TECHNICAL EVALUATION

&

PRELIMINARY DETERMINATION

APPLICANT

Jacksonville Lime LLC
1915 Wigmore Street
Jacksonville, Florida 32206

ARMS Facility ID No. 0310583

PROJECT

Permit No. PSD-FL-426
Project No. 0310583-001-AC

Jacksonville Lime

COUNTY

Duval County, Florida

PERMITTING AUTHORITY

Florida Department of Environmental Protection
Division of Air Resource Management
Office of Permitting and Compliance
2600 Blair Stone Road, MS#5505
Tallahassee, Florida 32399-2400

December 31, 2013

1 GENERAL PROJECT INFORMATION

1.1 Facility Description and Location

Jacksonville Lime LLC (Carmeuse Lime & Stone and Keystone Properties Joint Venture) will construct and operate a lime manufacturing facility at 1915 Wigmore Street in the Port of Jacksonville, Duval County, Florida. Link to Jacksonville Lime LLC The facility will be a categorized under Standard Industrial Classification No. 3274. Refer to **Figure 1** and **Figure 2**.

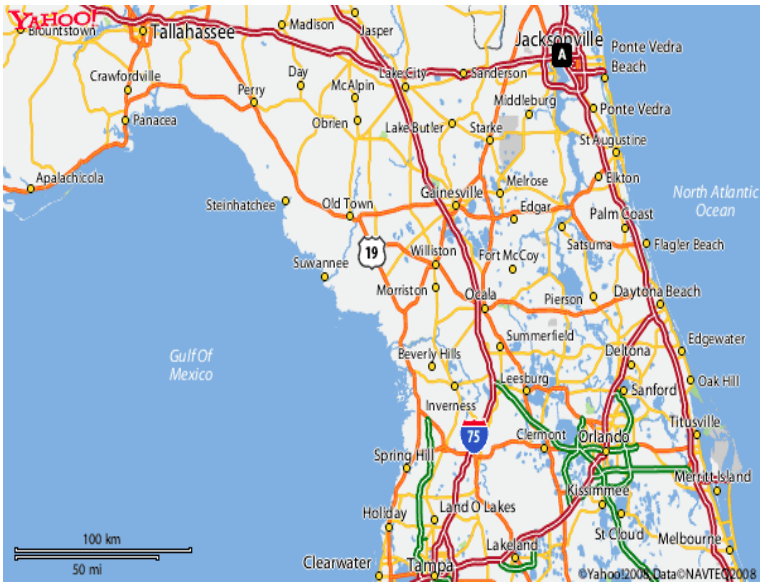


Figure 1 – Jacksonville, Duval County, Florida.

Figure 2 – Jacksonville Lime Site.

Figure 3 shows an aerial view of the Jacksonville Lime site. The UTM coordinates are Zone 17, 439.330 kilometers (km) East, and 3,359.622 km North.

Figure 3 – Keystone Property and Future Jacksonville Lime Site.

The project consists of the construction of two vertcal lime kilns and associated material and fuel handling equipment on a rehabilitated brownfield site (former pulp and paper plant). Each kiln will have a maximum lime production rate of 396 tons per day (tons/day) and will be fueled with natural gas, coal, petroleum coke (petcoke) and wood chips.

1.2 Project Description

1.2.1 How a Lime is Made

This description is extracted from the Carmeuse web site. Generalized Carmeuse Lime Process Description
Calcium carbonate ($CaCO_3$) is a natural product that can be found as marl, chalk, limestone or marble. The very pure limestone that Carmeuse extracts to make lime is light to dark grey in color with a $CaCO_3$ content of about 98% to produce quicklime (CaO) or dolomitic quicklime (CaO•MgO). The pebble-lime thus produced is screened, crushed or ground and stored according to customer specifications.

Limestone rock, in the form of $CaCO_3$, or dolomite ($CaCO_3$•$MgCO_3$), is selectively extracted and sorted according to its physical and chemical characteristics. The rocks are transported and unloaded in crushers where they are washed, screened, crushed, ground and stored according to their use. For the proposed project, the source rock will be obtained from off-site quarries.

Part of the extracted stone, selected according to its chemical composition and size distribution, is calcinated at about 1,000 Celsius (°C), or 1,832 Fahrenheit (°F), in different types of kiln, fired by such fuels as natural gas, coal, petcoke, fuel oil, etc. Carbon dioxide (CO_2) is released from the stone to produce dolomitic lime or quicklime. In the case of quicklime, the reaction is:

$$CaCO_3 + \text{heat} \longrightarrow CaO + CO_2$$

The pebble-lime thus produced is screened, crushed or ground and stored according to the characteristics demanded by the customers.

Quicklime can be hydrated (slaked), i.e. combined with water. Depending on the quantity of water added and the intended use, hydrated lime (calcium hydroxide – $Ca(OH_2)$ is obtained either in the form of very fine dry powder, or as a “putty lime”, or as “lime milk” in different concentrations. The reaction is:

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

The proposed facility will not produce hydrated lime.

1.2.2 Limestone Handling

Refer to **Figure 4**. Unprocessed limestone will be delivered to the Keystone property from an offsite quarry and will be conveyed via stacker conveyor to a surge hopper on the project site. Material will then be diverted to a series of belt conveyors and sent to live storage piles. From this point, an enclosed (tunnel) belt conveyor will be fed from the live storage piles with pan feeders to deliver the stone to a transfer conveyor and enclosed screen. The screen will segregate the limestone according to size; with finer material being delivered to a 65-ton reject bin and kiln feed stone delivered to two enclosed 120-ton charging bins.

From the charging bins, the kiln feed will be transferred via belt conveyors and skip hoists to the enclosed kiln feed surge bins. From the surge bins, kiln feed stone will be delivered via pan feeder to two 20-ton storage bins. The surge bins and associated material transfer points will be enclosed. The surge bins will feed limestone to the two proposed vertical kilns.

1.2.3 Fuel Handling

The applicant proposes to use petcoke as the primary fuel and also to use lignite, natural gas, and wood chips. Petcoke/coal will be loaded into a dump hopper by truck and/or front-end loaders and sent to a 500-ton coke/coal bin via belt conveyor. The petcoke/coal in the coke bin will be unloaded onto a weighing belt feeder that will send the petcoke to a bowl mill to dry and size the fuel prior to being combusted in the limestone kilns.

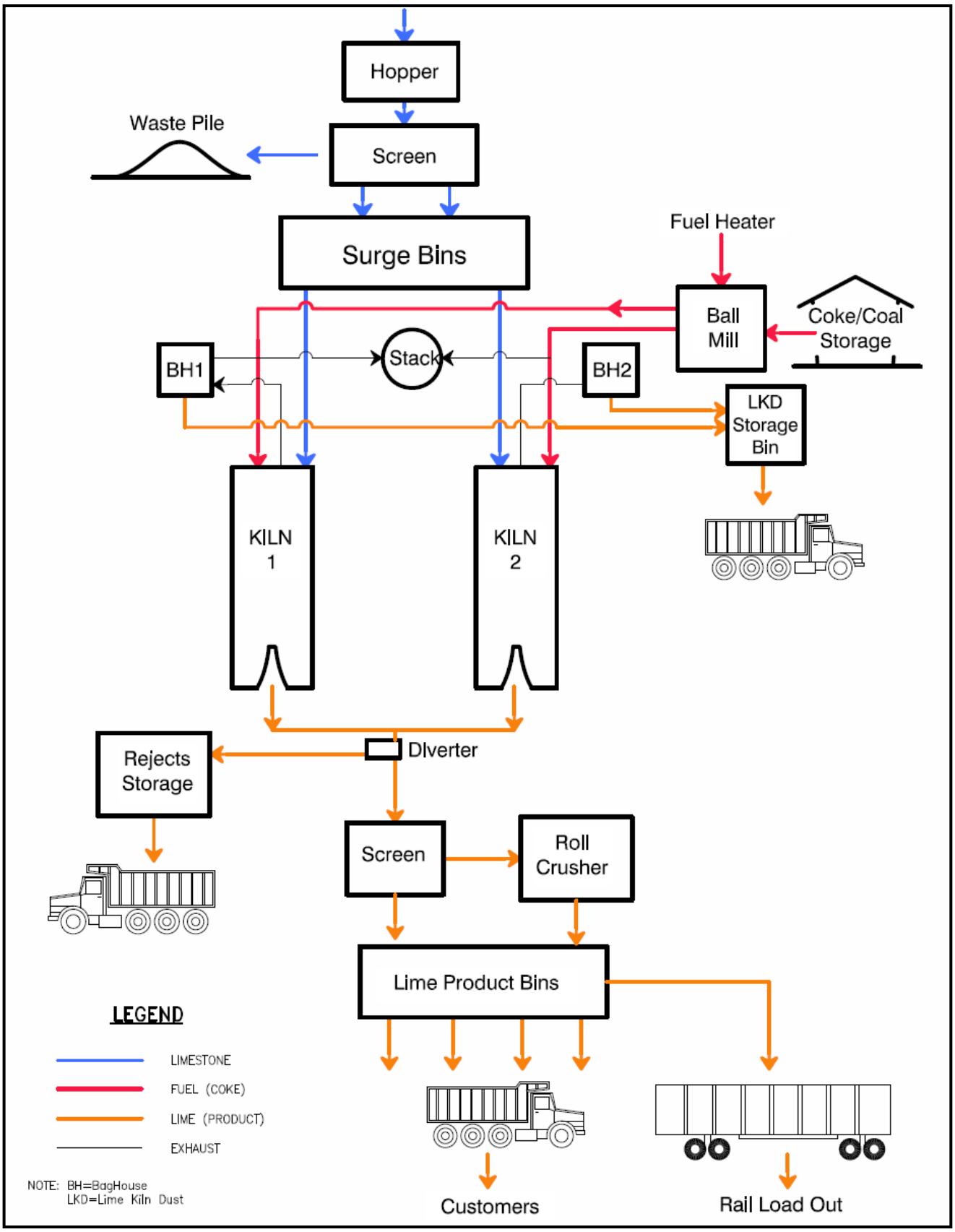


Figure 4 – Simplified Process flow Diagram for the Jacksonville Lime Facility.

Air for the mill to dry the petcoke/coal will be preheated by a natural gas-fired heater, rated at 3.5 million British thermal units per hour (MMBtu/hr). The milled petcoke/coal and air will be sent through a classifier and collected in a dust collector. The milled petcoke/coal collected in the dust collector is transferred via a pneumatic conveyor to a 50-ton petcoke/coal bin. The milled fuel is combined and pressurized in smaller bins for feed into the vertical lime kilns.

Wood-derived fuel will be loaded into a dump hopper by front-end loaders and/or dump trucks and sent to a 168-ton raw storage bin via a belt conveyor. The wood-derived fuel in the raw storage bin is transferred via a drag chain conveyor to a mill. The milled wood fuel is collected in a dust collector and pneumatically conveyed to a 50-ton ground chip storage bin. The milled fuel is combined and pressurized in smaller bins for feed into the vertical lime kilns. Emissions from the proposed wood-derived fuel storage bins and processing equipment are controlled by three fabric filter dust collectors.

1.2.4 Lime Product Handling

Details of the lime kilns are provided further below. The lime exiting the vertical kilns will be released into one of the two dedicated 18-ton hoppers per kiln (two per kiln chamber). The hoppers transfer the product to a drag chain conveyor. From the product belt conveyor, the lime will be transferred through a series of transfer chutes and additional conveyors. The lime product will then be directed to a screen and roll crusher located within an enclosed building prior to transfer to enclosed storage silos.

Reject material from product lime processing will be routed to the reject material handling system. The reject material handling system is comprised of a reject bin belt conveyor, 230-ton reject bin, and associated equipment including load-out, roll crusher, crusher product screw conveyor, and bucket elevators. The segregated final product is directed to one of four 500-ton product storage bins, each equipped with a self-contained dustless truck loading spout.

1.2.5 How a Lime Kiln Works

The following two paragraphs are extracted from EPA document AP-42, Section 11.17, Lime Manufacturing (1998 update). Link to EPA Lime Manufacturing Description

The heart of a lime plant is the kiln. The prevalent type of kiln is the rotary kiln, accounting for about 90 percent of all lime production in the United States. This kiln is a long, cylindrical, slightly inclined, refractory-lined furnace, through which the limestone and hot combustion gases pass counter currently. Coal, oil, and natural gas may all be fired in rotary kilns. Product coolers and kiln feed preheaters of various types are commonly used to recover heat from the hot lime product and hot exhaust gases, respectively.

The next most common type of kiln in the United States is the vertical, or shaft, kiln. This kiln can be described as an upright heavy steel cylinder lined with refractory material. The limestone is charged at the top and is calcined as it descends slowly to discharge at the bottom of the kiln. A primary advantage of vertical kilns over rotary kilns is higher average fuel efficiency. The primary disadvantages of vertical kilns are their relatively low production rates and the fact that coal cannot be used without degrading the quality of the lime produced. There have been few recent vertical kiln installations in the United States because of high product quality requirements.

There have been improvements and innovations in recent years that serve as updates to EPA's comments about vertical kilns. The following excerpt is from a publication by Maerz, a manufacturer of lime kilns:
Link to Large Maerz Kilns

> *"Until recently rotary kilns were considered to be first choice whenever high lime production capacity was an issue despite the comparatively high fuel consumption. The higher fuel consumption was widely accepted as the respective high production rates could only be realized by installing two or more parallel flow regenerative shaft (PFR) shaft kilns. Therefore, at high capacities PFR kilns had a disadvantage because of higher overall investment costs. This situation has completely changed due to the sharp increase of fuel costs and the recent development in PFR kiln technology regarding the maximum capacity per kiln unit.*

"To meet today's requirements for large capacity lime plants two options reflect the state of the art of technology:

1. *Shaft preheater rotary kilns equipped with a controllable sulfur bypass system to allow for low cost (high sulpur) fuels satisfying highest quality demands for low sulfur lime, or*
2. *High capacity PFR kilns operating at the lowest fuel consumption of all modern lime kilns and consequently producing significantly lower CO_2 emissions."*

1.2.6 Project Lime Kiln

Carmeuse Lime & Stone is the largest producer of lime and limestone products in North America. Their selection of the PFR technology reflects the shift towards the very energy efficient design of the latest PFR vertical shaft kilns. Kiln manufacturer, Cimprogetti, recently announced *"Jacksonville Lime (Carmeuse North America Group, USA) has ordered two regenerative twin shaft vertical kilns Model Cim-Reversy-FS 6, pulverized coal + natural gas fired."* Link to Cimprogetti

The nomenclature used by Cimprogetti for their PFR kilns is "Twin-Shaft Regenerative" (TSR). Their line of TSR kilns is called Cim-Reversy. **Figure 5** is a diagram of a Cim-Reversy Model NS or FS kiln with direct cross over channels. Link to Cimprogetti Models

The diagram is from the Cimprogetti site and is representative of a Cim-Reversy TSR kiln (Model lines NS or FS) with direct cross over channels. **Figure 6** is a representation of the process flows in a Cim-Reversy TSR kiln taken from a Cimprogetti brochure. Link to Cimprogetti 2010 TSR Brochure

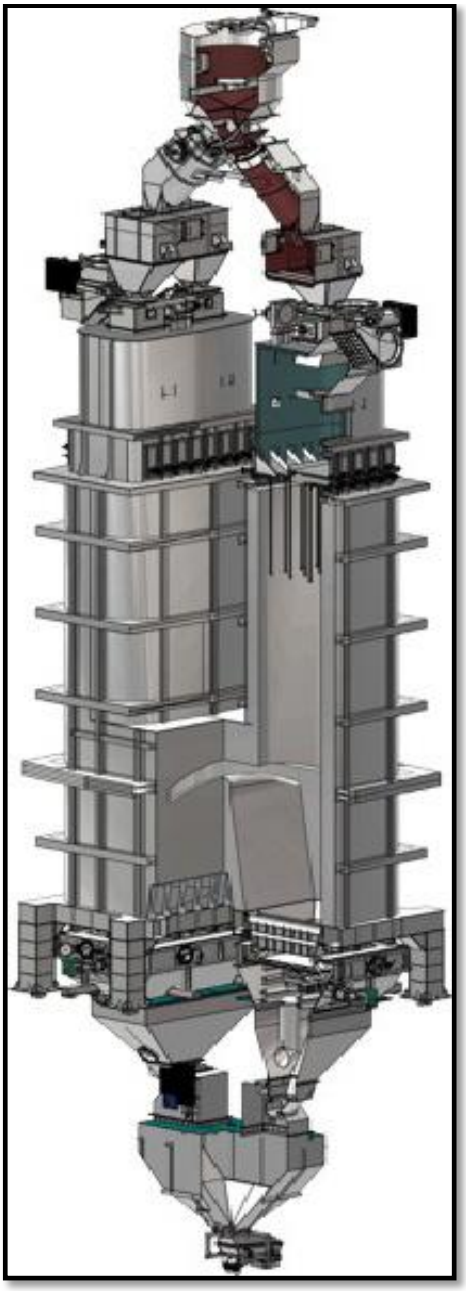
When one shaft operates in the burning mode, the other shaft operates in the regeneration (nonburning) mode. Each shaft operates for an equal amount of time in the burning and regeneration modes. According to Cimprogetti:

"The Cim-Reversy Twin Shaft kiln belongs to the group of vertical twin-shaft furnaces and also works on the PFR system ……. The combustion and waste gases are passed through the limestone to be de-acidified (i.e. calcinated) alternately in parallel or counter-current flow through the cyclic alternation of the burning and regenerative periods between the two shafts. This burning ensures optimal utilization of the energy applied when de-acidifying the limestone. Cim-Reversy Twin shaft kilns are primarily employed for production of highly reactive quicklime.

"The two shafts are alternately loaded from the top, with pre-weighted limestone charges. The fuel is introduced to only one of the two shafts at a time, at the upper side of the burning zone where the material is still un-calcined and can absorb most of the heat released by the combustion.

"The combustion gases travel downwards, in parallel flow with the material and leave the burning shaft through the crossover channel, entering the non-burning shaft travelling upwards in counter flow with the stone. The off-gases then cross the freshly loaded limestone in the pre-heating zone located in the upper part of the non-burning shaft, where they transfer most of their residual heat, before being vented off at temperatures around 100 °C on average.

"The heat transferred by the hot gases to the fresh limestone in the non-burning shaft, is then recovered in the next cycle, from the combustion air entering that shaft from the top, when that given shaft will shift to burning mode. The shifting between burning and non-burning modes is called "inversion" and it takes place at set intervals. In the lower part of the TSR kiln, the hot lime lumps are progressively cooled down to temperatures below 100 °C by means of cooling air introduced from the bottom of both shafts so as to be handled with standard conveying equipment."



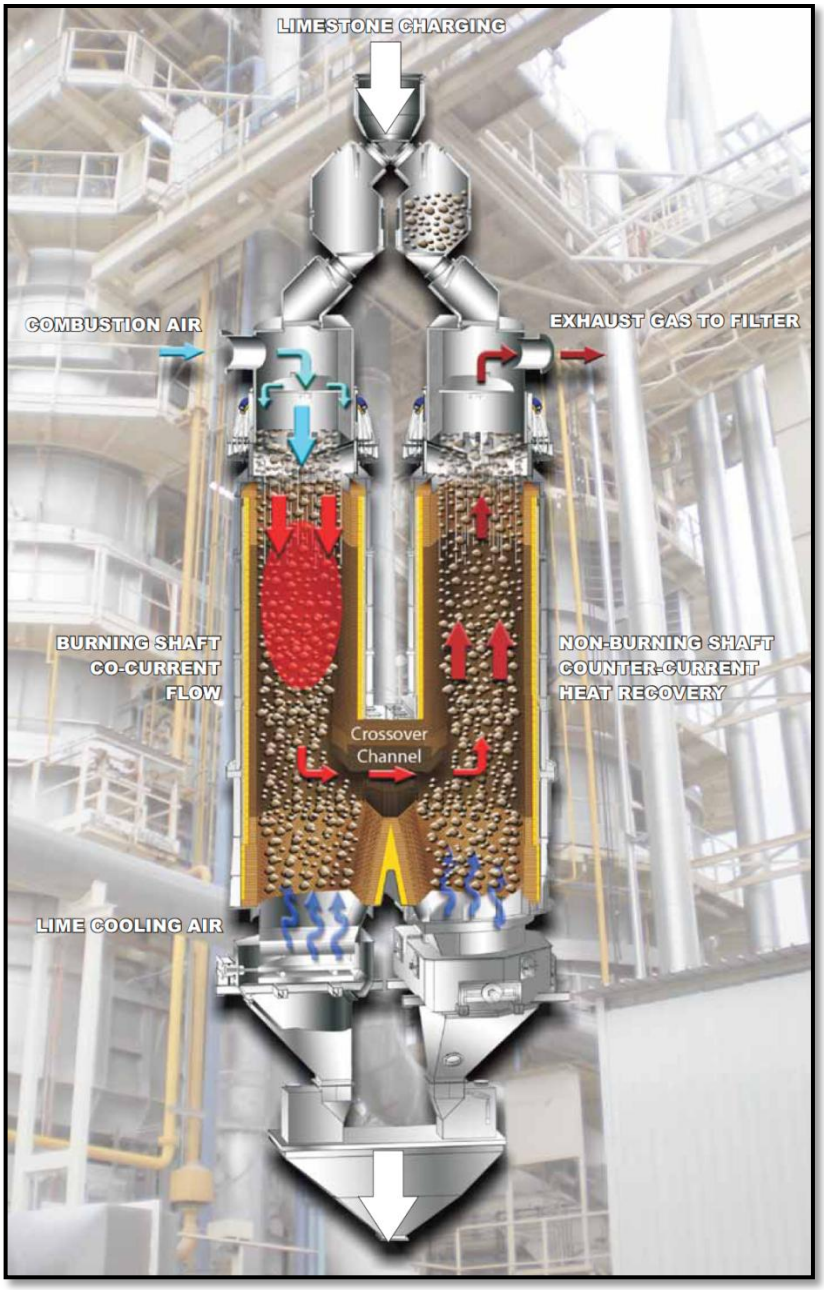


Figure 5 – Cim-R Model NS or FS. **Figure 6 – Process Flows in a Cimprogetti TSR Kiln.**

Parallel flow of hot gases and stone in the burning zone allows a mild burning of the limestone without over-burning. Regenerative preheating of all combustion air is accomplished using the limestone contained in the preheating zone of the kiln (in the non-burning shaft) as a heat accumulator.

