantly cause or contribute to a violation of a PSD increment.

This modeling involved the sources under review as well as sources from within and near the SIA in the inventory prepared by the Department and the applicant using approved screening techniques for determining the sources to be included in the modeling analysis. These runs were to identify regulatory high receptors, high-first-high for each year for the NO_2 and PM_{10} annual average, and high-second-high over the five years for the PM_{10} 24-hour average.

The applicant submitted a PSD Class II increment analysis based on 50 meter receptor spacing along the fence line and a Cartesian receptor grid. The Cartesian grid consisted of a grid with 100 meter spacing from the origin out to 2 km, 500 meter spacing from 2 km to 5 km and 1000 meter spacing from 5 km out to 10 km. All maximum concentrations were then refined by using a 50 meter grid. Cartesian receptors within the plant boundary were excluded. Further, the Department added 25 meter spacing along the fence-line where the largest short-term impacts were predicted by the applicant to ensure compliance with the increment. The results of the PM_{10} Class II increment analysis are given in the following table and show that the maximum predicted impacts are less than the respective allowable increments.

The predicted long-term maximum annual impact is well below the allowable increment. The predicted short-term maximum 24-hour impact is just below the allowable increment, and is located on the property line nearby a road leading in/out of the facility. The maximum predicted PM_{10} increment consumption values decrease with distance from the property line.

Table 18. PSD Class II Increment Analysis.

Pollutant	Averaging Time	Maximum Predicted Impact ($\mu g/m^3$)	Impact > Allowable Increment? (Yes/No)	Allowable Increment ($\mu g/m^3$)
PM_{10}	Annual	5	No	17
PM_{10}	24-hr	29.8	No	30

The applicant submitted a PSD Class I increment analysis based on 113 receptors in the CNWA. The results of the NO_X and PM_{10} Class I increment analysis are given below and show that the maximum predicted impacts are less than the respective allowable increments.

Table 19. PSD Class I Increment Analysis.

Pollutant	Averaging Time	Maximum Predicted Impact ($\mu g/m^3$)	Impact > Allowable Increment? (Yes/No)	Allowable Increment ($\mu g/m^3$)
NO_X	Annual	1.3	No	2.5
PM_{10}	24-hr	5	No	8

Ambient Air Quality Standards (AAQS) Analysis

AAQS compliance modeling was performed for PM_{10} because the Significant Impact Analysis indicated that the new sources would have a significant impact on air quality in the Class II area. The purpose of AAQS compliance modeling is to demonstrate that the new sources will not cause or contribute to a violation of an AAQS. AAQS compliance modeling addressed all areas within the SIA. The applicant used the same methods, sources and grids that were in the increment analysis. The table below gives the results and shows that maximum predicted impacts are less than the AAQS.

Table 20. Ambient Air Quality Impacts

Pollutant	Averaging Time	Major Sources Impact ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	Total Impact Greater than AAQS	Florida AAQS ($\mu g/m^3$)
PM_{10}	Annual	5	20	25	No	50
PM_{10}	24-hr	29.8	54	84	No	150

Good Engineering Practice Stack Height Determination

A Good Engineering Practice (GEP) review was conducted for each proposed new source to determine if building downwash effects needed to be included in the modeling and to determine the appropriate stack heights to be used with the models. The new stacks will be lower than GEP height; therefore building downwash effects were included in the modeling analyses.

D. Additional Impact Analysis

Impact on Ozone, Visibility and Regional Haze

The applicant submitted a regional haze analysis for the Class I Area CNWA. The analysis included modeling from the VISCREEN and PLUVUE II models. The models used predicted impacts in compliance with visibility impairment based on criteria from the NPS for the proposed project. The Fish and Wildlife Service has been given the opportunity to review and comment regarding this analysis. No comments have been received at this time.

Ozone, visibility and regional haze are area-wide considerations and their reduction involves broad-based local and regional reductions in their precursors such as NO_X, SO_2, VOC and direct $PM_{10}/PM_{2.5}$ emissions.

Many existing power plants in Florida that contribute to visibility impairment will participate in a cap and trade program under the Clean Air Interstate Rule (CAIR). According to EPA's projections for Florida given in the following table, CAIR will encourage SO_2 reductions of approximately 308,000 TPY by 2015 (65%) and NO_X reductions of approximately 192,000 TPY (76%).