Figure 7 is the approximate temperature profile within a Maerz PFR kiln. Link to Maerz Technical Document The diagram is consistent with the Cimprogetti discussion. **Figure 8** is a diagram available at the York University web page regarding limestone and lime. It shows the introduction of the fuel burners (lances) well into the raw materials within a Maerz PFR kiln. Link to York U CaCO3

In the Maerz PFR and Cimprogetti TSR designs, the difference between the material temperature and gas temperature is minimized. This is in contrast with the countercurrent designs, such as rotary kilns, where high peak combustion temperatures and large material/gas temperature differentials occur. The ramifications include of the PFR/TSR design include low thermal nitrogen oxide (NO_X) production and excellent energy efficiency.

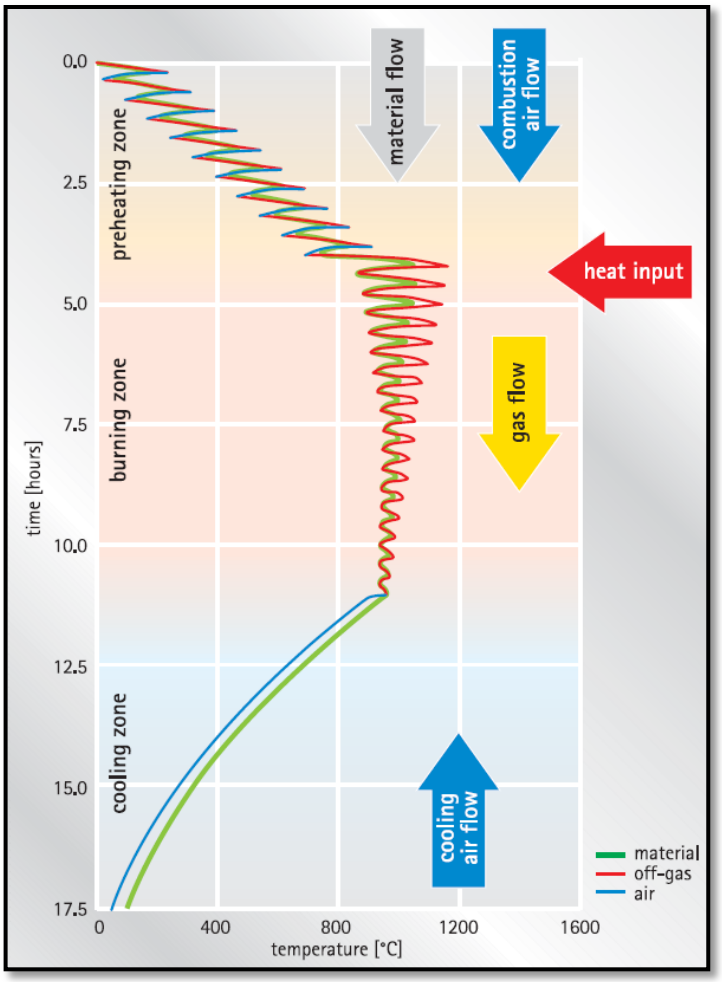


Figure 7 - Temperature Profile in a Maerz PFR Kiln.

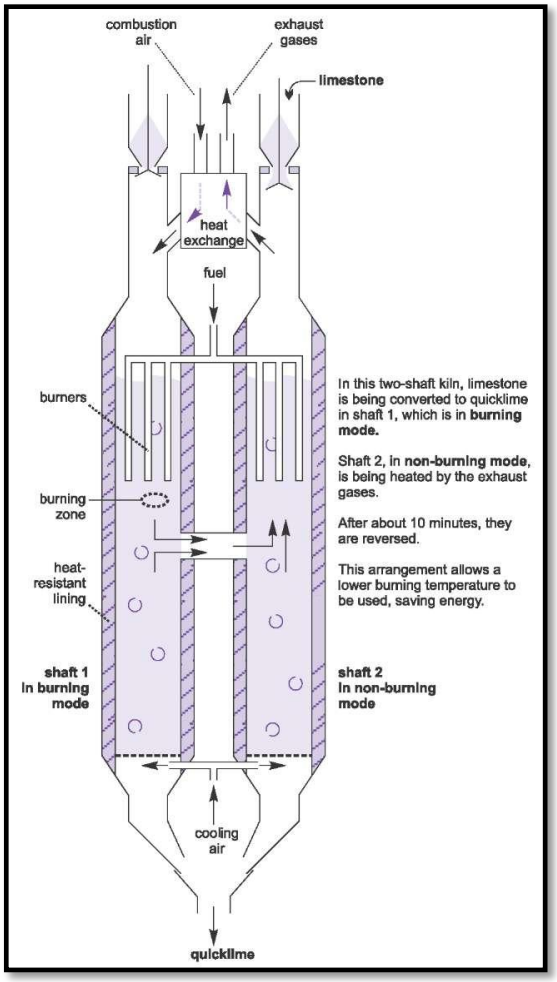


Figure 8 - Lime Manufacture in PFR Kiln.

1.2.7 Emissions and Controls

The principal project emissions sources are the two lime kilns and material handling equipment. The project results in emission increases of NO_X, carbon monoxide (CO), volatile organic compounds (VOC), sulfur dioxide (SO_2), particulate matter (PM), PM with a mean diameter of 10 microns or less (PM_{10}), PM with a mean diameter of 2.5 microns or less ($PM_{2.5}$), sulfuric acid mist (H_2SO_4 also called SAM) and carbon dioxide equivalents (CO_2e) for greenhouse gases (GHG). The applicant also projects emissions of hydrogen chloride (HCl) and very minor emissions of mercury (Hg) and lead (Pb). The following controls will be employed on the lime kilns:

- Low temperature combustion to avoid production of thermal NO_X;
- Most energy efficient PFR design to minimize fuel use and resulting emissions of all pollutants;
- Thorough mixing and residence time through preheat section to complete burnout of CO and VOC;
- Inherent scrubbing of burning zone exhaust gases by hot lime and of kiln exhaust gases by incoming limestone to reduce SO_2 and SAM;
- Use of a fabric filter to control emissions of $PM/PM_{10}/PM_{2.5}$ and provide further control of SO_2/SAM on the filter cake.
- Use of low-sulfur, pipeline-quality natural gas much of the time for control of all pollutants.

Table 1 is a listing of the emissions units (EUs) that comprise this project.

Table 1 – Listing of Emissions Units.

EU No.	Emissions Unit Description
001	Vertical Lime Kiln No. 1
002	Vertical Lime Kiln No. 2
003	Limestone Screening Operations
004	Limestone Screening and Crushing Operations
005	Lime Screening Operations
006	Wood Grinding Mill
007	Coke Grinding
008	Truck/Railcar Loading Areas and Enclosure
009	Conveyors, Transfer Points, and Storage Bins
010 - 016	Fabric Filter Baghouses

2 AIR POLLUTION REGULATIONS

2.1 Department Regulations

Projects at stationary sources with the potential to emit air pollution are subject to the applicable environmental laws specified in Section 403 of the Florida Statutes (F.S.). The statutes authorize the Department of Environmental Protection (Department) to establish air quality regulations as part of the Florida Administrative Code (F.A.C.), which includes the applicable chapters contained in Table 2:

Table 2 - Applicable Department Air and Permitting Rules

Chapter	Description
62-4	Permits
62-204	Air Pollution Control – General Provisions
62-210	Stationary Sources of Air Pollution – General Requirements
62-212	Stationary Sources – Preconstruction Review
62-213	Operation Permits for Major Sources (Title V) of Air Pollution
62-296	Stationary Sources – Emission Standards
62-297	Stationary Sources – Emissions Monitoring

2.2 Federal Rules

The U.S. Environmental Protection Agency (EPA) establishes air quality regulations in Title 40, Code of Federal Regulations, Part 60 (40 CFR 60) that identifies New Source Performance Standards (NSPS) for a variety of industrial activities. 40 CFR 61 specifies National Emission Standards for Hazardous Air Pollutants (NESHAP). 40 CFR 63 specifies NESHAP provisions based on the Maximum Achievable Control Technology (MACT) for given source categories.

Federal regulations adopted by reference are given in Rule 62-204.800, F.A.C. State regulations approved by EPA are given in 40 CFR 52, Subpart K; also known as the State Implementation Plan (SIP) for Florida.

2.3 Overview of Key Regulations Applicable to the Jacksonville Lime Project

- According to the applicant, the facility is a major source of hazardous air pollutants (HAP) because the potential to emit at least one HAP pollutant (hydrogen chloride - HCl) equals or exceeds 10 tons/year.
- The facility is a Title V major source of air pollution in accordance with Chapter 62-213, F.A.C. because the potential emissions of at least one regulated pollutant equals or exceeds 100 tons/year. Key regulated pollutants include CO, NO_X, PM, PM_{10}, $PM_{2.5}$, SO_2, VOC and SAM.
- The facility is a major stationary source in accordance as defined in Department Rule 62-210.200, F.A.C.
- This project is subject to Prevention of Significant Deterioration (PSD) review and a Best Available Control Technology (BACT) determination pursuant to Department Rule 62-212.400, F.A.C.
- This project is in a designated PM Maintenance Area that is delineated in Section 62-204.340(4)(b)2., F.A.C.
- The project is subject to the PM Reasonably Available Control Technology (RACT) PM requirements for Materials Handling, Sizing, Screening, Crushing and Grinding Operations at Section 62-296.711, F.A.C.
- The proposed project includes units subject to the NSPS of 40 CFR 60.
- The proposed project includes units subject to the NESHAP of 40 CFR 63.

2.4 New Source Performance Standards (NSPS) Applicable to the Project

2.4.1 40 CFR 60, Subpart A – General Provisions Link to NSPS Subpart A

Several sections from NSPS Subpart A, such as notifications and reporting, apply to this project.

2.4.2 40 CFR 60, Subpart HH – Lime Manufacturing Plants Link to NSPS Subpart HH

According to the definitions in NSPS Subpart HH, lime manufacturing plant *"means any plant which uses a rotary lime kiln to produce lime product from limestone by calcination."*

The regulation does not apply to the project because the lime kiln is a vertical shaft kiln and not a rotary kiln.

2.4.3 40 CFR 60, Subpart UUU – Lime Manufacturing Plants Link to NSPS Subpart UUU

According to the definitions in NSPS Subpart UUU, mineral processing plant "*means any facility that processes or produces any of the following minerals, their concentrates or any mixture of which the majority (>50%) is any of the following minerals or a combination of these minerals: alumina, ball clay, bentonite, diatomite, feldspar, fire clay, fuller's earth, gypsum, industrial sand, kaolin, lightweight aggregate, magnesium compounds, perlite, roofing granules, talc, titanium dioxide, and vermiculite."*

The regulation does not apply to the project because lime and limestone are not included in the list of minerals to which the regulation applies. The regulation specifically excludes vertical shaft kilns in the magnesium compounds (e.g. dolomitic lime) industry.

2.4.4 40 CFR 60, Subpart OOO – Non-Metallic Mineral Processing Plants Link to NSPS Subpart OOO

Lime and limestone are non-metallic minerals. The provisions of NSPS Subpart OOO are applicable to crushers, grinding mills, screening operations, bucket elevators, belt conveyors, bagging operations, storage bins and enclosed truck or railcar loading station.

The proposed project includes most of the described operations. Subpart OOO specifies PM or visible emissions (opacity) limitations, monitoring, testing, reporting, and recordkeeping for such operations.

2.4.5 40 CFR 60, Subpart Y – Coal Preparation and Processing Plants Link to NSPS Subpart Y

According to NSPS Subpart Y, *"the provisions of this subpart apply to affected facilities in coal preparation and processing plants that process more than 200 tons of coal per day."*

The regulation does not apply to the project because the facility will primarily process petcoke and will process less than 200 tons/day of coal. The Department will include appropriate provisions in the permit to ensure this regulation does not apply.

2.5 National Emission Standards for Hazardous Air Pollutants (NESHAP) Applicable to the Project

2.5.1 40 CFR 63 Subpart A Link to NESHAP Subpart A

Several sections from NESHAP Subpart A, such as notifications and reporting, apply to this project.

2.5.2 40 CFR 63 Subpart AAAAA – Lime Manufacturing Plants Link to NESHAP AAAAA

According to NESHAP Subpart AAAAA, "this subpart applies to each existing or new lime kiln(s) and their associated cooler, and processed stone handling operations system(s) located at a lime manufacturing plant that is a major source (of HAP).

NESHAP Subpart AAAAA specifies PM and visible emissions (opacity) limits on the kiln and processed stone handling operations.

3 PSD APPLICABILITY

3.1 General PSD Applicability

The Department regulates major stationary sources in accordance with Florida's PSD program pursuant to Rule 62-212.400, F.A.C. PSD preconstruction review is required in areas that are currently in attainment with the state and federal ambient air quality standards (AAQS) or areas designated as "unclassifiable" for these regulated pollutants.

Commonly addressed PSD pollutants in the power industry include: CO, NO_X, PM, PM_{10}, $PM_{2.5}$, SO_2, VOC, SAM, Pb, fluorides (F), and Hg.

Additional PSD pollutants that are more common to certain other industries include: hydrogen sulfide (H_2S), TRS including H_2S, reduced sulfur compounds (RSC) including H_2S, municipal waste combustor (MWC) organics measured as total tetra- through octa-chlorinated dibenzo-p-dioxins and dibenzofurans (dioxin/furan), MWC metals measured as PM; MWC acid gases measured as SO_2 and HCl, and municipal solid waste (MSW) landfill emissions as non-methane organic compounds (NMOC).

As defined in Rule 62-210.200(Definitions), F.A.C., a stationary source is a "major stationary source" (major PSD source) if it emits or has the potential to emit (PTE):

- 250 tons per year (tons/year) or more of any PSD pollutant; or
- 100 tons/year or more of any PSD pollutant and the facility belongs to one of the 28 listed PSD major facility categories.

The list given in the citation includes the category of "lime plants". The Jacksonville Lime project is a major stationary source based on the potential to emit 100 tons/year or more of several individual PSD pollutants.

40 CFR 52.21 is the federal PSD regulation potentially applicable to sources of six greenhouse gases (GHGs) in Florida and several other states. Link to Federal PSD Regulations According to this regulation, the pollutant GHGs shall also be subject to regulation (under PSD) at a new stationary source that will emit or have the potential to emit 100,000 tons carbon dioxide equivalent emissions (CO_2e) of GHGs per year. This regulation is administered by EPA until the Florida SIP at 40 CFR 52, Subpart K is updated to reflect approval of a state rule to regulate GHGs.

Once a new facility is considered a major stationary source based on one PSD pollutant, then all other PSD pollutants are reviewed for PSD applicability based on the respective Significant Emission Rate (SER) defined and specified in Rule 62-210.200, F.A.C. Each pollutant projected to be emitted at a rate equal to or greater than its respective SER is also considered to be "*significant*" and subject to PSD preconstruction review, including a determination of best available control technology (BACT).

Although a facility may be "major" (i.e. emits or has the potential to emit 100 or 250 TPY as applicable) for only one PSD pollutant, a project must include BACT controls for any PSD pollutant that exceeds the corresponding significant emission rates (SERs) given in **Table 3**.

Table 3 – List of Significant Emission Rates By PSD-Pollutant. [1, 3]

Pollutant	SER (TPY)	Pollutant	SER (TPY)
CO	100	NO_X	40
$PM/PM_{10}/PM_{2.5}$	25/15/10	Ozone (VOC) [2]	40
$PM_{2.5}$ (NO_X)	40	$PM_{2.5}$ (SO_2)	40
Ozone (NO_X) [2]	40	SAM	7
SO_2	40	Pb	0.6
Hg	0.1	GHG (CO_2e)	75,000 [3]

1. Excluding fluoride and those pollutants defined for Pulp and Paper, MWC, MSW landfills.
2. Ozone (O_3) is regulated by its precursors (VOC and NO_X). PSD for $PM_{2.5}$ can be triggered by its precursors (NO_X and SO_2).
3. Not technically a SER. However the pollutant GHGs is subject to federal regulation under 40 CFR 52.21 at a new major stationary source for a pollutant other than GHGs and that emits or will have the potential to emit 75,000 tons CO_2e/year or more of GHGs.

The project is located in Duval County, which is in an area that is currently in attainment with the state and federal AAQS or otherwise designated as unclassifiable. The combined cycle project will emit the following PSD-pollutants SO_2, NO_X, CO, PM, PM_{10}, $PM_{2.5}$, SAM, VOC, CO_2e, and small amounts of Hg and Pb.

3.2 Projected Emissions from the Jacksonville Lime facility

Table 4 provides the applicant's PSD applicability calculations based on the Potential to Emit (PTE) in tons per year from the Jacksonville Lime project.

Table 4 – Potential Annual Emissions Estimated by the Applicant and PSD Applicability [1].

Pollutant	Kilns 1 and 2	Fuel Dryer	Miscellaneous PM Sources	Total	PSD SER	Trigger PSD?
SO_2	180.1	0.02	N/A	180.1	40	Yes
NO_X	343.3	1.4	N/A	344.7	40	Yes
CO	411.9	0.6	N/A	412.5	100	Yes
PM (f) [2]	24.9	~ 0	19.9	36.6	25	Yes
PM_{10} (f + c) [3]	41.6	~ 0	19.9	61.5	15	Yes
$PM_{2.5}$ (f + c) [3]	41.6	~ 0	9.9	51.5	10	Yes
SAM	1.6	~ 0	N/A	1.6	7	No
VOC	19.2	0.1	N/A	19.3	40	No
Lead	0.01	~0	N/A	0.01	0.6	No
GHG (CO_2e)	357,014	1,794	N/A	358,808	75,000	Yes
HAP	24.2	~0	N/A	24.2	N/A	N/A
Mercury	3.2 lb/yr	~0	N/A	3.2 lb/year	200 lb/yr	No

1. Several of these values will be reduced by the Department's BACT determination.
2. Filterable (f) portion only.
3. Filterable (f) and condensable (c) combined.

3.3 Conclusion Regarding PSD Applicability

The project is subject to PSD and BACT determinations for SO_2, NO_X, CO, $PM/PM_{10}/PM_{2.5}$ and GHGs (CO_2e). EPA is processing the GHGs application.

4 DEPARTMENT'S BACT REVIEW

4.1 Definition of BACT

Rule 62-210.200, F.A.C. defines "BACT" as:

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.

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.

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

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.

The Department conducts its case-by-case BACT determinations in accordance with the requirements given above. Additionally the Department generally conducts its reviews in such a manner that the determinations are consistent with those conducted using the Top/Down Methodology described by EPA. These determinations are provided in the following sections and are organized and presented by emission unit.

The rules do not specifically state that BACT determinations must be at least as stringent as Reasonably Available Control Technology (RACT) requirements (such as for the materials handling operations). However it is common sense as well as actual practice that a BACT determination is generally at least as stringent as a corresponding RACT.

4.2 BACT for the Parallel Flow Regenerative Kilns

Very few PFR lime kilns have been built in the U.S. Furthermore, most of the kilns built in the U.S. are not particularly energy efficient by today's standards. Finally, little good data are readily available from operating kilns in the U.S. that can be used to determine BACT.

4.2.1 Energy Considerations in the Lime Manufacturing

4.2.1.1 *Fuels Used to Manufacture Lime*

Lime manufacturing is an energy intensive industry. In lime burning, the fuel provides the necessary energy for calcining. It also interacts with the process, and the combustion products react with the quicklime. Many different fuels are used in lime kilns. Most kilns can operate on more than one fuel, but some fuels cannot be used in certain kilns.

The most common fuels are coal, natural gas, fuel oil, petroleum coke (petcoke), and (recently), biomass. Coal, petcoke, natural gas and biomass (wood chips) are proposed as fuels for the Jacksonville Lime project.

4.2.1.2 *Energy Use for Different Lime Kiln Designs*

Assuming perfect efficiency, producing a ton of lime from pure calcium carbonate requires 2.77 million Btu. In practice, the process is considerably less efficient. EPA Lime Industry Profile There are significant heat losses via the exhaust gases, temperature of the product, kiln wall losses and lime kiln dust.

Table 5 indicates the typical fuel consumption for different types of lime kilns. The values in the table are net calorific values (NCV), also known as lower heating value (LHV). The lowest values are achievable only when the limestone is not fully calcined.

Table 5 – Typical Fuel Energy Use for Different Types of Lime Kilns.

Kiln Type	Thermal Energy Consumption [1,2, 3]	
	(Gigajoules/metric ton lime)	(MMBtu/short ton lime)
Long Rotary (LR) Kilns	6.0 – 9.2	5.2 – 7.9
Preheater Rotary (PR) Kilns	5.1 – 7.8	4.4 – 6.7
Parallel Flow Regenerative (PFR) Kilns	**3.2 – 4.2**	**2.8 – 3.6**
Annular Shaft (AS) Kilns	3.3 – 4.9	2.8 – 4.2
Mixed Feed Shaft (MFS) Kilns	3.4 – 4.7	2.9 – 4.0
Other Shaft (OS) Kilns	3.5 – 7.0	3.0 – 6.0

1. Basis is net calorific value (NCV), also known as the lower heating value (LHV).
2. Energy consumption depends on type of product, product quality, process conditions and raw materials.
3. Values in the lower range can only be achieved with high residual CO_2 content of the quicklime.

PFR kilns have the lowest heat input requirement to make a ton of lime. The applicant's selection of a PFR kiln provides the lowest range of (2.8 – 3.6 MMBtu/short ton) based on NCV among available kiln options. According to the calculations in the Jacksonville Lime application, the proposed kilns require approximately 3.2 MMBtu per short ton of lime produced (MMBtu/ton, NCV). According to the Maerz documents cited in section 1.2.6 above, approximately 3.5 gigajoules/metric ton (3.0 MMBtu/short ton, NCV) are required to make lime containing 96 percent CaO in a PFR kiln.

4.2.2 Nitrogen Oxides

4.2.2.1 *NO_X Formation*

There are two main sources for the formation of NO_X; *Thermal NO_X* and *Fuel NO_X*.

Thermal NO_X forms from nitrogen (N_2) and oxygen (O_2) at temperatures (much) above 1000 °C, i.e. in the burning zone of the kiln, where the temperatures are sufficiently high. The amount of thermal NO_X produced increases with higher temperatures and oxygen content in the burning zone. Since kilns producing hard or dead burned lime with low reactivity have to be operated with higher temperatures in the burning zone, they tend to generate more thermal NO_X than kilns producing soft burned lime with high reactivity. Because of this temperature dependence, NO_X emissions in vertical shaft kilns are generally lower than in rotary kilns.

Compared with rotary kilns, very little thermal NO_X is formed in the modern PFR kilns. The PFR design features lower peak temperatures and smaller temperatures differences between gases and materials as discussed above and shown in Figure 7.

Fuel NO_X is generated by the oxidation of the nitrogen compounds present in the fuel. For example, upon introduction of coal into a furnace, volatile nitrogen-containing compounds are released that include ammonia (NH_3) and hydrogen cyanide (HCN). The resulting char particles (containing char-nitrogen) ignite. The formation of fuel NO_X proceeds as follows:

The NO_X derived from coal nitrogen may be either produced from homogeneous gas phase reactions through HCN and NH_3 intermediates or from heterogeneous reactions taking place on the coal char surface. To complicate the picture, NO produced from homogeneous reactions can be reduced to N_2 by contact with coal char carbon.

Some NO_X control strategies are specifically geared to creating or prolonging reducing (low oxygen) conditions and promoting the catalytic reactions to fuel nitrogen to N_2 before the inevitable formation of NO. A very rough pictorial representation of the processes that transform fuel nitrogen to NO and N_2 is shown in **Figure 9**. It is possible that some degree of catalysis occurs on lime particles and rock surfaces in a manner similar to that shown for ash.

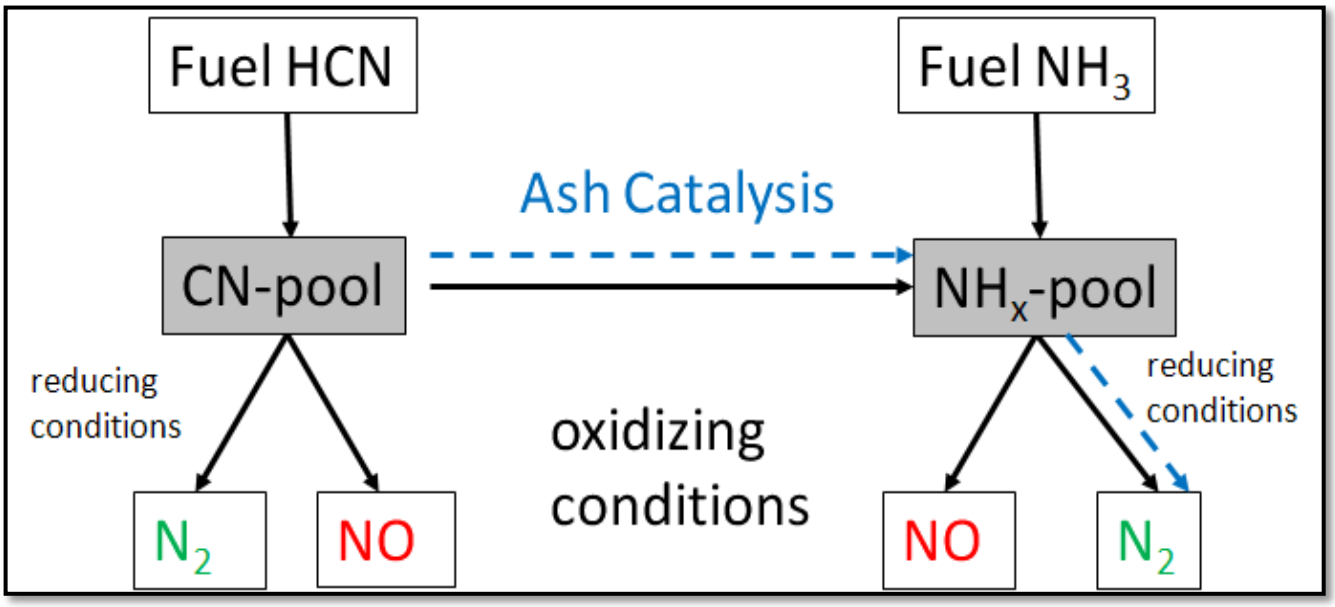


Figure 9 - Pictorial Representation of Fuel NO Formation and Partial Destruction.

4.2.2.2 *Possible NO_X Controls*

The possibilities to reduce NO_X emissions from lime kilns include *primary techniques* to reduce the formation of NO_X and *secondary techniques* to destroy NO_X by reduction to N_2. As discussed above, maximization of energy efficiency is a key factor in reducing NO_X mass emissions if not concentrations.

Given a particular kiln design, primary techniques to further reduce NO_X include:

- Fuel selection to limit the nitrogen content in the fuel;
- Process optimization such as flame shaping and temperature profile;
- Burner design such as a low NO_X burner (LBN); and
- Air staging.

The primary techniques are the most cost effective, but their application is ultimately limited by the inherent design of the type of kiln selected and the temperature levels required to maintain the quality of lime. Secondary techniques involve injection of a reagent to reduce NO_X to N_2 and include:

- Selective non-catalytic reduction (SNCR); and
- Selective catalytic reduction (SCR).

No additional additional control techniques beyond process optimization are typically specified as BACT for PFR kilns. The applicant reached the same conclusion regarding primary and secondary techniques. However, the possibility of add-on controls, such as SNCR and SCR, requires further review.

4.2.2.3 *Further Evaluation of SNCR and SCR*

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:

Ammonia reacts with available hydroxyl radicals to form amine radicals (indicated by *) and water per the following theoretical equation:

$$NH_3 + OH^* \longrightarrow NH_2^* + H_2O$$

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

$$NH_2^* + NO \longrightarrow N_2 + H_2O$$

The two steps are typically expressed as a single "global reaction":

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

The simplified equation does not convey the kinetics. But it suggests that, theoretically, SNCR will function best in an oxidizing atmosphere. In a reducing atmosphere, CO competes with ammonia for available OH radicals:

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

The applicant assumed that it is necessary to reheat the cooled, filtered exhaust gas from much less than 200°C to the 850-1050°C temperature window gas in order to implement SNCR. Such reheating is contrary to the concept of the very efficient PFR design. However, the required temperature window exists throughout the burning zone and partially into the preheat zone.

Refer back to **Figure 7** and **Figure 8**. It is at least theoretically possible to inject ammonia into the shafts via lances or special injectors. Note that the reaction mechanisms for NO_X destruction by SNCR are similar to those depicted earlier in **Figure 9**. This suggests that it should be possible to use lances to inject ammonia or even some natural gas into the region just beyond (i.e. below) the hottest part of the burning zone and effect some NO_X reduction. This has not been demonstrated in practice for a lime kiln, but it is only a matter of time before suppliers will patent and offer such a strategy.

It may also be possible to inject NH_3 into the exhaust from the shaft that is in the burning mode via the cross-over channel. The exhaust gas would be carried into the hot part of the preheat zone of the second shaft and also effect some NO_X reduction. As the exhaust proceeds and cools through the preheat zone, it is even possible that further catalytic reduction can occur by reaction on metals (such as vanadium from petcoke) or even on small amount of iron contained on incoming stone.

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. Unreacted ammonia from the SNCR process or from raw materials reacts with SO_2, SO_3 and chlorides (e.g. from coal and petcoke combustion) at temperatures prevalent in the upper preheater section, heat exchangers, dust control equipment and outside the stack.

Ammonium bisulfate is formed in accordance with the following reaction.

$$NH_3 + SO_3 + H_2O \longrightarrow NH_4HSO_4$$

Ammonium sulfate is formed per the following reaction.

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

Ammonium bisulfite is formed as follows.

$$NH_3 + SO_2 + H_2O \longrightarrow NH_4HSO_3$$

Finally, ammonium chloride is formed as follows.

$$NH_3 + HCl \longrightarrow NH_4Cl$$

Very likely most, if not all, SO_2 and SO_3 released by fuel combustion will react with lime or limestone. Also such plumes can be avoided by careful management of the NH_3 injection and avoidance of high molar ratios of reagent to NO_X.

By nature of their design, it is possible to install SNCR on a preheater rotary (PR) Gepol design lime kiln. Again, rotary kiln designs are not as efficient as a PFR kiln and inherently form much more NO_X. In Flandersbach, Germany, it was possible to achieve NO_X reduction efficiencies of 50 to 70% at a PR Gepol kiln. Higher abatement ratios are possible, but lead to high NH_3 emissions.

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 160 and 600 °C (optimal at ~ 400 °C). This range is much less than 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 **Figure 10**.

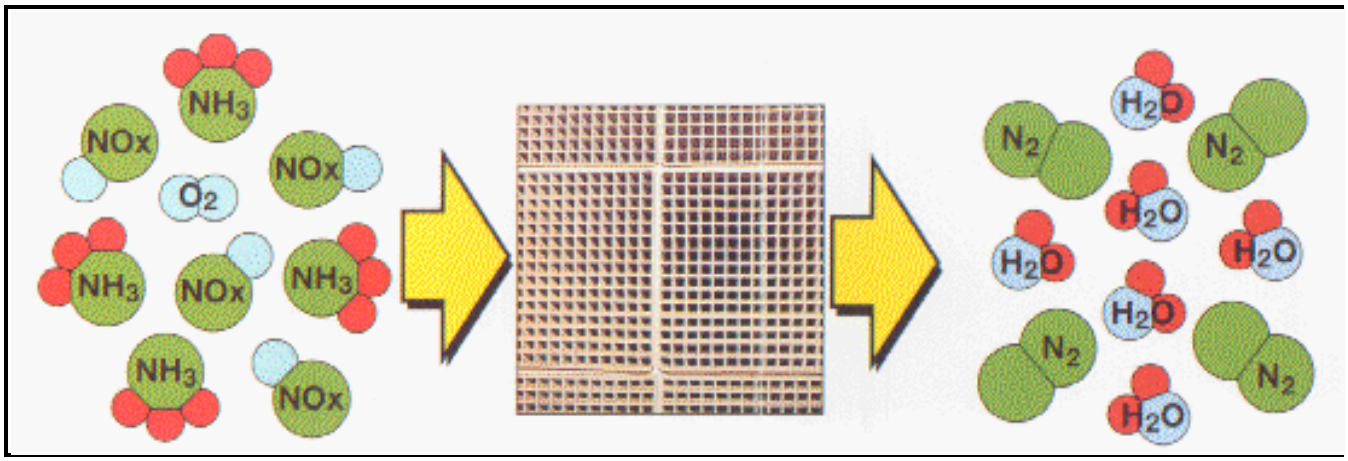


Figure 10 - Gas with NO_X and NH_3. Reaction over Catalyst. Yields N_2 and Water.

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). Other known catalyst structures are plate, molded wire, pellets or dust.

The basic requirements of an SCR catalyst for a petcoke/coal-fueled lime kiln application are:

- Suitable to handle gas containing dust if placed before the PM control device;
- High activity and selectivity;
- Low oxidation rate of SO_2 to SO_3; and
- High resistance to CaO/calcium sulfate ($CaSO_4$) fouling.

The appropriate SCR temperature window exists from the upper stages of the two shafts of a PFR kiln. Alternatively, it is possible to reheat the exhaust gas from the expected exit temperature of 146°C to the 160 - 600°C temperature window for SCR. This level of reheat is not as drastic as what would be required to achieve NO_X reduction by SNCR following the dust filter. While there are now about a half dozen cement rotary kiln references, there are no known examples of SCR installed at any lime kiln.

Applicant's cost analyses of SNCR and SCR. The applicant conducted additional cost analyses for installation of SCR or SNCR units on the Jacksonville Lime PFR kilns. The applicant concluded that these techniques are not cost effective at $9,900 and 23,200/ton NO_X removed for SCR and SNCR, respectively. At these values, the cost of control by would be on the order of approximately $4/ton of lime produced (assuming operation at full capacity). For moderately efficient (70%) control by SCR:

[($1,192,417/year)x(year/365 days)x(kiln-day/396 tons lime)]/(2 kilns) = $4.12/ton lime produced.

For relatively inefficient (40%) control by SNCR:

($1,852,644/year)x(year/365 days)x(kiln-day/396 tons lime)/(2 kilns) = $6.41/ton lime produced.

Department's Conclusion Regarding SNCR and SCR. SNCR and SCR have not yet been demonstrated on PFR kilns, but they probably are technically feasible. They are not yet cost-effective for NO_X reduction on the basis of $/ton NO_X removed (even at half the costs cited by the applicant). The Department believes that eventually manufacturers will develop a more cost-effective SNCR system that can be applied on a PFR kiln without reheat or significantly reducing the inherent energy efficiency characteristics of the PFR design.

At this time, the Department concludes that add-on controls are not cost-effective for NO_X BACT on a PFR kiln. The conclusion does not necessarily extend to other types of kilns.

4.2.2.4 *NO_X Emissions from Lime Kilns*

The applicant provided a listing of BACT determinations for lime kilns from the EPA's RACT/BACT/LAER Clearinghouse (RBLC) and some emission results. However, very little emissions data are readily obtainable for lime kilns in the U.S.; particularly PFR kilns. Add-on controls are not yet economically feasible for such kilns. Thus, it is important to determine low, realistic BACT emission standards for PFR kilns using primary controls.

The very efficient PFR design has become the norm in Europe and an extensive body of information regarding their emission characteristics was compiled by the European Commission in its Best Available Techniques (BAT) Reference Document for the Production of Cement, Lime and Magnesium Oxide (the EU BAT). Link to EU BAT Document NO_X emissions from different types of lime kilns are shown in **Figure 11**. The values are given in terms of milligrams per normal cubic meter, dry, 0°C, corrected to 11% O_2 (mg/Nm^3).

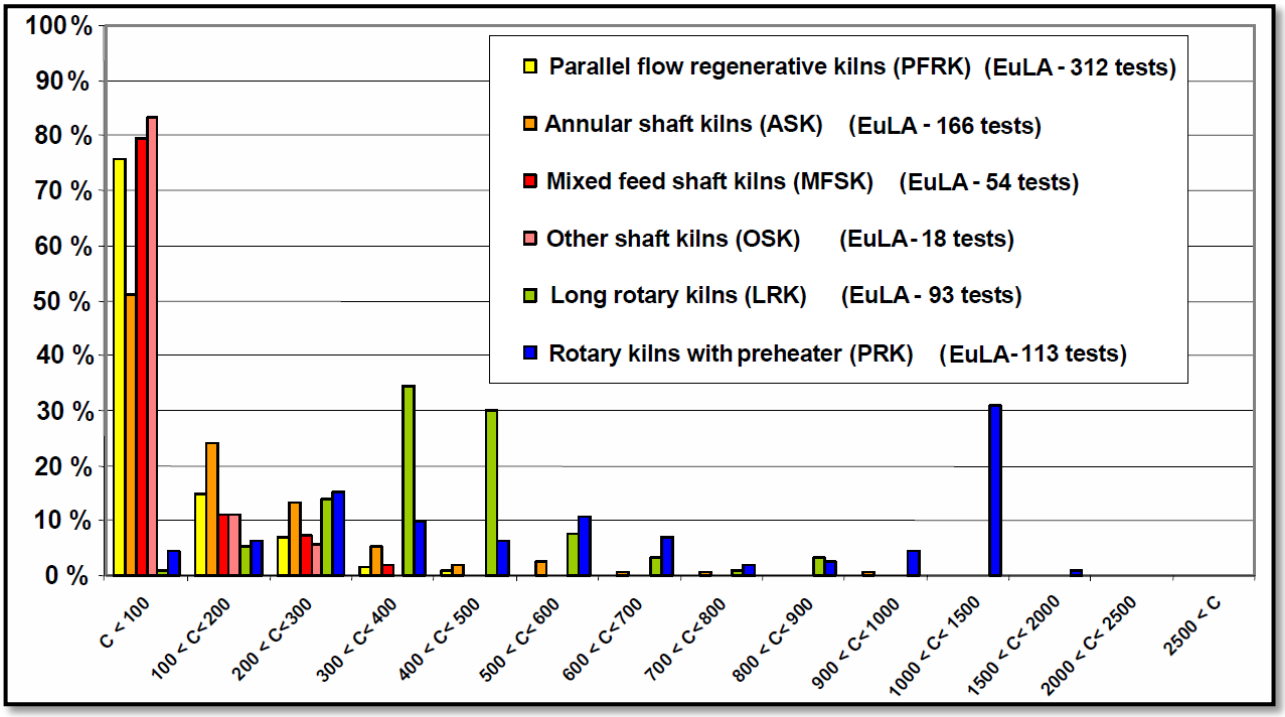


Figure 11 - NO_X Emissions Measured from Different Types of Lime Kilns (mg/Nm^3).

Shaft kilns, including PFR kilns, clearly exhibit much less NO_X emissions in terms of mg/Nm^3 than conventional rotary kilns or rotary kilns equipped with preheaters. About 75% of the PFR kiln NO_X measurements were less than 100 mg/Nm^3. Most likely, these measurements were taken while combusting natural gas. The few measurements greater than 200 mg/Nm^3 were likely conducted while the PFR kiln used solid fuels such as coal, petcoke or wood chips.

Because of the high energy consumption, even if the emission concentrations from a rotary kiln was equal to that of a PFR kiln, the emission rate of the rotary kiln would be about twice as high for the rotary kiln in terms of lb/ton of lime produced. **Table 6** is a summary of NO_X emission tests in mg/Nm^3 from two relatively new PFR lime kilns manufactured by Maerz and located in Ireland. Raheendoran Kiln Emissions Toonagh Kiln Emissions

Table 6 – NO_X Emission Test Results From Maerz PFR Kilns in Ireland (Clogrennane Lime Ltd.)

Plant Location	Years	Fuel	NO_X (mg/Nm^3)	NO_X (lb/ton lime)
Toonagh	2008 - 2012	Petcoke	186 - 392	~ 1.0 - 2.2
Raheendoran		Natural Gas	30 - 44	~ 0.2
		Petcoke	132 - 210	~ 0.7 – 1.2

The kiln at Toonagh uses petcoke and the one at Raheendoran uses both petcoke and natural gas. The Department calculated the emission factors assuming the kilns require 3.2 MMBtu/ton lime. The NO_X emission test results for the two Irish PFR kilns are consistent with those given in **Figure 11** for PFR kilns.

The Department reviewed the permit for the 1991 Chemical Lime Company project in Idaho. The project was for a Maerz Circular Shaft PFR kiln fueled with natural gas. An updated version of the original permit is available at the following link: Link to Idaho Permit The kiln capacity given in the permit is 600 tons/day (550 metric tonnes/day) per the Maerz reference brochure. Link to Maerz References **Table 7** is a summary of the emission limits given in the Idaho permit.

Table 7 – Permitted Limits and Emissions at Chemical Lime, Idaho, Natural Gas-fueled PFR Lime Kiln.