Table 21. EPA's Projections of Power Plant SO_2 and NO_X Reductions in Florida.

Pollutant	2003	2010	2015
SO_2 Emissions	475,000	218,000	167,000
NO_X Emissions	253,000	69,000	61,000

Because CAIR will be implemented via a cap-and-trade system, there are not plant-by-plant specific emission reduction requirements with the exception of the TECO Big Bend Station. However the Department has issued or is reviewing permits for the following projects in the nearby counties:

- Natural gas repowering of the residual fuel oil-fired Progress Bartow Plant in Pinellas County;
- Installation of SCR equipment at Lakeland Electric McIntosh Unit 3 in Polk County;
- An SO_2 scrubber and SCR at Progress Energy Crystal River Units 4 and 5 in Citrus County; and
- NO_X reductions by SCR at TECO Big Bend Station Units 1, 2, 3 and 4 in Hillsborough County.

The reductions in ozone precursors and $PM_{2.5}$ emissions and precursors will exceed the additional emissions from the CEMEX Line 3 project. The increases in regional ozone from CEMEX's additional VOC and NO_X emissions will also be moderated by reductions effected by the nearby power plant projects.

A sophisticated model to calculate the impacts on ozone from the CEMEX project would project impacts that will be less than the uncertainty of the actual regional ozone reductions that the power plant projects will actually effect.

Notwithstanding the above analysis, the Department is presently reviewing an application from CEMEX for a determination of Best Available Retrofit Technology (BART). This analysis is required because Line 1 was constructed during the applicable time frame for BART applicability and it has been shown that it has an effect on visibility in the nearby CNWA.

It is important to insure that Line 3 impacts are minimal. The Department has proposed the lowest NO_X BACT determination in the United States for the present project and the second lowest NO_X standard. The aggregates of $PM_{2.5}$ surrogates and precursors (NO_X+SO_2+VOC+PM_{10} + NH_3) and ozone precursors (NO_X+VOC) are low. Therefore the impacts on ozone, visibility and regional haze will be minimized.

The emission increases expected due to new cement projects in Hernando and Sumter Counties will not reverse the present and expected favorable trend towards less $PM_{2.5}$ and ozone precursor stationary source emissions in the region from Hillsborough to Citrus County.

Impacts on Soils, Vegetation, and Wildlife

The likely impacts to ambient air resulting from emissions of NO_X and PM_{10} are well below the applicable National Ambient Air Quality Standards. Compliance with PSD Class II and Class I increments establishes an effective ambient air quality standard that is much more stringent than the ambient air quality standards. As part of the Additional Impact Analysis, Air Quality Related Values (AQRV) are evaluated with respect to the Class I areas within 300 km. This includes the analysis of deposition.

The ISCST model is used in this analysis to produce quantitative impacts since the CNWA is within 50 km of the facility. The results of this analysis show that nitrogen deposition rates are 16% higher than the significant impact levels in the CWNA as determined by the National Park Service. The Fish and Wildlife Service received the application for the CEMEX Kiln No. 3 project. The Department has not received any comments or concerns regarding this project from the Fish and Wildlife Service.

The applicant provided additional information regarding vegetation. According to the application the most sensitive vegetation will experience adverse impacts from SO_2 if pollutant concentrations exceed 917 micrograms per cubic meter in an hour period. SO_2 emissions from the existing plant are reportedly only 14 TPY and are overwhelmed by other sources. Very low modeled concentrations of SO_2 (~6 $\mu g/m^3$) are predicted. Similar results are seen with NO_X and CO.

The projected CAIR reductions will also ameliorate some of the past regional impacts on soils, vegetation and wildlife. In conclusion, increases of PM_{10}, SO_2, CO and NO_X due to this project will not have a meaningful impact on soils, vegetation and wildlife.

Growth-Related Impacts Due to the Proposed Project

According to the applicant, the proposed project will result in approximately 20 new jobs at the existing cement plant. Therefore, no air quality impacts are expected as a result of commercial, residential or industrial growth as a result of this project.

The population of Hernando County grew from 44,469 in 1990 to 130,802 in 2000. Rather than causing significant growth additional growth in the area, the project is a response to substantial growth in Hernando and the contiguous or adjacent counties. Construction of the plants will reduce the present and expected high level of cement importation to Florida particularly from abroad.