Pollutant	Emission Limits			Reported Emissions [1]
	lb/hour	tons/year	lb/ton lime	lb/ton lime
PM/PM_{10} (filterable)	2.35	10.3	~ 0.094	0.026
CO	12.0	52.6	~ 0.48	0.45
NO_X	8.1	35.5	~ 0.32	0.24
SO_2	1.6	7.0	~ 0.064	0.012

1. Emissions Survey Conducted at Chemstar Lime Company. American Environmental Testing Company, Inc., February 26, 1993. As incorporated into Table 11.17 in AP-42, Emission Factors for Lime Manufacturing. AP-42, Chapter 11.17, Lime Manufacturing

The project was characterized by very low emission limits, considering that it was permitted more than 20 years ago. In fact, at the low emission limits, it did not trigger PSD. The permitted (non-BACT) NO_X limit at the Idaho kiln and the reported emission results are compatible with the test results obtained at the Irish kilns. Assuming that the Idaho kiln is as efficient as the proposed Jacksonville Lime kiln, then the emission limit of 0.32 lb NO_X/ton would equate to roughly 63 mg/Nm^3 when using natural gas.

4.2.2.5 *NO_X BACT Determination*

The applicant has proposed a BACT determination of 2.5 lb NO_X/ton of lime. This value equates to approximately 453 mg/Nm^3 (dry, 0°C, 11% O_2) when combusting petcoke and 492 mg/Nm^3 when burning natural gas. According to **Table 3**, NO_X is a precursor of the condensable portions of PM_{10} and $PM_{2.5}$. Therefore, the NO_X BACT determination is part of the BACT for PM_{10} and $PM_{2.5}$. Because of the variety of fuels fired and different BACT limits for each fuel, the Department will require a continuous emission monitoring system (CEMS) for NO_X. The Department requires as BACT for NO_X:

- Efficient PFR kiln design (to minimize lb of pollutant/ton of lime);
- NO_X limit of 100 mg/Nm^3 when using natural gas (~0.5 lb/ton);
- NO_X limit of 350 mg/Nm^3 when using coal or petcoke (~1.9 lb/ton); and
- NO_X limit of 500 mg/Nm^3 when using wood chips (~2.6 lb/ton).

Continuous compliance with the NO_X emission limits will be demonstrated by a CEMS on the basis of 30 rolling operating days. For each PFR kiln, the applicable NO_X limit (mg/Nm^3) for a given 30 rolling operating day period will be calculated as follows:

(MMBtu NG)*(100 mg/Nm^3)+(MMBtu C+P)*(350 mg/Nm^3)+(MMBtu W)*(500 mg/Nm^3)/Total MMBtu

Where: NG is natural gas, C is coal, P is petcoke and W is wood.

Thus, if the applicant uses equal heat input of natural gas, petcoke, coal and wood over 30 operating days, the applicable NO_X limit will be 325 mg/Nm^3 and approximately 1.74 lb/ton lime. The emission concentration used to compare with the 30 rolling operating day applicable limit is the simple sum of the mass of NO_X (as NO_2) emitted during the 30 operating days calculated divided by the total gas volume (dry, 20°C, 11% O_2) exhausted during the 30 operating days.

4.2.3 Sulfur Dioxide and Sulfuric Acid Mist

4.2.3.1 *SO_2 Formation*

SO_2 emissions depend on the sulfur content of the fuel, the design of kiln and the required sulfur content of the lime produced. The sulfur content of the incoming raw material can also affect emissions, especially if the limestone contains metal sulfides such as pyrite minerals. In the less efficient rotary kilns, there is not particularly intimate and complete contact between the exhaust gases (containing the SO_2) with produced lime and incoming stone. By contrast, the contact is much more intimate between the exhaust gases in a highly efficient PFR kiln and the produced lime and stone.

4.2.3.2 *SO_2 Emissions from Lime Kilns*

SO_2 emissions from different types of lime kilns are shown in **Figure 12**. Shaft kilns, including PFR kilns, clearly exhibit much less SO_2 emissions in terms of mg/Nm^3 than conventional rotary kilns or rotary kilns equipped with preheaters. Over 90% of the PFR kiln SO_2 measurements were less than 50 mg/Nm^3. Most likely, these measurements were taken while combusting natural gas or biomass. The few measurements greater than 50 mg/Nm^3 were likely conducted while the PFR kiln used solid fuels such as coal, petcoke or when the raw materials contained excessive amounts of pyrites.

Table 8 is a summary of SO_2 emission tests in mg/Nm^3 from the two previously discussed Maerz PFR kilns located in Ireland. The estimated annual emissions are also included.

Table 8 – SO_2 Emission Test Results from Maerz PFR Kilns in Ireland (Clogrennane Lime Ltd.).

Plant Location	Years	Fuel	SO_2 (mg/Nm^3)	SO_2 (metric tonnes/year)
Toonagh	2008 - 2012	Petcoke	< 5 - 177	0.7 – 15.1
Raheendoran		Natural Gas	2 – 7.9	0.6 – 6.9
		Petcoke	5 - 80	

SO_2 can be reduced by methods that increase the contact between the exhaust gases and the lime and limestone. At a straight rotary kiln fed with dolomite it has been observed that significant reductions in SO_2 emissions can occur with feed stones that contain high levels of finely divided limestone or that are prone to break up on heating. The finely divided limestone calcines and is entrained in the kiln gases. It subsequently removes SO_2 in the exhaust and in the dust collector (e.g. on filter cake in baghouse).

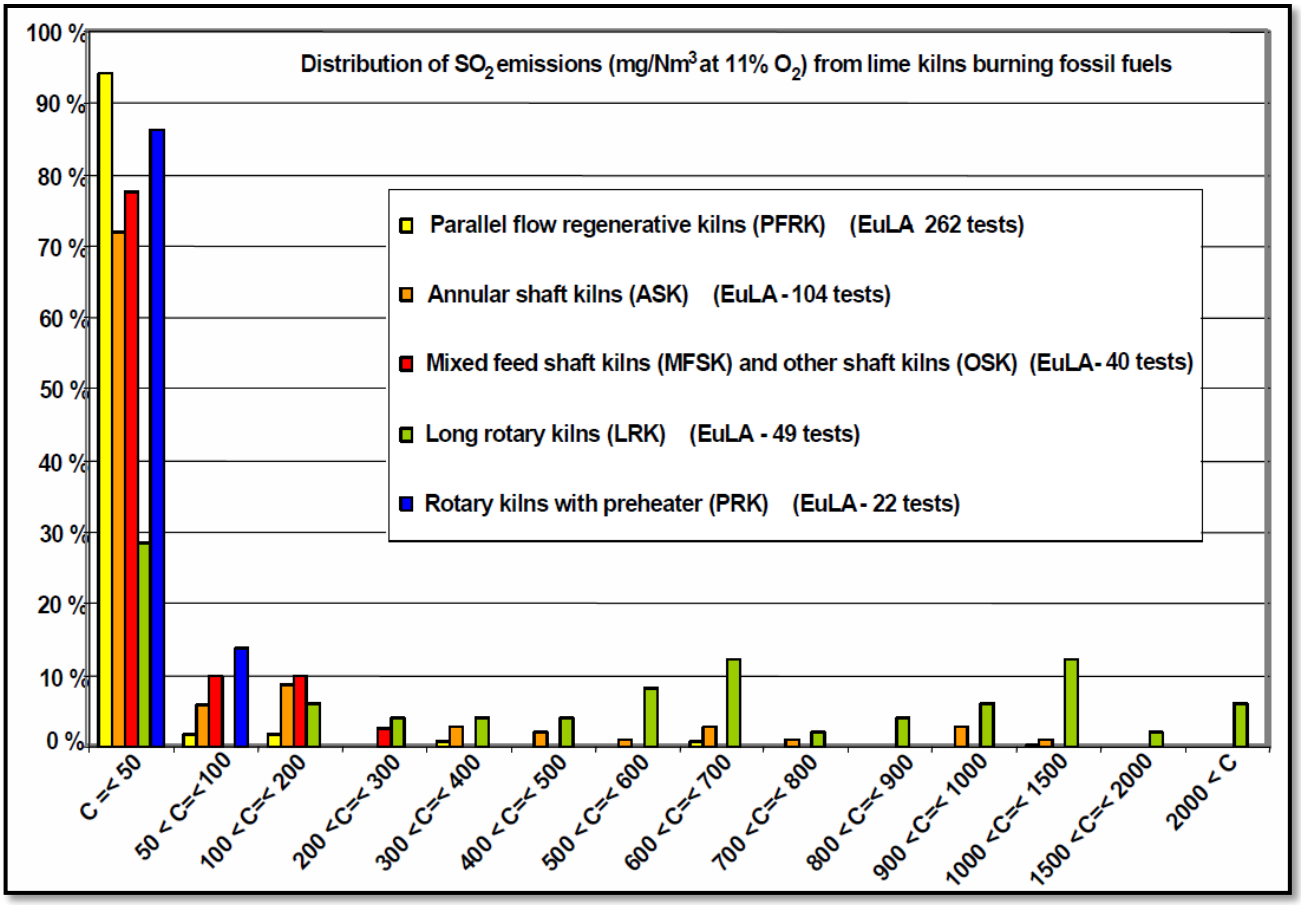


Figure 12 - SO_2 Emissions Measured from Different Types of Lime Kilns (mg/Nm^3).

Sorbent addition techniques for the reduction of SO_2 emissions include cascade-type packed bed adsorbers, module adsorber systems, and dry flue-gas cleaning with a fabric filter or electrostatic precipitator (ESP). The use of sorbents to reduce SO_2 emissions is well established in other industries; however, it has not yet been applied to rotary lime kilns. At rotary kilns, the following techniques may be considered:

- Use of fine limestone;
- Injection of finely divided quick lime or hydrated lime into the combustion air; and
- Injection of a sorbent into the exhaust gases (e.g. hydrated lime or sodium bicarbonate) while providing sufficient gas residence time between the injection point and the dust collector (preferably a fabric filter) to obtain efficient absorption.
- Use of a wet scrubber employing an alkaline reagent (e.g., wet limestone, lime slurry, soda ash, caustic, ammonia).

In the case of PFR kilns, there is very intimate contact between exhaust gases and the lime product in the shaft undergoing burning or with incoming limestone in the shaft that is in preheat mode. Therefore the cost-effectiveness of further SO_2 control by sorbent injection or wet scrubbing is not favorable.

4.2.3.3 *Applicant's SO_2 BACT Proposal*

The applicant has proposed a BACT determination of 1.5 lb SO_2/ton of lime. This value equates to approximately 272 mg/Nm^3 (dry, 0°C, 11% O_2) when combusting coal or petcoke. The applicant proposes to use petcoke with a maximum sulfur (S) concentration of 5.2%. This equates to an input of 8.7 lb SO_2/MMBtu and 27.7 lb SO_2/ton lime produced.

To achieve 1.5 lb SO_2/ton when burning the highest sulfur petcoke an SO_2 removal efficiency of 94.6% is required. When burning coal, the removal efficiency would need to be closer to 90%. The applicant assessed a number of options including:

- Exclusive use of natural gas;
- Wet or semi-wet scrubbing;
- Multichem oxidation/reduction system using peroxide;
- Inherent scrubbing of exhaust gas by product lime and limestone; and
- Limitations of 3% S in coal and 5.2% S in petcoke.

The applicant concluded that the cost-effectiveness of different fuel strategies ranges from $10,059 to 25,084/ton removed on an incremental cost basis. The applicant also concluded that scrubbers and the oxidation/reduction systems are not cost-effective at high capital costs on the order of $3 to 5.5 million and $10,000 or more/ton of SO_2 removed on an incremental cost basis. The applicant did not consider the alternatives such as injection of fine limestone, quick lime or hydrated lime in the firing zone or injection or the exhaust.

4.2.3.4 *Department's SO_2 BACT Determination*

The Department does not necessarily agree with the cost assessment provided by the applicant. However, add-on controls are not required because the inherent scrubbing capability of the PFR kiln is even greater than assumed by the applicant. Add-on control equipment would not be cost-effective given the low emissions using primary measures.

Because of the variety of fuels fired and different BACT limits for each fuel, the Department will require a continuous emission monitoring system (CEMS) for SO_2. The Department requires as BACT for SO_2:

- Efficient PFR kiln design (to minimize lb/ton of lime);
- SO_2 limit of 50 mg/Nm^3 when using natural gas or wood (~0.25 lb/ton); and
- SO_2 limit of 200 mg/Nm^3 when using coal or petcoke (~1.1 lb/ton).

The values account for the possibility that some pyrites will at times be present in the raw materials. Continuous compliance will be demonstrated by a CEMS on the basis of 30 rolling operating days. For each PFR kiln, the applicable SO_2 limit (mg/Nm^3) for a given 30 rolling operating day period will be calculated as follows:

(MMBtu NG+W)*(50 mg/Nm^3)+(MMBtu C+P)*(200 mg/Nm^3)/total MMBtu

Where: NG is natural gas, C is coal, P is petcoke and W is wood.

Thus, if the applicant uses equal heat input of natural gas, petcoke, coal and wood over 30 operating days, the applicable SO_2 limit will be 125 mg/Nm^3 and approximately 0.68 lb/ton lime. The emission concentration used to compare with the 30 rolling operating day applicable limit is the simple sum of the mass of SO_2 emitted during the 30 operating days calculated divided by the total gas volume (dry, 0°C, 11% O_2) exhausted during the 30 operating days.

The limit when burning coal and petcoke is less than requested by the applicant. However, the applicant can enhance the inherent scrubbing of the process by a number of means or blend the coal and petcoke to provide lower sulfur into the process.

4.2.4 Carbon Monoxide

4.2.4.1 *CO Formation*

CO is a product of initial combustion kinetics and its actual emission is a signal of incomplete combustion or burnout. Its rate of formation is very much dependent upon the fuel used, temperature, residence time, turbulence, etc. Operators strive to minimize emitting CO because it is an indicator that not all of the energy contained in the fuel has been used.

4.2.4.2 *CO Emissions from Lime Kilns*

CO emissions from different types of lime kilns are shown in **Figure 13**.

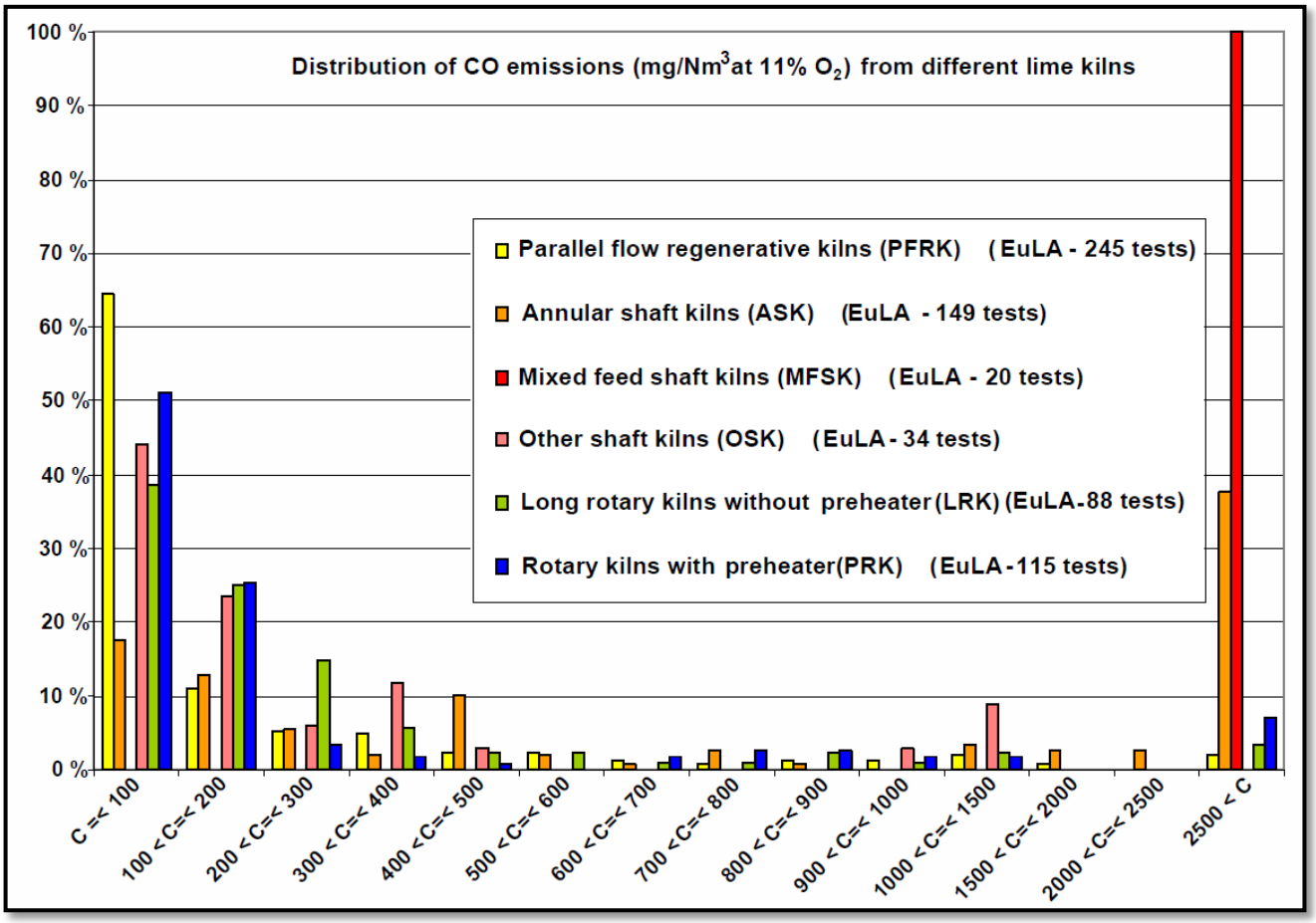


Figure 13 - CO Emissions Measured from Different Types of Lime Kilns (mg/Nm^3).

PFR kilns exhibit less CO emissions in terms of mg/Nm^3 compared with conventional rotary kilns and similar CO emissions compared with rotary kilns equipped with preheaters. Approximately 65% of the PFR kiln CO measurements were less than 100 mg/Nm^3. Most likely, these measurements were taken while combusting natural gas. The measurements greater than 200 mg/Nm^3 were likely conducted while the PFR kiln used solid fuels such as coal, petcoke or biomass.

Note that certain types of shaft kilns emit very high concentrations of CO. In the case of mixed feed shaft (MFS) kilns CO is generated because of the existence of a reduction zone where some CO_2 actually reacts with unburned carbon (C) to form CO. Other shaft (OS) kilns also exhibit high CO emissions.

For PFR kilns, very short CO peaks appear at the beginning a cycle. At the end of the cycle, fuel injection is stopped in the shaft where burning is occurring. Before reversal to preheat mode, only air is injected for a time to ensure all the fuel is burned. A small quantity of fuel may remain under the lances. After reversal, it completes combustion while in the preheat mode producing a 'peak' concentration of CO.

CO emissions for PFR kilns range usually from 100 to 400 mg/Nm^3 depending on the type of fuel used. This range equates to approximately 0.6 to 2.4 lb/ton lime for an average efficiency PFR kiln. It would represent a lower range (0.5 to 2.2 lb/ton lime) for the more efficient PFR kiln proposed by Jacksonville Lime.

4.2.4.3 *Applicant's CO BACT Proposal*

The applicant has proposed a BACT determination of 3.0 lb CO/ton of lime using "good combustion controls". This value equates to approximately 544 mg/Nm^3 (dry, 0°C, 11% O_2) when combusting coal or petcoke; 591 mg/Nm^3 when burning natural gas; and 569 when burning wood chips.

The applicant assessed a number of options including:

- Thermal oxidation (at ~ 1,500°F/815°C);
- Oxidation catalyst; and
- Good combustion techniques.

According to the applicant, since there are no demonstrated applications of thermal oxidation on lime kilns, thermal oxidization can be considered technically infeasible. The Department disagrees with this conclusion because CO can be destroyed at lower temperatures. Also, regenerative thermal oxidation (RTO) is actually used at the TXI Cement Kiln 5 in Midlothian to reduce both VOC and CO. This technology is not, however, cost-effective except for massive CO emissions or high VOC emissions.

According to the applicant, catalytic oxidation for the reduction of CO is a technically infeasible control technique for the proposed project. According to the applicant, the oxidation catalyst must be installed downstream of the particulate control device to ensure that the catalyst is not chemically damaged. The Department disagrees with this conclusion because catalysts for NO_X have been demonstrated in the cement industry both ahead of and after the PM control device. Similarly, oxidation catalyst and SCR catalyst have been installed at some biomass facilities using processes that include heat exchangers and ceramic media to reduce both CO and NO_X.

The applicant evaluated of thermal oxidation and concluded that (assuming it is technically feasible) the cost would be $7,300 to 11,000/ton CO removed. The Department believes the cost would be less than estimated, but would not consider this technology to be cost-effective at half the cited cost.

4.2.4.4 *Department's CO BACT Determination*

There are no applications of CO add-on controls for lime kilns and the Department does not believe it would be cost-effective to add CO controls.

The indicated techniques to achieve BACT are:

- Selection of raw materials with a low content of organic matter; and
- Process optimization techniques to achieve stable and complete combustion.

These techniques are consistent with the applicant's conclusion that BACT for the project would be "good combustion controls". The Department will require separate stack tests for natural gas and solid fuels operation.

The Department requires as BACT for CO:

- Efficient PFR kiln design (to minimize lb/ton of lime);
- CO limit of 200 mg/Nm^3 when using natural gas (~1.0 lb/ton);
- CO limit of 400 mg/Nm^3 when using coal, petcoke or wood, or combination thereof (~2.2 lb/ton):
- Proper specification of raw materials and fuels to achieve the BACT limits; and
- Process optimization including use of a process CEMS to achieve stable and complete combustion.

Compliance will be demonstrated by an initial test using at least 90% natural gas and an initial test using at least 90% coal, petcoke or wood chips (or combination thereof). Annual tests shall be conducted using at least 90% natural gas or at least 90% coal, petcoke or wood chips (or combination thereof).

4.2.5 Particulate Matter (PM)

4.2.5.1 *PM Formation*

This discussion concerns "filterable" PM and not condensable PM discussed below as a component of PM_{10} and $PM_{2.5}$. (Filterable) PM consists of finely divided particles in the limestone feed, from thermal and mechanical degradation of the lime and limestone within the kiln, and fuel ash. The levels of PM at the inlet of the particulate control equipment vary widely, depending on kiln design, capacity, raw material, fuel and kiln operation.

4.2.5.2 *PM Emissions from Lime Kilns*

Because of the wide range of exhaust gas conditions, a variety of PM collectors are used, including cyclones, wet scrubbers, fabric filters, ESPs and gravel bed filters. Typical cyclones remove about 90% of the filterable PM from lime kilns. PM emissions from lime kilns using different types of controls are shown in **Figure 14**.

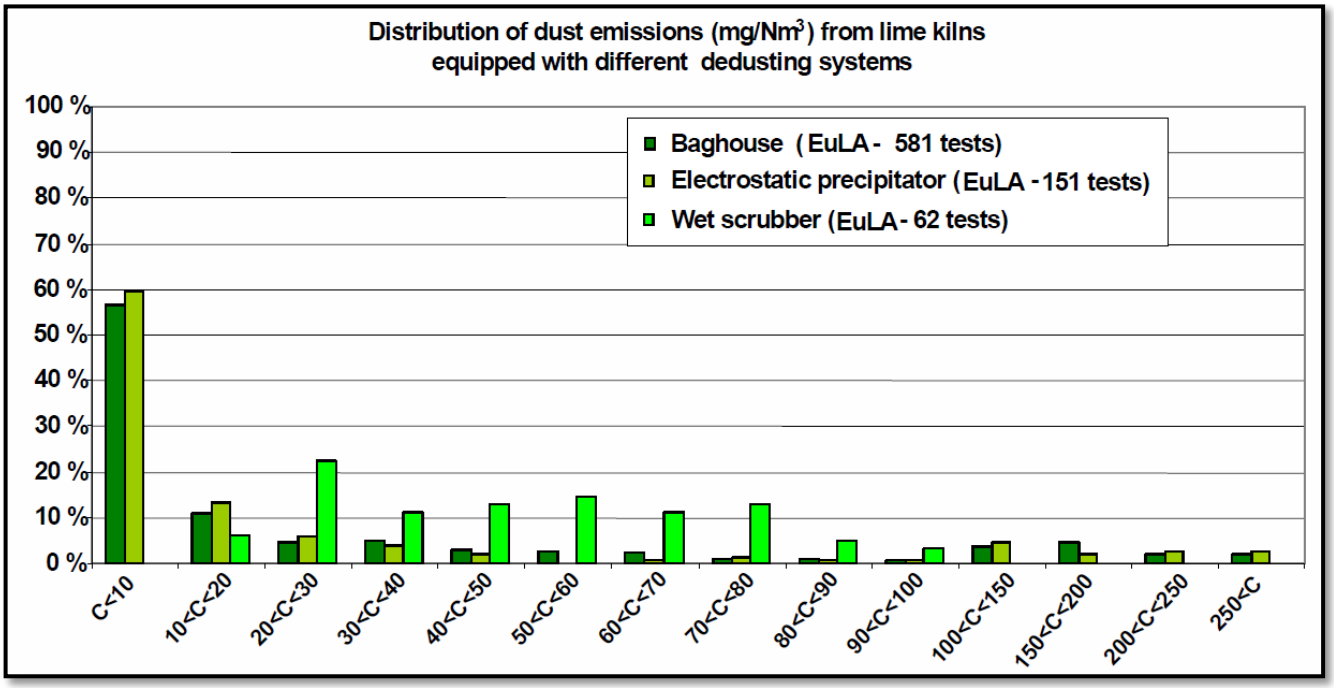


Figure 14 – PM Emissions from Lime Kilns with Different Types of Controls (mg/Nm^3).

Fabric filters (baghouses) and ESPs achieve excellent control and clearly less PM emissions in terms of mg/Nm^3 than wet scrubbers. Over 55% of the baghouse PM measurements were less than 10 mg/Nm^3 and 70% were less than 20 mg/Nm^{3}of the PM measurements. 20 mg PM/Nm^3 equates to approximately 0.11 lb PM/ton of lime (when firing petcoke) and 0.0081 grains per dry standard cubic foot @11% O_2 (gr/dscf). For reference, all shaft kilns (including PFR kilns) in Germany are equipped with fabric filters. The (filterable) PM emission values do not depend on the type of fuel used whether of fossil or waste origin.

Table 9 is a summary of PM emission tests in mg/Nm^3 from the two previously discussed Maerz PFR kilns located in Ireland. There is no difference between the results when firing petcoke compared with natural gas.

Table 9 – Filterable PM Test Results from Maerz PFR Kilns In Ireland (Clogrennane Lime Ltd.).

Plant Location	Years	Fuel	PM (mg/Nm^3)	PM (metric tonnes/year)
Toonagh	2008 - 2012	Petcoke	1.5 – 6.2	0.2 – < 1
Raheendoran		Natural Gas or Petcoke	0.4 – 7.9	0.4 – < 1

The test method used is similar to EPA Method 5, but allows for an in-stack filter if the exhaust is hot enough to avoid condensation of gaseous species. It provides for a heated out-of-stack filter, if necessary, to avoid condensation of gaseous emissions on the filter.

The Department also reviewed a report in support of a substantial modification of a Maerz PFR kiln at Calce San Pellegrino, Terni Province, Italy. The project involved a permit modification to combust woody biomass. A (filterable) PM requirement of 10 mg/Nm^3 was specified. Link to C S Pellgrino Modification

4.2.5.3 *Applicant's PM BACT Proposal*

Jacksonville Lime proposed a BACT PM value of 0.12 lb/ton of lime using fabric filters to achieve 0.01 gr/dscm (presumably @11% O_2) or approximately 25 mg PM/Nm^3 @11% O_2. The applicant also considered ESPs as well as wet scrubbers and venturi scrubbers. The applicant selected fabric filters over ESPs that have roughly equal control capability. The fabric filter is a better choice for this project because there is less possibility of a CO trip and the filter cake helps to react and remove SO_2.

The proposed value is less than the PM emission standard of 0.1 lb/ton of stone feed (roughly 0.18 lb/ton lime) given in NESHAP Subpart AAAAA, but twice the value of the Idaho kiln.

4.2.5.4 *Department's PM BACT Determination*

The Department is required to include the limit of 0.1 lb/ton of stone feed (~ 37 mg/Nm^3) in the permit to satisfy NESHAP Subpart AAAAA. Compliance is determined using EPA Method 5. The PM BACT determination must be at least as stringent as the limit given in NESHAP Subpart AAAAA.

The Department will require initial and annual testing of PM. Because of the similarity in PM emission characteristics, the applicant can test using any fuel to satisfy the initial and annual test requirements for PM, but not necessarily the condensable portions of PM_{10} and $PM_{2.5}$ as discussed further below.

In accordance with NESHAP Subpart AAAAA, the operator is required to maintain and operate the fabric filter such that the baghouse leak detection system (BLDS) or PM detector alarm condition does not exist for more than 5 percent of the total operating time in a 6-month period. In lieu of a BLDS or PM detector the operator shall maintain the fabric filter such that the 6-minute average opacity for any 6-minute block period does not exceed 15%. This provision is adopted as part of the BACT determination to provide reasonable assurance of continuous compliance with the BACT PM limit.

In summary, the Department requires as BACT for PM:

- Efficient PFR kiln design (to minimize lb/ton of lime);
- PM limit of 10 mg/Nm^3 = 9.3 mg/dscm when using any fuel (~ 0.055 lb/ton lime and ~ 7.9 tons/year for two kilns);

- EPA Method 5 shall be used to demonstrate compliance with the filterable PM BACT limit except that the probe and filter holder heating system shall be operated at ≤ 160 ± 14°C (320 ± 25°F); and
- Use of BLDS or PM detector alarm or opacity monitor and their respective criteria (leakage, alarm or opacity) to ensure continuous compliance between compliance tests.

The applicant shall also test to demonstrate initial compliance with the requirements of NESHAP Subpart AAAAA (0.1 lb/ton stone feed). The tests shall be conducted using EPA Method 5. The probe and filter holder heating system shall be operated at 120 ± 14°C (248 ± 25°F). Link to EPA Method 5

Refer **Figure 15** for a diagram of the key components of an EPA Method 5 sampling train.

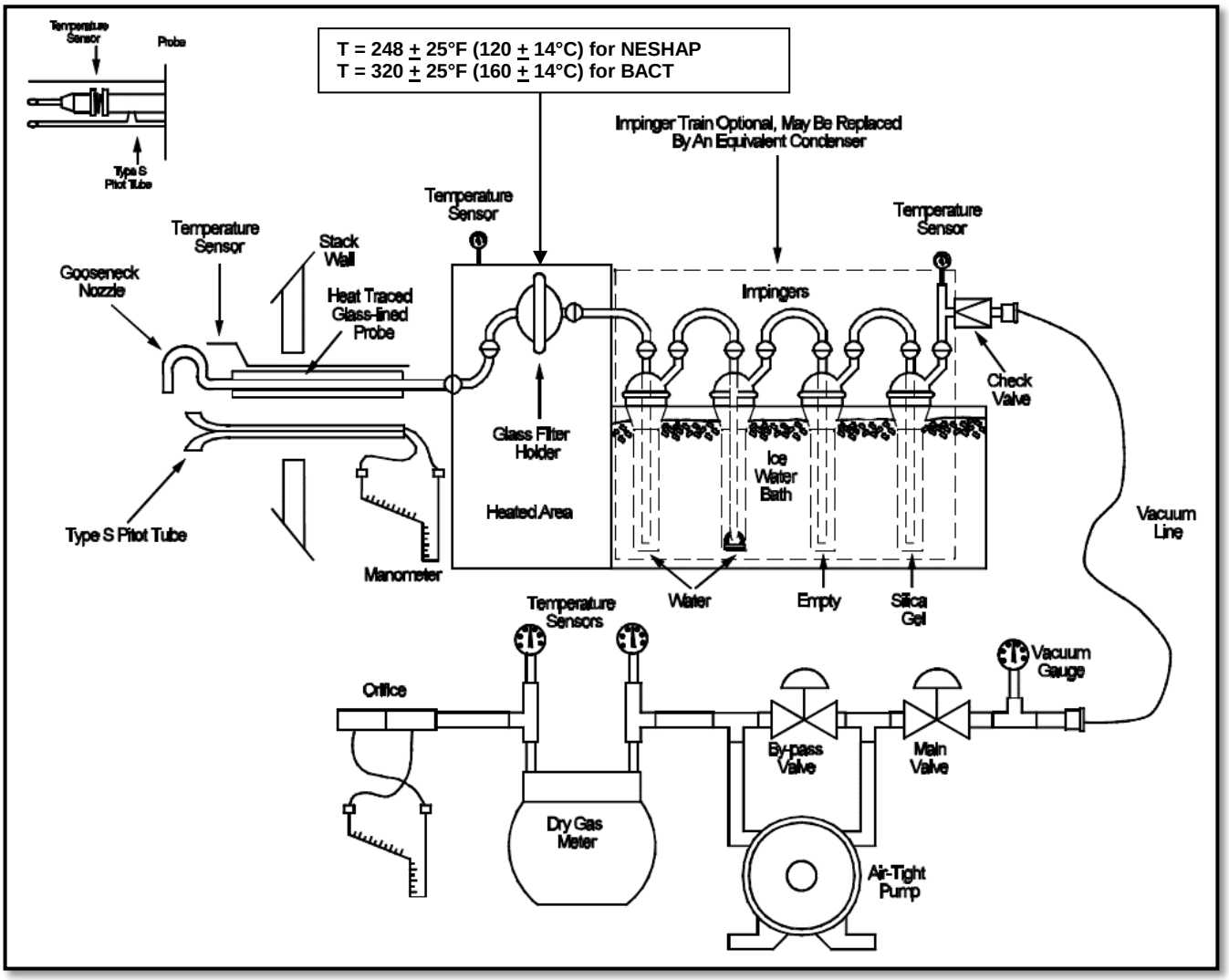


Figure 15 - Standard EPA Method 5 PM Sampling Train.

4.2.6 $PM_{10}/PM_{2.5}$

4.2.6.1 *$PM_{10}/PM_{2.5}$ Formation, Including Condensables*

Filterable $PM_{10}/PM_{2.5}$ emissions are formed and controlled in the same manner described above for PM. However, according to Department Rule 62-210.200 (Definitions), F.A.C., for purposes of PSD and PSD avoidance, PM_{10} and $PM_{2.5}$ emissions shall include ***condensable*** PM_{10} and $PM_{2.5}$, respectively. Condensable PM_{10} and $PM_{2.5}$ consists of gaseous emissions that condense at ambient temperatures to form PM_{10} and $PM_{2.5}$.

PM emissions [at 120 ± 14°C (248 ± 25°F)] from the two PFR kilns were estimated by the applicant are estimated at 24.9 TPY. After considering the Department's BACT determination, the annual PM emissions will be a little less than 8 tons/year [at 160 ± 14°C (320 ± 25°F). However, emissions of $PM_{10}/PM_{2.5}$ are estimated by the applicant at 41.6/41.6 TPY when including condensables. Furthermore, the project also triggered PSD for $PM_{10}/PM_{2.5}$ because emissions of the precursors (SO_2 and NO_X) are greater than 40 TPY.

Although the formation and control of filterable $PM_{10}/PM_{2.5}$ is similar to PM, the formation and control of condensable $PM_{10}/PM_{2.5}$ is much different than filterable $PM/PM_{10}/PM_{2.5}$. The condensable portion is comprised of compounds such as ammoniated chlorides, sulfates, nitrates, VOC and other such species condensing at low temperature. Some of these species would be gaseous at the exhaust gas temperature of approximately 146°C (295°F) or if measured at the standard EPA Method 5 filter temperature of 120°C ± 14°C (248°F ± 25°F).

Most condensable PM_{10} and $PM_{2.5}$ emissions from the Jacksonville Lime project will be caused by SO_2 conversion to sulfur trioxide (SO_3) in an excess air environment and then to sulfuric acid mist (SAM) via the reactions:

$$2SO_2 + O_2 \longrightarrow 2\,SO_3$$

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

Use of petcoke (and certain coals and residual fuel oil) with high vanadium content can catalyze the conversion of SO_2 to SO_3. **Figure 16** is a graph (developed by Verhoff and Banchero, 1974) and cited in a recent EPA/Babcock Power evaluation of SAM emissions from coal-fired power plants.

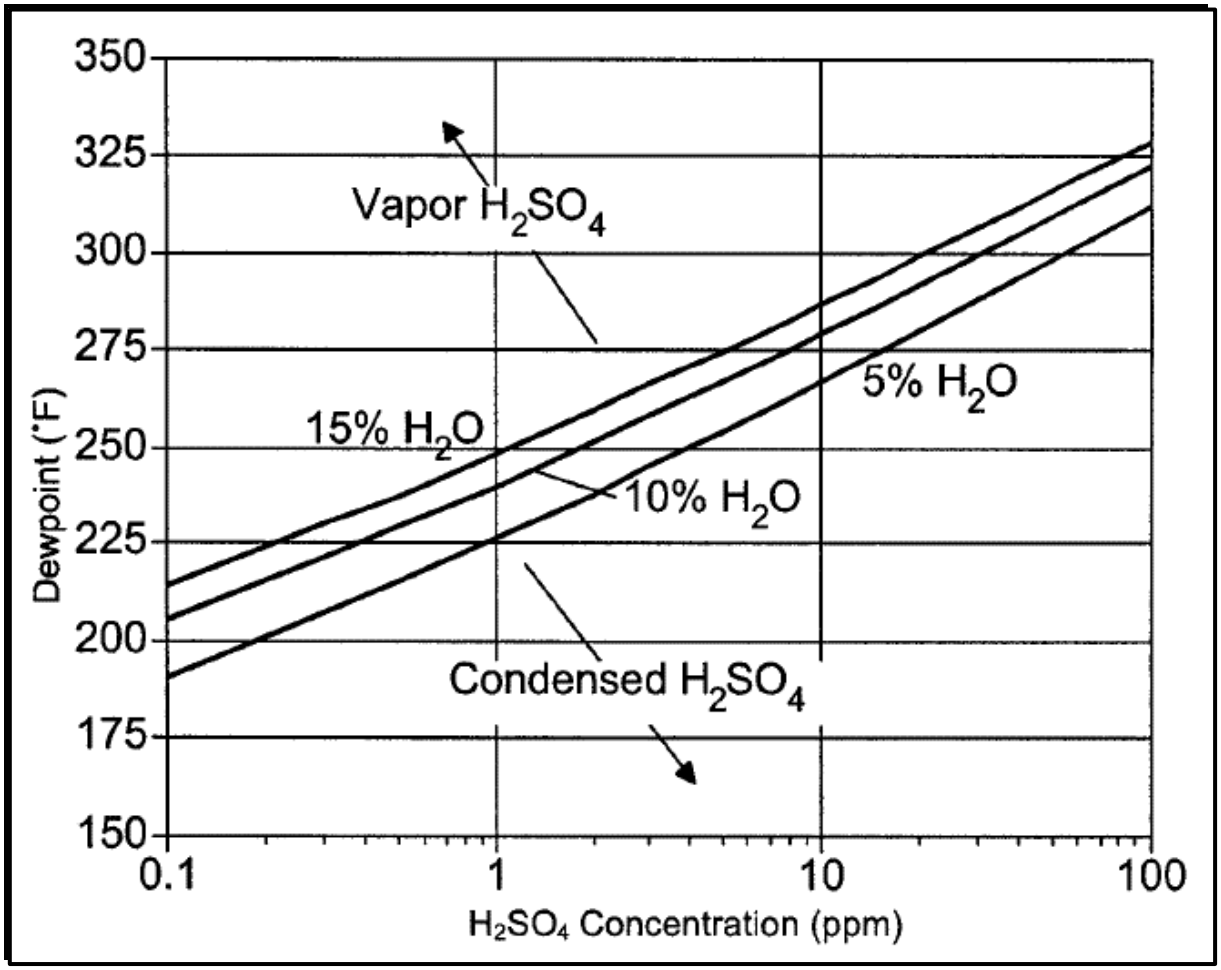


Figure 16 - Dew Point versus H_2SO_4 Concentration.

The graph indicates the dew point variation of power plant exhaust gases at different concentrations of SAM and water. It takes a concentration of just 1 ppm of SAM to cause condensation at 250 °F and 15% H_2O. Link to EPA - Babcock Power Article On the other hand, it takes a much greater concentration of 100 ppm of SAM to cause condensation at 325°F and 15% H_2O.

The incoming limestone and baghouse filter cake should be very effective at removing SAM and the Department believes that such emissions will not be substantial. However, the EPA Method 5 sampling train must be operated at a high temperature to avoid biasing the BACT (filterable) PM test since the limit is based on high temperature operation and thus exclusion of condensables.

Refer to **Figure 17**. The typical $PM_{2.5}$ sampling train is a hybrid of EPA Methods 201A and 202. The first portion (left hand side) is used to sample the gas stream and, by inertial separation, remove filterable PM larger than 10 micrometers (µm) and then filterable PM between 10 and 2.5 µm in aerodynamic diameter.

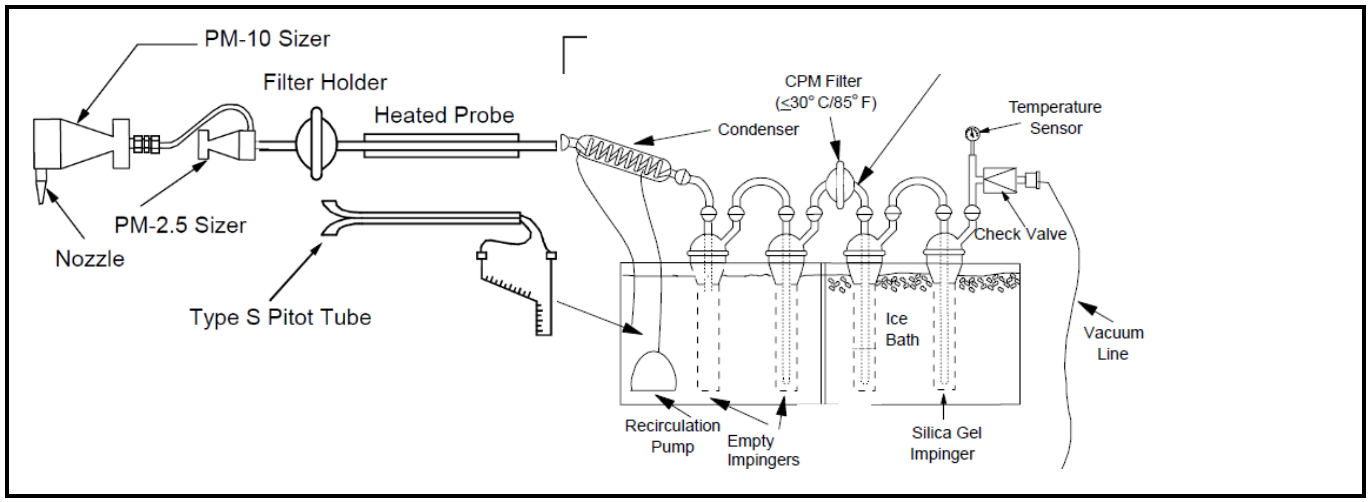


Figure 17 - EPA Hybrid Method 201A/202 Filterable and Condensable $PM_{2.5}$ Sampling Train

A filter is then used to remove by mechanical impaction, interception and diffusion virtually all the filterable $PM_{2.5}$ existing at near-stack temperature conditions. The exhaust gas sample (cleansed of filterable $PM/PM_{10}/PM_{2.5}$) is maintained at relatively high temperature in a heated probe and then passed through a condenser to nucleate condensable species and convert them into filterable PM. The sample is then passed through the condensable PM (CPM) filter that is operated at a "defined ambient temperature" $\leq$ 30°C (85°F).