IX. CONCLUSION

The Department makes a preliminary determination that the proposed project will comply with all applicable state and federal air pollution regulations as conditioned by the Draft Permit. This determination is based on a technical review of the complete PSD application, reasonable assurances provided by the applicant, the draft determinations of Best Available Control Technology (BACT), review of the air quality impact analysis, and the conditions specified in the Draft permit.

References

[1] Linero, A.A. "What's Up With Cement Plant Permitting?", in Proceedings of the 94th Annual Air and Waste Management Association Conference and Exhibition. June 2001. Orlando, Florida.

[2] Duoflex™ Kiln Burner, F.L. Smidth-Fuller: Bethlehem, PA, 1999.

[3] Linero, A.A. "SNCR NO_X at U.S. Cement Plants. Is SCR Close Behind?" in Proceedings of the 98th Annual Air and Waste Management Association Conference and Exhibition. June 2005. Minneapolis, Minnesota.

[4] Thomsen, K.; Jensen, L.S.; Schomberg, F. "FLS-Fuller ILC-Low NO_X Calciner Commissioning and Operation at Lone Star in St. Cruz in California," Zement Kalk Gips International, 1998, No. 10, 542-550.

[5] Terry, Mark S. "BACT: What is available with Today's Technology," Krupp Polysius Technical Seminar. 1999.

[6] Thomsen, K.; Jensen, L.S.; Schomberg, F. "FLS-Fuller ILC-Low NO_X Calciner Commissioning and Operation at Lone Star in St. Cruz in California," Zement Kalk Gips International, 1998, 10, 542-550.

[7] Sprung, Siegbert. Technological Problems in Pyroprocessing Cement Clinker: Cause and Solution. Beton Verlag. 1982.

[8] Electronic mail transmission and attachments from Lancaster, T., Environmental Manager, Titan America to A. A. Linero. NO_X and CO CEMS Data from Titan Pennsuco Cement Plant. November 2006 through February 2007.

[9] Florida Department of Environmental Protection. Annual Production Increase From Modernized Dry Process Cement Plant. Technical Evaluation and Draft CO BACT Determination for Titan America. October 12, 2005.

[10] Rowley, A. (CEMEX); Babel, D. (KHD). "The Kosmosdale Expansion Project" in Proceedings of the 2002 IEEE-IAS/PCA Cement Industry Technical Conference.

[11] Seymour, D.; Shureck, J. "Revamping Roberta" International Cement Review. June 2003.

[12] Florida Department of Environmental Protection. Production Increase, Fly ash Injection, and SNCR at Suwannee American Cement Plant. Final Permit Modification. March 15, 2005.

[13] Letter from Barry Lower of Holnam to Roger Randolph of the Missouri Air Pollution Control Program, November 6, 2000.

[14] Miller, F. M. "Management of Detached Plumes in Cement Plants" in Proceedings of the 2001 IEEE-IAS/PCA Cement Industry Technical Conference.

[15] Reference 14.

[16] Institute for Prospective Technological Studies, Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries; European Integrated Pollution Prevention and Control Bureau: Seville, Spain, March 2000.

[17] Verein Deutcher Zementwerke. Umweltdaten der Deutschen Zementindustrie 2004. Forschungsinstitut der Zementindustrie. September 2005. Dusseldorf, Germany.

[18] Junker, P., Director of Environmental Protection for Gotland County, Swedish EPA. "Reduction with SNCR Technology at Slite Cement Plant", In Proceedings of the *Paris NO_X/N_2O-conference,* March 21-22, 2001.

[19] Electronic mail transmission and attachments from Junkers, P., Director of Environmental Protection for Gotland County, Swedish EPA to A. A. Linero. Swedish Contribution to European Union Best Available Techniques Reference for the Cement Industry. August 14, 2006.

[20] Märker Zement, GmbH. Unterrichtung der Öffentlichkeit über Emissionen. www.maerker-gruppe.de/media/emizw05.pdf accessed on March 17, 2007, 2007.

[21] Electronic mail transmission and attachments from Ebertsch, G., Bavarian Environmental Agency to A. A. Linero, Florida DEP. Results of High Efficiency SNCR Installation at a Bavarian Cement Plant. July 26, 2006.