This is a very cumbersome method that would be used once a year to determine the condensable portion of PM_{10} and $PM_{2.5}$. The Department believes there are better alternatives that will ensure low emissions of PM_{10} and $PM_{2.5}$ including condensables.

4.2.6.2 *Applicant's $PM_{10}/PM_{2.5}$ BACT Proposal*

The applicant has proposed a BACT $PM_{10}/PM_{2.5}$ value of 0.303 lb/ton lime (including condensables) using fabric filters and the inherent scrubbing of SO_2. The proposed value equates to approximately 55 mg/Nm^3 when combusting petcoke and approximately 60 mg/Nm^3 when burning natural gas. These values (including condensables) are approximately 5 to 6 times the Department's estimate of filterable PM (measured at the higher temperature and excluding condensables).

4.2.6.3 *Department's $PM_{10}/PM_{2.5}$ BACT Determination*

The Department requires as BACT for $PM_{10}/PM_{2.5}$:

- Efficient PFR kiln design (to minimize lb/ton of lime);
- The (filterable) BACT PM limit of 10 mg/Nm^3 (~0.05 lb/ton), referenced to measurement at 160 $\pm$ 14°C to reduce direct emissions of filterable PM_{10} and $PM_{2.5}$;

- Use of BLDS or PM detector alarm or opacity monitor and their respective criteria (leakage, alarm or opacity).
- Low NO_X and SO_2 BACT determinations to minimize emissions of $PM_{10}/PM_{2.5}$ condensable species precursors; and
- CEMS for SO_2 and NO_X to provide reasonable assurance of continuous low emissions of the condensable $PM_{10}/PM_{2.5}$ precursors.

4.2.7 Summary of Draft BACT Determinations for the PFR Kiln

Table 10 is a summary of the Department's Draft determinations for the PFR kilns at the Jacksonville Lime project.

Table 10 – Draft BACT Determinations for the Jacksonville Vertical PFR Lime Kilns.

Pollutant	Fuel [a]	Draft BACT Emissions Standards [b, c, d] mg/Nm^3, (equivalent lb/hr)	Compliance Method	Equivalent Process-based Standards (lb/ton lime) [f]	Applicant's Proposal (lb/ton lime)
NO_X [e]	PC, C	350 (~ 31.9)	30-operating day, rolling, CEMS [e] (prorated by fuel)	~ 1.9	2.5
	NG	100 (~ 8.3)		~ 0.5	
	WC	500 (~ 43.6)		~ 2.6	
SO_2 [e]	PC, C	200 (~18.2)		~ 1.1	1.5
	NG, WC	50 (~ 4.2)		~ 0.05	
CO [g]	PC, C, WC	400 (~39.6)	Stack Tests	~ 2.2	3.0
	NG	200 (~19.8)		~ 1.0	
PM [h, i]	All	10 (~0.9)	Stack Tests	~ 0.05	0.12
		0.10 lb/ton of stone feed NESHAP Subpart AAAAA	Stack Tests	~ 0.18	~ 0.18
$PM_{10}/PM_{2.5}$		The Draft BACT limits for PM and the precursors of condensable $PM_{10}/PM_{2.5}$ (i.e. SO_2 and NO_X) shall comprise the BACT for PM_{10} and $PM_{2.5}$, including condensables. Compliance using the methods for BACT PM, SO_2 and NO_X shall indicate compliance with BACT for PM_{10} and $PM_{2.5}$.			0.303
Visible Emissions [j]	All	15% Opacity NESHAP Subpart AAAAA	COMS [i]		

a. PC = petroleum coke, C = coal (including lignite), NG = natural gas and WC = wood chips.
b. lb/ton of stone feed = pounds of PM per ton of limestone feed to kiln; mg/dscm = milligrams per dry standard cubic meter corrected to 11% O_2, 20°C, dry; and BLDS = Bag Leak Detection System.
c. All values are BACT emission standards, except for the NESHAP PM limit of 0.10 lb/ton of stone feed. The allowable emissions standards apply to each lime kiln at all times. Efficient twin shaft PFR design is part of the BACT determination.
d. The potential to emit is limited by the enforceable kiln process limit of 396 tons of lime/day coupled with the BACT concentration limit and the allowable hours of operation. The mass emission rates in pounds per hour (lb/hour) are reference values and are not emission limits.
e. Continuous compliance with the 30-operating day rolling average shall be demonstrated with data collected by the required NO_X and SO_2 CEMS. The applicable limit for a given 30-operating day period shall prorated based on the relative heat input and BACT emissions standard of each fuel used during the same period.
f. lb of pollutant per ton of lime produced. Assumes heat consumption factor of approximately 3.2 MMBtu/ton lime.
g. Compliance with the CO emissions standard shall be determined by EPA Method 10. The BACT limit for PC, C and WC can be demonstrated on any of the fuels or solid fuel blends. The BACT limit for CO on NG shall be determined by EPA Method 10.
h. EPA Method 5 shall be used to demonstrate compliance with the NESHAP PM limit. The probe and filter holder heating system shall be operated at 120 $\pm$ 14°C (248 $\pm$ 25°F).
i. EPA Method 5 shall be used to demonstrate initial and annual compliance with the PM BACT limit except that the probe and filter holder heating system shall be operated at $\leq$ 160 $\pm$ 14°C (320 $\pm$ 25°F). The test may be conducted using any combination of fuels.
j. Continuous opacity monitoring system (COMS). Not to exceed 15% in any 6-minute block period. Requirement in lieu of a baghouse leak detection system (BLDS) or PM detector for fabric filters to satisfy requirements of NESHAP Subpart AAAAA.

4.3 BACT for Materials Handling Operations

4.3.1 Requirements of Applicable NSPS and NESHAP

Table 11 and **Table 12** contain the NSPS Subpart OOO -requirements applicable to operations at new nonmetallic mineral processing plants. The two tables address operations with capture systems and those that generate fugitive emissions, respectively. **Table 13**, **Table 14**,

Table 15 and **Table 16** contain the NESHAP Subpart AAAAA requirements applicable to kilns, processed stone handling (PSH) operations, fugitive sources and storage bins at lime plants, respectively.

Table 11 – NSPS Subpart OOO – Stack Emission Limits, Nonmetallic Mineral Processing Plants.

PM Stack Emission Limits for Operations with Capture Systems	
Emissions Standards [1]	**Compliance Requirements**
0.032 g/dscm (0.014 gr/dscf) [2] **7% Opacity** for dry control devices on individual enclosed storage bins	Initial performance test according to §60.8 of NSPS Subpart A and §60.675 of NSPS Subpart OOO; and monitoring of baghouses according to §60.674(c), (d), or (e) and §60.676(b).
1. g/dscm means grams per dry standard cubic meter at 20°C; gr/dscf means grains per dry standard cubic foot. 2. Not applicable to individual enclosed storage bins and other equipment. See §60.672(d) through (f) of NSPS Subpart OOO.	

Table 12 – NSPS Subpart OOO – Fugitive Emission Limits, Nonmetallic Mineral Processing Plants.

Fugitive Emission Limits	
Emissions Standards	**Compliance Requirements**
7% Opacity for grinding mills, screening operations, bucket elevators, transfer points on belt conveyors, bagging operations, storage bins, enclosed truck or railcar loading stations or from any other affected facility as defined in §§60.670 and 60.671 of NSPS Subpart OOO. **7% Opacity** for crushers at which a capture system is not used.	An initial performance test according to §60.11 of NSPS Subpart A and §60.675 of Subpart OOO; and periodic inspections of water sprays according to §60.674(b) and §60.676(b); and a repeat performance test according to §60.11 and §60.675 within 5 years from the previous performance test for fugitive emissions from affected facilities without water sprays. Affected facilities controlled by water carryover from upstream water sprays that are inspected according to the requirements in §60.674(b) and §60.676(b) are exempt from this 5-year repeat testing requirement.

Table 13 – NESHAP AAAAA – Stack Emissions Limits – New Lime Kilns.

Stack Emissions from New Lime Kilns	
Emissions Standards	**Compliance Requirements**
0.10 lb/ton of stone feed **15% Opacity** any 6-minute block period in lieu lieu of a baghouse leak detection system (BLDS) or PM detector for fabric filters.	EPA Method 5 performance test. COMS per 40 CFR part 63, subpart A, General Provisions; PS-1 of appendix B to part 60 of this chapter, readings are every 15 seconds.

Table 14 - NESHAP AAAAA – Stack Emissions Limits - Processed Stone Handling (PSH) At Lime Plants.

Stack Emissions from All PSH Operations	
Emissions Standards	**Compliance Requirements**
0.05 g/dscm **7% Opacity** for dry control devices on individual enclosed storage bins [1]	EPA Method 5 or Method 17 performance test. Record scrubber pressure drop and liquid flow rate as applicable. EPA Method 9.
1. Unless the stack emissions are discharged through a wet scrubber control device.	

Table 15 – NESHAP AAAAA – Fugitive Emissions Limits - PSH at Lime Plants.

Fugitive Emissions from all PSH operations Limits	
Emissions Standards	**Compliance Requirements**
10% Opacity except for operations enclosed in a building. **0.05 g/dscm and 7% Opacity** from stacks and **10% Opacity** from fugitive sources at PSH operations within a building. **Or** **0.05 g/dscm and 7% Opacity** from building vents and no other visible emissions.	EPA Methods 5, 22, 9, or 17 as applicable.

Table 16 – NESHAP AAAAA – Storage Bin Stack Emission Limits at Lime Plants.

Emissions Standards	**Compliance Requirements**
7% Opacity from each fabric filter that controls emissions from one enclosed storage bin. **0.05 g/dscm and 7% Opacity** from multiple storage bins vented through a combined stack.	EPA Methods 5, 9, 22, or 17 as applicable.

4.3.2 Applicant's Materials Handling Operations BACT Proposal

Table 17 is a list of the processed stone handling (PSH) operations for the Jacksonville Lime project.

Table 17 - Processed Stone Handling Operations at Jacksonville Lime Project.

Source ID	Emissions Source Description	Applicable Subparts	Pollution Control Device
SN-210	Screen 210	OOO	Wet Suppression
BC-110	Belt Conveyor 110	OOO	Wet Suppression
BC-120	Belt Conveyor 120	OOO	Wet Suppression
BC-125	Belt Conveyor 125	OOO	Wet Suppression
BC-200	Belt Conveyor 200	OOO	Wet Suppression
BC-205	Belt Conveyor 205	OOO	Wet Suppression
LB-232	120-ton charging bin	OOO, AAAAA	Partial enclosure
LB-233	120-ton charging bin	OOO, AAAAA	Partial enclosure
SB-241	Surge Bin 241	OOO, AAAAA	Enclosure
SB-251	Surge Bin 251	OOO, AAAAA	Enclosure
SB-244	Surge Bin 244 (20-tons)	OOO, AAAAA	Enclosure
SB-245	Surge Bin 245 (20-tons)	OOO, AAAAA	Enclosure
SB-254	Surge Bin 254 (20-tons)	OOO, AAAAA	Enclosure
SB-255	Surge Bin 255 (20-tons)	OOO, AAAAA	Enclosure
BN-901	Reject Bin 901	OOO	BM-32
SP-901C	Truck Loadout	OOO	BM-23
1 DC and BM relate to dust collectors and baghouses.			

The applicant proposes to use reasonable precautions, including wet suppression as needed to meet the visible emissions limitation of 7% opacity for all fugitive emissions from material handling operations. The applicant also proposes to use fabric filters to meet a limit of 0.01 gr/dscf from the non-fugitive operations such as storage.

4.3.3 Department's Materials Handling Operations BACT Determination

The Department accepts the applicant's proposal except that the visible emissions limitation shall be 5% opacity (instead of 7%) for the fugitive emissions from material handling operations. This ensures the BACT determination is at least as stringent as the RACT, NSPS Subpart OOO and NESHAP Subpart AAAAA that are applicable to these operations. The compliance procedures specified by NSPS Subpart OOO and NESHAP Subpart AAAAA shall be used to demonstrate compliance with 5% opacity (instead of 7%).

4.4 BACT for Fuel Heater

The project includes a small (3.5-MMBtu/hr) natural gas-fueled mill heater for the coal/petcoke mill. There is no applicable NSPS or NESHAP and the unit will emit only 0.6 tons/year of CO and 1.4 tons/year of NO_X. The applicant proposes and the Department accepts use of natural gas and a fabric filter as BACT for the fuel heater.

5. AIR QUALITY IMPACT ANALYSIS

The proposed Jacksonville Lime project will result in emissions of the following PSD-pollutants at levels in excess of their respective PSD SER: PM_{10}, $PM_{2.5}$, CO, SO_2, and NO_X. The applicant must provide a demonstration utilizing approved air quality models that the predicted emission levels of these pollutants will not cause or contribute to a violation of the national ambient air quality standard (NAAQS) or PSD increment for each, as applicable. PM_{10}, $PM_{2.5}$, CO, SO_2, and NO_X (as NO_2) have defined NAAQS and PM_{10}, $PM_{2.5}$, SO_2, and NO_2 have defined PSD increments. In addition, significant impact levels (SIL) are used to determine the scope of the modeling analyses.

5.1. Major Stationary Sources near the Jacksonville Lime Project Site

To provide some perspective on the relative scale of the proposed Jacksonville Lime Project, **Table 18** to **Table 21** list the largest stationary sources of actual emissions, by pollutant, around the project site. The maximum potential future emissions from the project are also shown for comparison (the project is highlighted).

Table 18 - Largest Sources of NO_X (2012) Near the Jacksonville Lime Project Site.

Owner/Company Name	Site Name	County	Emissions (tons/year)
Jacksonville Electric Authority (JEA)	Northside/SJRPP	Duval	14,711
Cedar Bay	Cogenerating Facility	Duval	1,119
Ardagh Glass	Jacksonville Plant	Duval	541
Carmeuse	**Jacksonville Lime**	**Duval**	**345**
Anheuser-Busch	Jacksonville Brewery	Duval	236

Table 19 - Largest Sources of CO (2012) Near the Jacksonville Lime Project Site.

Owner/Company Name	Site Name	County	Emissions (tons/year)
JEA	Northside/SJRPP	Duval	3,955
Gerdau Ameristeel	Jacksonville Mill	Duval	428
Cedar Bay	Cogenerating Facility	Duval	413
Carmeuse	**Jacksonville Lime**	**Duval**	**412**
City of Jacksonville	Trail Ridge Landfill	Duval	353

Table 20 - Largest Sources of $PM_{10}/PM_{2.5}$ (2012) Near the Jacksonville Lime Project Site.

Owner/Company Name	Site Name	County	Emissions (tons/year)
JEA	Northside/SJRPP	Duval	375
JEA	Brandy Branch	Duval	97
Ardagh Glass	Jacksonville Plant	Duval	71
Carmeuse	**Jacksonville Lime**	**Duval**	**62**
Owens – Corning	Jacksonville Plant	Duval	37

Table 21 - Largest Sources of SO_2 (2012) Near the Jacksonville Lime Project Site.

Owner/Company Name	Site Name	County	Emissions (tons/year)
JEA	Northside/SJRPP	Duval	13,835
Cedar Bay	Cogenerating Facility	Duval	905
IFF Chemical Holdings	Lane Ave.	Duval	809
Renessenz	Jacksonville Facility	Duval	294
Carmeuse	**Jacksonville Lime**	**Duval**	**157**

All nearby facilities that were included in the cumulative modeling for the PM_{10}, $PM_{2.5}$, SO_2, and NO_2 NAAQS and increment analyses (see subsection 5.5) are shown in **Figure 18**.

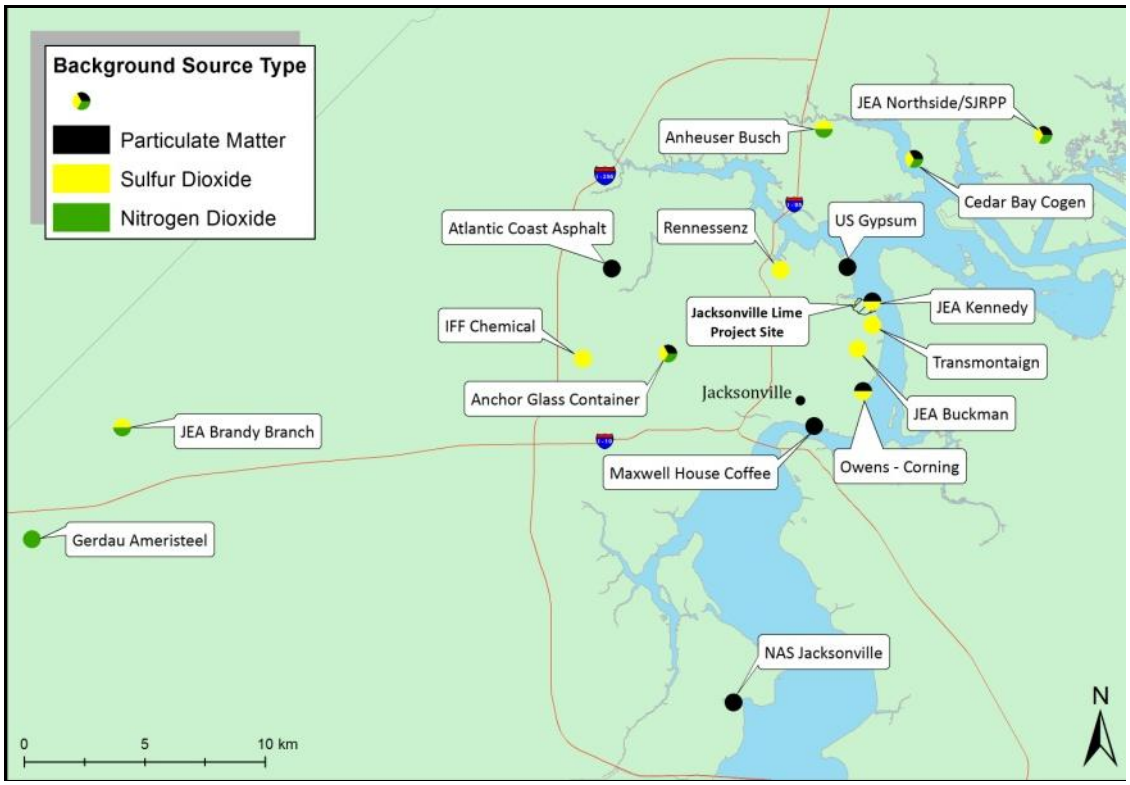


Figure 18 - Background Emission Sources near the Jacksonville Lime Project Site.

5.2. Ambient Air Monitoring Surrounding the Jacksonville Lime Project Site

Pre-construction ambient air monitoring is required for those pollutants subject to PSD review or, for ozone, if the potential emissions of NO_X or VOC exceed 100 tons/year; however, if there are representative regulatory monitors already in place, these data can satisfy the pre-construction monitoring requirement. An exemption to this pre-construction requirement is available if the project's impact for a particular pollutant is less than a defined significant monitoring concentration defined by rule. While this exemption would apply to most of the applicable pollutants, the Florida Department of Environmental Protection (DEP) is using local representative monitors for each of these pollutants to establish current air quality conditions.

For the Jacksonville Lime project, the maximum potential emissions of $PM_{2.5}$, PM_{10}, SO_2, NO_X, and CO exceed the SER; thus, the submittal of monitoring data for these pollutants and ozone is required. The State of Florida ambient air monitoring network operated by DEP and its partners (local air pollution control programs) includes monitors in many Florida counties. Several monitors are operated within a few km of the Jacksonville Lime site as shown in **Figure 19**.

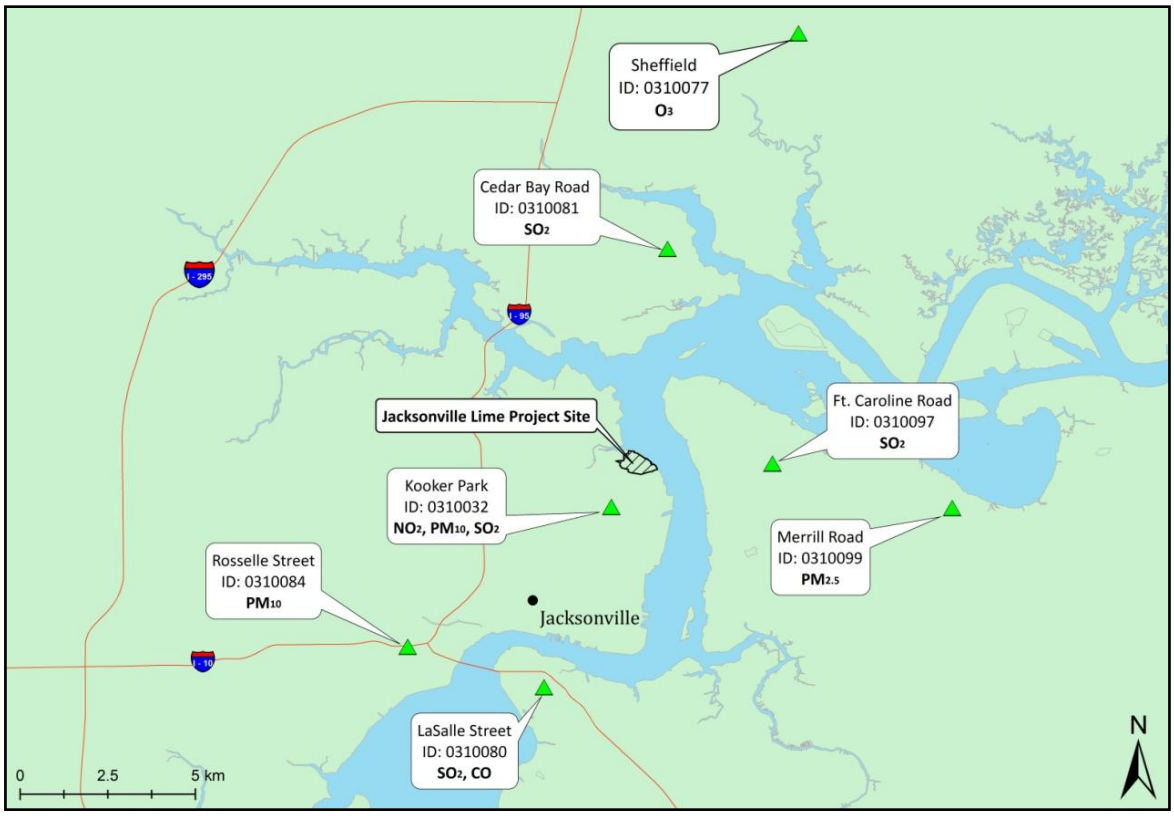


Figure 19 - Ambient Air Monitors near the Jacksonville Lime Project Site.

These monitors shown in the figure are considered to be representative or conservatively representative of the project site and are used to estimate the existing air quality in the area and to satisfy pre-construction monitoring requirements.

The NO_2 monitor at Kooker Park (ID: 031-0032) is less than two km to the southwest of the Jacksonville Lime project site. A detailed analysis of NO_2 readings at this monitor indicated that the highest NO_2 values occur when the wind is blowing from the direction of Downtown Jacksonville. This would imply a significant mobile source contribution to the overall NO_2 levels in the area. It would also be affected by the nearby Buckman Wastewater Treatment Plant, the JEA Kennedy Station and various port facilities. This monitor is therefore considered to provide a conservative representation of the ambient NO_2 levels near the Jacksonville Lime project site due to its closer proximity to the mobile sources of NO_2 in Downtown Jacksonville.

The ambient air measurements for the chosen monitors are listed in **Table 22**. These values do not contain 'exceptional events'. An 'exceptional event' is defined by EPA in accordance with 40 CFR 50.14 as an event that affects air quality, is not reasonably controlled or preventable, and is an event caused by human activity that is unlikely to recur at a particular location or natural event.

5.3. Existing Ambient Air Quality near the Jacksonville Lime Project Site

5.3.1. Ozone and NO_2

Ozone is a key indicator of the overall state of regional air quality. It is not emitted directly from combustion processes; rather it is formed from VOC and NO_X emitted primarily from regional industrial and transportation sources. VOC is also emitted naturally from vegetation. These two precursors participate in photochemical reactions that occur on an area-wide basis and are highly dependent on meteorological factors. The ozone and NO_2 measurements in **Table 22** are summarized on three year blocks, rolled annually. The reported ozone value was calculated by taking the three year average of the yearly fourth highest maximum 8-hour average readings recorded each day during the three years (2010-2012) and is reported in **Table 22** and **Figure 20** as 64 ppb.

Table 22 - Ambient Air Quality Measurements Nearest to the Jacksonville Lime Project Site (2010-2012).

Pollutant	Duval County (Site Number)	Averaging Period	Ambient Concentration			
			Compliance Period	Value	Standard	Units
PM_{10}	031-0032	24-hour [a]	2010-2012	77	150	μg/m^3
$PM_{2.5}$	031-0099	24-hour [b]	2010-2012	19.0	35	μg/m^3
		Annual [c]	2010-2012	8.0	12	μg/m^3
NO_2	031-0032	Annual [d]	2012	8.1	53	ppb
		1-hour [e]	2010-2012	40.0	100	ppb
Ozone	031-0077	8-hour [f]	2010-2012	64	75	ppb
SO_2	031-0032	1-hour [g]	2010-2012	16	75	ppb
CO	031-0080	1-hour [h]	2010-2012	7.5	35	ppm
		8-hour [i]	2010-2012	3.9	9	ppm

a. Three year average of the highest yearly 24-hour average.
b. Three year average of the 98th percentile daily 24-hour average.
c. Three year average of the annual arithmetic means.
d. Annual arithmetic mean.
e. Three year average of the annual 98th percentile daily maximum 1-hour average.
f. Three year average of the annual 99th percentile daily maximum 8-hour average.
g. Three year average of the annual 99th percentile daily maximum 1-hour average.
h. Three year highest 1-hour average.
i. Three year highest 8-hour average.

The reported NO_2 1-hour compliance value (40 ppb) was calculated by taking the three year average of the yearly eighth highest maximum 1-hour average readings recorded each day during the three years (2010-2012) and is reported in **Table 22** and **Figure 21**. The reported NO_2 annual compliance value (8.1 ppb) shown in **Table 22** and **Figure 21** was calculated as the average of all readings in 2012.

5.3.2. $PM_{2.5}$

$PM_{2.5}$ (also known as PM_{fine}) is another important indicator of regional air quality. Some $PM_{2.5}$ is directly emitted as a product of combustion from transportation and industrial sources, as well as from fires. Much of it consists of particulate nitrates and sulfates formed through chemical reactions between gaseous precursors such as SO_2 and NO_X from combustion sources and ammonia (NH_3) naturally present in the air or added by other industrial sources.

$PM_{2.5}$ measurements in **Table 22** are again summarized on three-year blocks, rolled annually. The 24-hour compliance value for $PM_{2.5}$ was calculated by taking the three year average of the yearly eighth highest 24-hour average reading (19 micrograms per cubic meter (μg/m^3)) and compared with the standard of 35 μg/m^3. The simple average of all $PM_{2.5}$ measurements within each of the three years (2010-2012) was also calculated and then the mean of the three averages (8.0 μg/m^3) was reported as the annual compliance value and compared with the standard of 12 μg/m^3. These compliance values are reported in **Table 22** and **Figure 22**.

The reported compliance values for $PM_{2.5}$, ozone, and NO_2 for the monitors in the vicinity of the project site indicate that Duval County is well within attainment of all applicable national NAAQS.

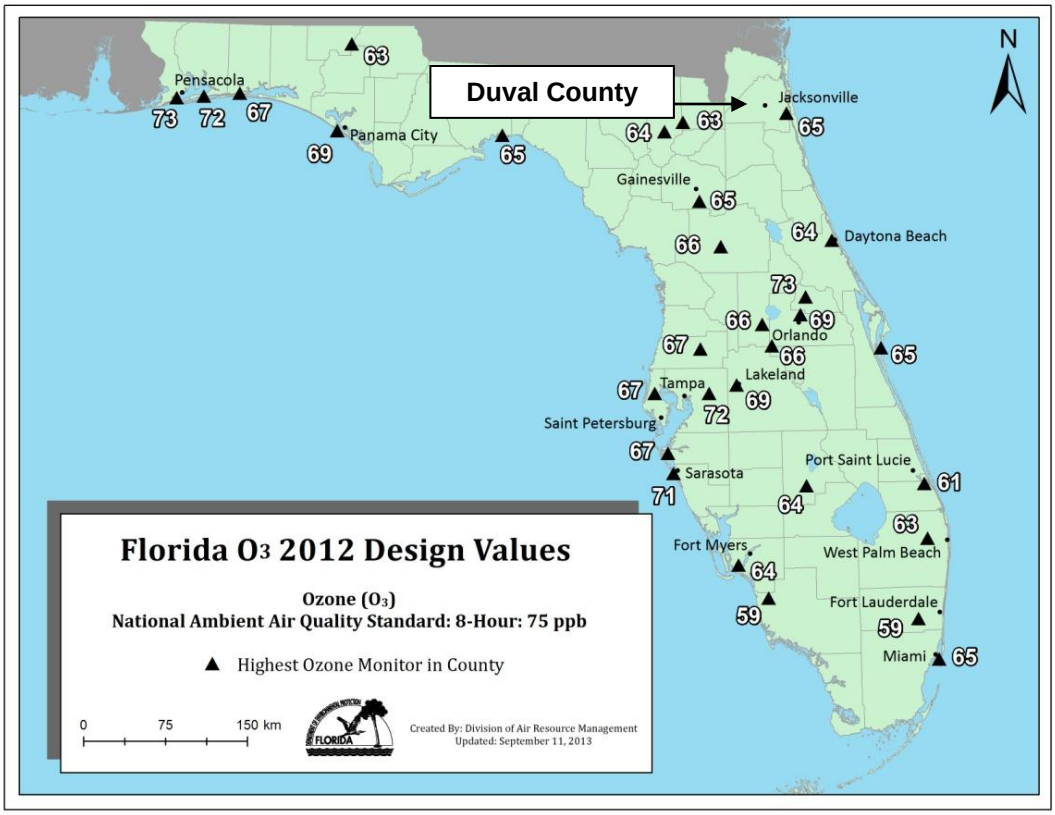


Figure 20 - Florida Ozone Compliance Values.

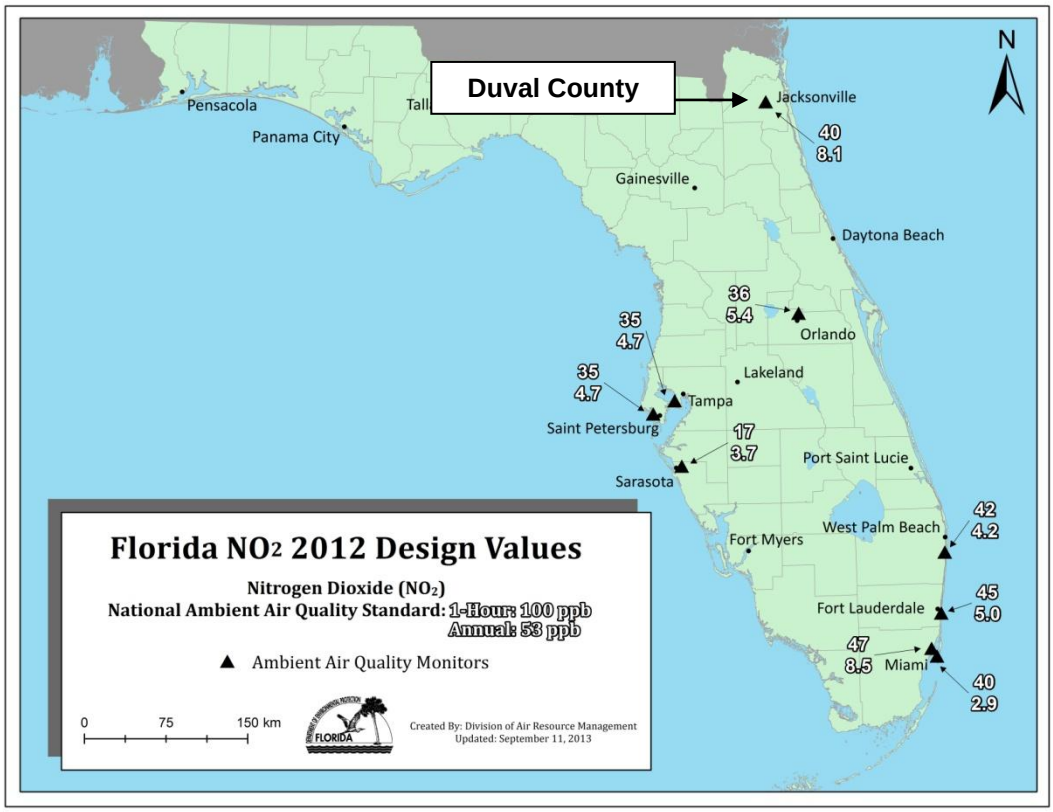


Figure 21 - Florida NO_2 Compliance Values.

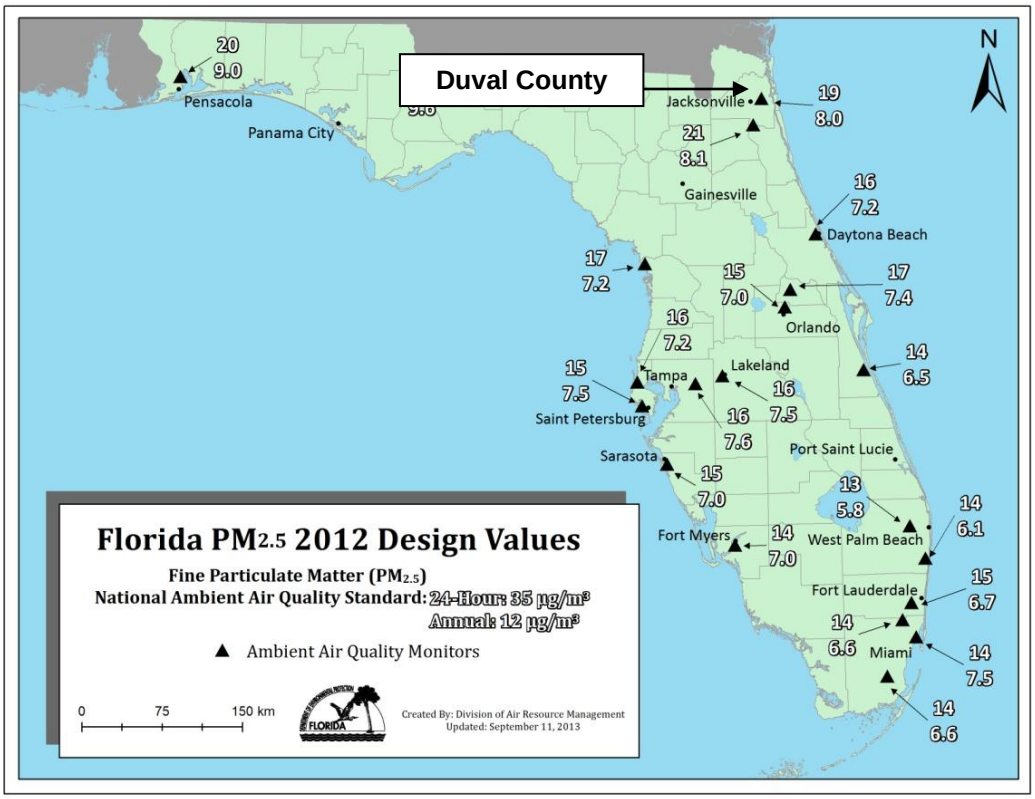


Figure 22 - Florida $PM_{2.5}$ Compliance Values.

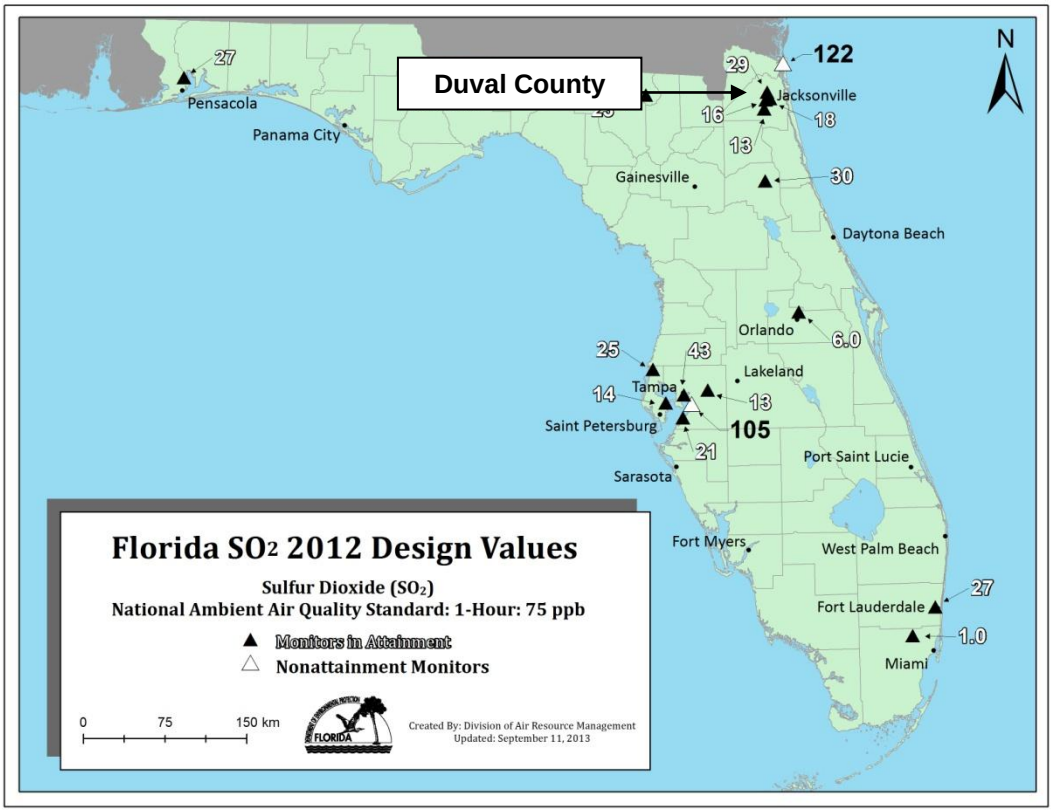


Figure 23 - Florida SO_2 Compliance Values.

5.4. Air Quality Impact Modeling

5.4.1. Models, Emissions Data, and Meteorological Data

The EPA-approved AERMOD modeling system was used to evaluate the pollutant emissions from the project in the surrounding Class II areas. AERMOD is a Gaussian steady-state plume dispersion modeling system that simulates pollutant dispersion methods based on planetary boundary layer turbulence structure and scaling concepts, including the treatment of both surface and elevated sources, and both simple and complex terrain. AERMOD contains two input data processors: the AERMET meteorological processor and the AERMAP terrain processor.

The applicant used a series of specific model features recommended by the EPA that are referred to as the regulatory options. Direction specific building downwash parameters for each stack were calculated for all proposed structures at the Jacksonville Lime project site using the BPIPPRM program. Emissions data used in the modeling analysis were obtained from the DEP ARMS database, DEP permit files, and recent PSD permit reviews.

The AERMET meteorological data used with the AERMOD model consisted of a concurrent 5-year period of hourly surface weather observations from the National Weather Service (NWS) Automated Surface Observing System (ASOS) station and upper air sounding data collected at the Jacksonville International Airport (JAX). This data was compiled by DEP for the period 2006 through 2010 with the inclusion of a land cover and use analysis input from AERSURFACE and detailed wind data from AERMINUTE. The ASOS station at JAX is located approximately 14 km NNE of the Jacksonville Lime project site and is the closest primary weather station considered to have representative meteorological data. As the JAX ASOS station is only 14 km from the project site, both sites are approximately the same distance from the coastline, and the terrain between the two sites is mostly flat, the wind direction and wind speed frequencies measured at the ASOS location are considered to be very similar to those experienced at the project site.

5.4.2. Significant Impact Analysis

The general modeling approach for the significant impact analysis for the proposed Jacksonville Lime project followed the EPA and DEP modeling guidelines for determining compliance with NAAQS and PSD increments. For all criteria pollutants that will be emitted in excess of the PSD SER due to a proposed project, a significant impact analysis is performed to determine whether the emission and/or stack configuration changes due to the project alone will result in predicted impacts that are in excess of the EPA SIL for Class I (designated areas such as National Parks) and Class II areas (everywhere else). For the proposed project, emissions increases above the PSD SER occur for the following criteria pollutants: PM_{10}, $PM_{2.5}$, CO, SO_2, and NO_X. As NAAQS and/or PSD increments exist for all of these pollutants, a significant impact analysis was completed for each to determine if the project has the potential to cause an increase in ground-level concentration greater than the respective SIL.

If the modeling for a particular pollutant shows ground-level increases less than its respective SIL, the applicant need not conduct any further modeling. If the modeled concentrations from the project exceed the SIL then additional refined modeling, including emissions from nearby facilities and/or projects (multi-source modeling), is required to determine the proposed project's impacts compared to the NAAQS and PSD increments for those pollutants.