[22] Haug, N., Dr. Ing.; Sauter, G., Dipl. Ing.; Samant, G., Dr. Ing., "Einsatz der High-Dust-SCR Technologie in der Zementindustrie", in VDI Vortrag 2002.

[23] Leibacher, U.; Bellin, C.; Linero, A.A., "High Dust SCR Solution," International Cement Review. December 2006.

[24] Miller, F. M.; Hawkins, G. J. "Formation and Emission of Sulfur Dioxide from the Portland Cement Industry" in *Proceedings of the 93rd Air and Waste Management Association Conference.* 2000. San Diego, CA.

[25] Presentation. Waste Management Technologies in Japanese Cement Industry. Taiyeho Cement, Taiyeho Engineering, CTI/Industry Joint Seminar, February 2004.

[26] Miller, F. M.; Young, G. L.; von Seebach, M., *Formation and Techniques for Control of Sulfur Dioxide and Other Sulfur Compounds in Portland Cement Kiln Systems*; Portland Cement Association: Skokie, Illinois, 2001.

[27] Greer, W. L., *Interactions Among Gaseous Pollutants from Cement Manufacture and Their Control Technologies*; Portland Cement Association: Skokie, Illinois, 2003.

[28] Letter and attachments from Walter Greer, Ash Grove Cement, to John Ramsey, Kansas Department of Health and Environment, re: Sulfur Absorbing Enhancements at the Chanute Plant, dated May 14, 1999.

[29] SO_2 Removal and Secondary Plume Abatement – MicroMist Micro-fine Lime™ Semi-dry Injection Systems. Product Information Brochure. EnviroCare International: Novato, CA, 1998.

[30] Texas Natural Resources Conservation Commission. Technical Review – New Kiln and Modification of Existing Plant at Texas Industries, L.P. Midlothian Cement Plant. Permit No. 1360a. August 1998

[31] Letter from Fred Cohrs of Florida Rock to Kirby Green of Florida DEP, September 2000.

[32] Terry, Mark S. "BACT: What is available with Today's Technology," Krupp Polysius Technical Seminar. 1999.

[33] Kupper, D. "Trends on Desulfurization and Denitrification Techniques in the Cement Industry," in Proceedings of the 34th IEEE Cement Industry Technical Conference. 1992. Dallas, TX.

[34] de Quervain, B., Ph.D., "Umweltfreundliche Klarschlammverbrunnung am Beispiel des PCW Portand-Cement-Werks," GWA des Schweizerichen Vereins des Gas und Wasserfaches, 1992, Sonderdruck No. 1258.

[35] Final Rule. National Emission Standards for Hazardous Air Pollutants From the Portland Cement Manufacturing Industry Federal Notice Vol. 71, No. 244 / Wednesday, December 20, 2006 / Rules and Regulations.

[36] Arizona Department of Environmental Quality. Drake Cement Technical Support Document and Statement of Basis. Air Quality Permit No. 1001770.

[37] Scur, P., Dipl. Ing.; Hoppe, H., Ph.D., "The Present State of NO_X Abatement with the SNCR Process," Cement International, No. 2/2006.

[38] Electronic mail transmission and attachments from Plickert, S., German Federal Environmental Office to A. A. Linero. Annex VI to German Contribution to the Review of the Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries to European Union Best Available Techniques Reference for the Cement Industry. June 13, 2006.

[39] Newspaper Article. Ben Ready. "Non-Profit Threatens to Sue CEMEX." The Daily Times-Call. February 28, 2007.

[40] Presentation. September 2006 Revisions to the National Ambient Air Quality Standards for Particle Pollution. United States Environmental Protection Agency. September 2006.

[41] Schaefer, S.; Hoenig, V. "Betriebstechninische Einflüsse auf die Quecksilber-Emissionen aus Drehrohröfen der Zementindustrie". Cement Calk Gyps International, 2001, No. 11, 591-601.

[42] Presentation. Mercury Study. Presented at Public Meeting in Center Hill. Sumter Cement Company. 2005.

[43] Special Use Petition. Florida Crushed Stone Company. Unit No. 2 Project – Special exemption. Received by Hernando County Planning Department. January 19, 2005.