5.4.2.1. *Class II SIL*

For the Class II analysis, a combination of fence line, near-field and far-field receptors were chosen for predicting maximum concentrations in the vicinity of the project. Receptor locations used in the modeling analysis were based on Universal Transverse Mercator (UTM) coordinates from Zone 17, North American Datum 1983 (NAD83). The air modeling domain was set as a 30 km X 30 km grid centered at UTM 17N east and north coordinates of 439319.13 and 3359618.5 meters, respectively. A discrete Cartesian grid of 2,478 receptors was located at the following intervals and distances:

- 50 m spacing along the property boundary and fence line;
- 100 m spacing from the fence line to approximately 2,000 m;

- 500 m spacing from approximately 2,000 m to 5,000 m from the fence line;
- 1,000 m spacing from approximately 5,000 m to 15,000 m from the fence line.

The modeling results in **Table 23** demonstrate that maximum concentrations due to the project are predicted to exceed the SIL for the 1-hour and annual NO_2, 24-hour and annual PM_{10}, 24-hour $PM_{2.5}$, and the 24-hour and 1-hour SO_2 impacts. As a result, additional modeling analyses for these pollutants must consider other nearby sources and background concentrations to determine the cumulative impact of these sources for comparison to the NAAQS and PSD increments.

Table 23 - Max Predicted Air Quality Impacts of the Jacksonville Lime Project Compared to Class II SIL.

Pollutant	Averaging Time	Max Impact (μg/m^3)	SIL (μg/m^3)	Significant Impact?
PM_{10}	Annual 24-Hour	1.5 13.8	1 5	**Yes** **Yes**
$PM_{2.5}$	Annual 24-Hour	0.25 1.63	0.3 1.2	No **Yes**
NO_2	Annual 1-Hour	1.1 41.3	1 7.6	**Yes** **Yes**
CO	8-hour 1-hour	44.0 60.1	500 2,000	No No
SO_2	Annual 24-hour 3-hour 1-hour	0.63 9.18 20.7 19.66	1 5 25 7.9	No **Yes** No **Yes**

5.4.2.2. *Class I SIL*

There are five Class I areas located within 300 km of the Jacksonville Lime project site: the Bradwell Bay, Chassahowitzka, Okefenokee, St. Marks, and Wolf Island National Wilderness Areas (NWA). The two closest areas, Okefenokee and Wolf Island were evaluated in this analysis. The Okefenokee NWA is approximately 55.4 km northwest of the project site while Wolf Island is 108.3 km to the north northeast. The EPA-approved CALPUFF non-steady-state puff dispersion model is recommended for evaluation of emission impacts at distances greater than 50 km. This model was used to evaluate pollutant impacts in the two closest Class I areas. Modeling receptor grids were provided by the Federal Land Manager (FLM), the National Park Service (NPS) for use in CALPUFF. The Okefenokee NWA contains 500 discrete receptors and Wolf Island contains 30. Meteorological input data created using the meteorological preprocessor CALMET and used in the modeling analysis was provided by DEP for the years 2001-2003. The modeling analysis followed established and recommended guidelines for long-range regulatory modeling.

The maximum pollutant concentrations predicted for the proposed Jacksonville Lime project are compared to the PSD Class I SILs in **Table 24**. The modeling results indicate that maximum concentrations due to the project are predicted to be less than the Class I SILs for all pollutants and all averaging times. As a result, detailed analyses to demonstrate compliance with the allowable PSD Class I increments are not required.

5.4.3. NAAQS Analyses

The NAAQS analyses are cumulative source analyses that evaluate whether the air quality impacts from all nearby sources will comply with the NAAQS for each pollutant and averaging time. The analyses consider the modeled impacts from future sources at the proposed Jacksonville Lime project site, emissions from other nearby sources, and a non-modeled background concentration.

Table 24 - Max Predicted Air Quality Impacts of the Jacksonville Lime Project Compared to Class I SIL.

Pollutant	Averaging Time	Max Impact (μg/m^3) Okefenokee	Max Impact (μg/m^3) Wolf Island	Class I SIL (μg/m^3)	Significant Impact?
NO_2	Annual	0.00758	0.00297	0.1	No
PM_{10}	Annual	0.00024	0.00015	0.2	No
	24-Hour	0.0076	0.0026	0.3	No
$PM_{2.5}$	Annual	0.00020	0.00016	0.04	No
	24-hour	0.0068	0.0023	0.07	No
SO_2	Annual	0.00523	0.00230	0.1	No
	24-hour	0.118	0.045	0.2	No
	3-hour	0.237	0.147	1.0	No

The background concentration is based on monitoring data and is designed to take into account any existing natural or anthropogenic sources of each pollutant in the area that are not explicitly modeled. This concentration for each pollutant was derived from local monitoring data as shown in **Table 22**. Pollutant sources within 50 km of the Jacksonville Lime site were considered for inclusion in the analyses. The background sources that were explicitly modeled are shown in **Figure 18** above. Since no attempt was made to remove the impact each of these sources had on the established monitored background levels, which are added to the modeling results, there is likely a certain level of 'double-counting' occurring and thus this method is considered to be a conservative approach.

As previously mentioned the 1-hour and annual NO_2, 24-hour and annual PM_{10}, 24-hour $PM_{2.5}$, and the 24-hour and 1-hour SO_2 modeled impacts exceeded the applicable SIL and are thus subject to cumulative modeling; however, NAAQS do not currently exist for the annual PM_{10} and the 24-hour SO_2 impacts so an analysis is not required for these pollutants/averaging periods. The results from theses analyses are presented in **Table 25**.

Table 25 - Cumulative NAAQS Analysis Modeling Results.

Pollutant	Averaging Time	Max Jax Lime Contribution to Modeled Exceedance (μg/m^3)	Monitored Background (μg/m^3)	Max Modeled Sources Contribution (μg/m^3)	Max Modeled Concentration (μg/m^3)	NAAQS (μg/m^3)	Jax Lime Significant to a Modeled Exceedance?
NO_2	Annual	1.49	15.2 [a]	5.53	20.73	100	No
	1-hour	0.04	44.37 [b]	144.91	189.28	188	No
PM_{10}	24-hour	0.76	77 [c]	31.77	108.77	150	No
$PM_{2.5}$	24-hour	0.6	19 [d]	34.58	53.58	35	No
SO_2	1-hour	7.51	41.9 [e]	534.95	493.05	196	No

a. 2012 design value for Kooker Park Monitor (ID: 031-0032).
b. 2010-2012 hour-of-day average for Kooker Park Monitor (ID: 031-0032).
c. 2010-2012 average of yearly highest 24-hour average for Kooker Park Monitor (ID: 031-0032).
d. 2012 design value for Merrill Rd. Monitor (ID: 031-0099).
e. 2012 design value for Kooker Park. Monitor (ID: 031-0032).

While some modeled exceedances exist, Jacksonville Lime is not expected to cause or significantly contribute to any actual violation of a NAAQS.

5.4.3.1. *1-hour NO_2 NAAQS*

The 1-hour NO_2 NAAQS analysis is a more complex analysis. This is mainly due to the fact that the emitted pollutant, NO_X, is not the controlled pollutant, NO_2. NO_X is the sum of the nitrogen-oxide species NO and NO_2. In general, a large portion of the NO_X emitted from sources is NO. Once the plume leaves the stack, oxidation reactions between NO and ozone in the ambient air converts a certain amount of the NO to NO_2. EPA guidance recommends a three tiered approach to determining the ratio of NO_2 to NO_X both in-stack and in the ambient air:

- Tier 1: 100% conversion of NO to NO_2.
- Tier 2: 80% ambient conversion of NO to NO_2 on an hourly basis.
- Tier 3: Default in-stack ratios of 50% conversion (or lower if defensible) with up to 90% ambient conversion utilizing either the ozone limiting method (OLM) or plume volume molar ratio method (PVMRM) algorithms.

For this analysis, the Tier 3 method was utilized with the OLM algorithm and the in-stack ratios shown in **Table 26.**

Table 26 - Tier 3 In-Stack Ratios.

Source	NO_2/NO_X Ratio	Source	NO_2/NO_X Ratio
Jacksonville Lime Kiln Stack (BM-19)	0.14	JEA Northside FBB 1 (EU26)	0.1
JEA Northside Boiler 1 (EU16)	0.1	JEA Northside FBB 2 (EU27)	0.1
JEA Northside Boiler 2 (EU17)	0.1	All Other NO_X Sources	0.5

The modeling procedure followed established departmental and federal guidelines for the new 1-hour NO_2 standard. This included an hourly ozone concentration file compiled by DEP for the Sheffield monitor (ID: 031-0077) for the years 2006-2010 that was utilized by the OLM algorithm for calculating ambient NO_2 concentrations. Missing data within the file was replaced by the applicant using an established protocol involving linear interpolation and substitution.

The monitored background NO_2 level was included in the model as the three year average of each hour of day from the Kooker Park Monitor (ID: 031-0032) using the BACKGRND HROFDY keyword as shown in **Table 27**.

Table 27 - Hour of Day NO_2 Monitored Background Concentration

Hour	NO_2 (ppb)	Hour	NO_2 (ppb)	Hour	NO_2 (ppb)	Hour	NO_2 (ppb)
1	29.0	**7**	28.0	**13**	20.0	**19**	31.3
2	26.7	**8**	29.3	**14**	17.3	**20**	32.7
3	26.7	**9**	27.3	**15**	18.0	**21**	34.7
4	26.3	**10**	25.0	**16**	18.7	**22**	33.0
5	25.7	**11**	25.0	**17**	20.7	**23**	32.0
6	27.0	**12**	20.7	**18**	26.3	**24**	30.7

The MAXDCONT keyword was used to output a file that shows the contribution of each source to any modeled exceedance of the NAAQS in order to determine significant contributions.

Two modeling runs were performed for the 1-hour NO_2 NAAQS analysis using two different receptor grids. The initial grid included every receptor for which Jacksonville Lime exceeded the SIL in the Class II SIL analysis. The maximum concentration predicted from this run was 184.69 $\mu g/m^3$, below the NAAQS of 188 $\mu g/m^3$. However, upon closer inspection, the area of highest concentrations was found to be in an area of large receptor spacing approximately eight km northeast of the Jacksonville Lime project site. A second run was then performed using a nested grid of 441 receptors with 100 m spacing centered over the area of highest concentrations. While there were three modeled exceedances of the 1-hour NO_2 NAAQS found within this high resolution nested grid, Jacksonville Lime's maximum contribution to any of these was less than 1% of the SIL. These modeled exceedances have been further investigated and DEP is confident that there is no actual violation of the 1-hour NO_2 NAAQS occurring.

5.4.3.2. *1-hour SO_2 NAAQS*

There are also modeled exceedances of the SO_2 1-hour NAAQS that are associated with explicitly modeled background sources: Jacksonville Electric Authority's (JEA) St Johns River Power Plant (SJRPP), Northside, Kennedy, and Buckman Street facilities. There are four SO_2 ambient air monitors within a few kilometers of these facilities and, as can be seen in **Figure 23**, all are well within attainment of the 1-hour SO_2 NAAQS. Based on the locations of the modeled exceedances, the Kooker Park monitor is optimally placed to record the highest modeled concentrations.

The highest concentrations were predicted to be downwind, southwest, of JEA Kennedy and JEA Buckman when the wind is aligned with JEA Northside and SJRPP to the northeast. As shown in Figure 19, the Kooker Park monitor is less than two kilometers to the southwest of the JEA Kennedy site yet has a 2012 design value of just 16 ppb compared to a NAAQS of 75 ppb. As shown in **Figure 24** below, there is a long term trend in decreasing SO_2 concentrations at all four monitors in the area.

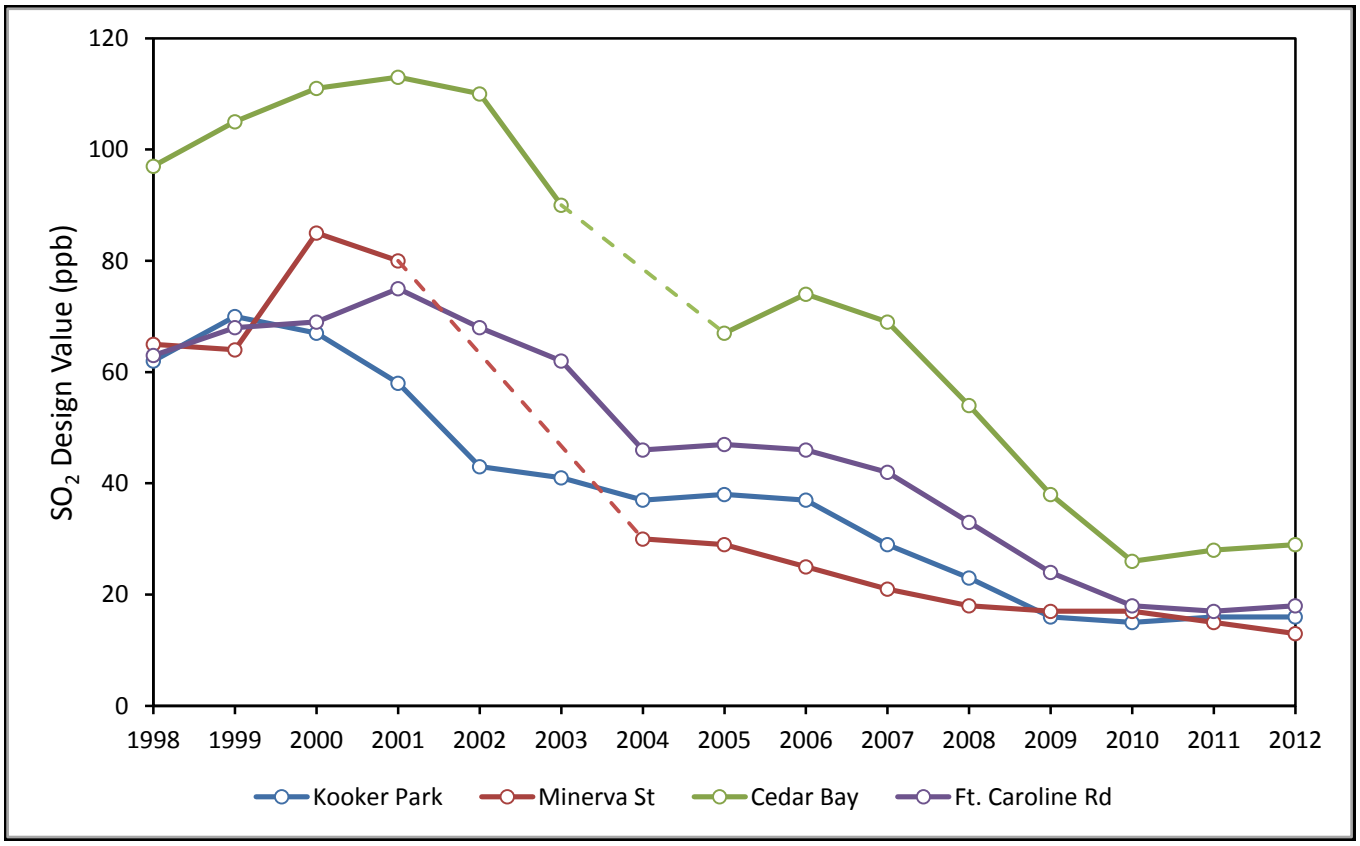


Figure 24 –Jacksonville Area SO_2 Ambient Air Monitor Design Values 1998-2012.

In order to get a better understanding of the large discrepancy between the modeled potential concentrations and the monitored concentrations in the Jacksonville area, DEP investigated the actual emissions of the largest background source of SO_2: the JEA Northside/SJRPP site. Combined, these two facilities have five large, fossil fuel-fired electric generating units (EGUs) with a potential SO_2 emission rate of over 87,000 tpy. Actually, these units have a five year average of less than 15,000 tpy of actual SO_2 emissions (**Figure 25**). Northside Unit No. 3 has the largest difference between potential (43,687 tpy) and actual (148 tpy in 2012) emissions; a difference of 99.7%. This can be attributed to the introduction of new pollution control systems approximately 10 years ago and the substitution of natural gas for oil and coal that has occurred on Unit 3 in the past few years. This trend is expected to continue with the introduction of new rules such as the Mercury and Air Toxics Standard, MATS.

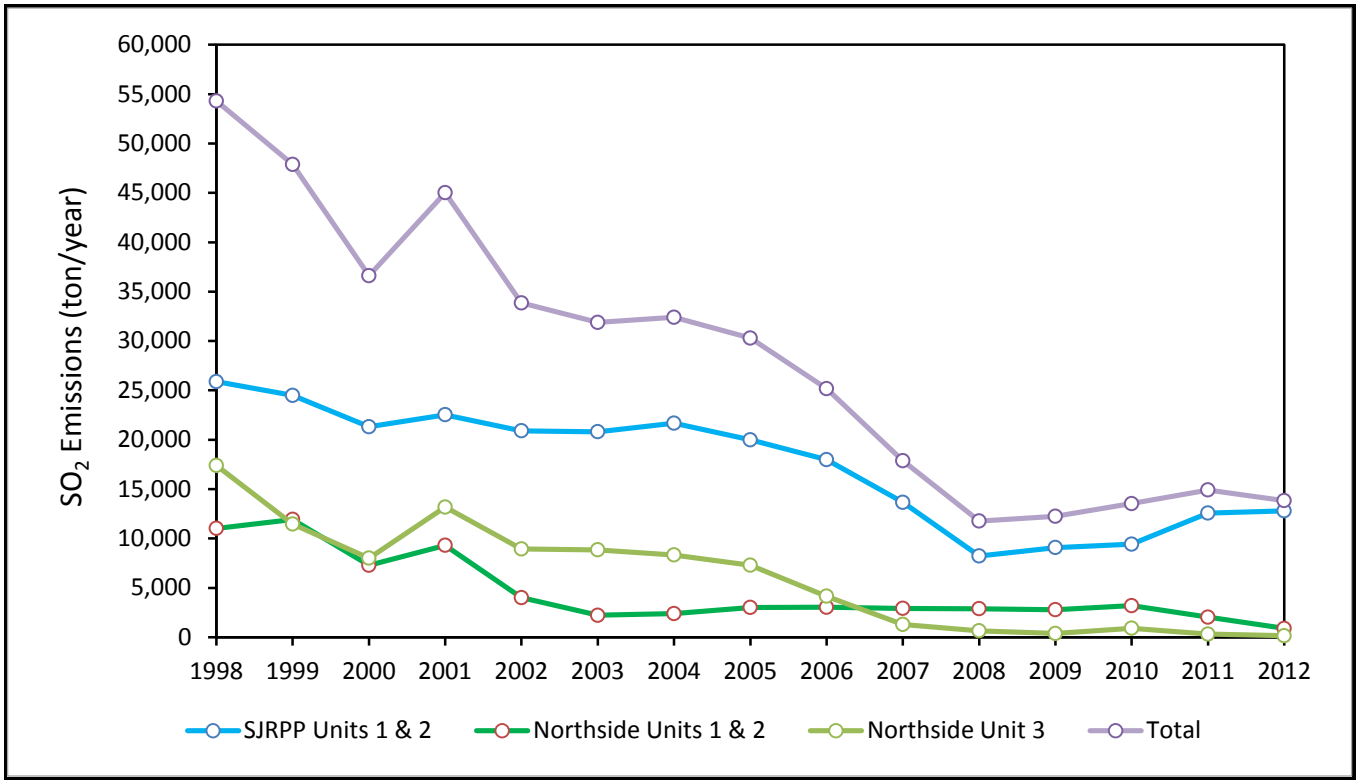


Figure 25 – JEA Northside/SJRPP SO_2 Actual Annual Emission Rates 1998-2012.

Based on these analyses, DEP has reasonable assurances that the Jacksonville Lime project will not significantly contribute to or cause any violation of the 1-hour SO_2 NAAQS and is confident that there are no actual violations of the NAAQS occurring presently. The large background sources contributing to the modeled exceedances will be more closely examined in the near future as a part of Phase II of the 1-hour SO_2 NAAQS implementation.

5.4.4. PSD Increment Analyses

A PSD increment analysis is required of each pollutant and averaging time that exceeds the applicable SIL; however, PSD increments do not currently exist for the 1-hour NO_2 and SO_2 impacts.

The PSD increment represents the level that new sources may increase the local ambient ground level concentrations of a pollutant above a baseline concentration. PSD increment modeling is similar to NAAQS modeling in that it is a cumulative analysis that takes into account the impact from nearby increment consuming sources. The highest second-high predicted short-term average concentration for each year 2006-2010 was calculated and is compared to the applicable PSD increments in **Table 28**.

Table 28 - Cumulative PSD Increment Analysis Modeling Results.

Pollutant	Averaging Time	Max Modeled Impact (µg/m^3)	PSD Increment (µg/m^3)	Exceeds Increment?
NO_2	Annual	2.57	25	No
PM_{10}	Annual	1.52	17	No
	24-hour	10.14	30	No
$PM_{2.5}$	24-hour	3.46	9	No
SO_2	24-hour	62.6	91	No

The results show that the Jacksonville Lime project is not expected to cause or contribute to any violation of a PSD increment in the vicinity.

5.4.5. Ozone Analysis

Projects with VOC or NO_X emissions greater than 100 tpy are required to perform an ambient air impact analysis for ozone including the gathering of pre-construction ambient air quality data. The applicant estimated annual potential VOC and NO_X emissions from the project to be 19 and 344 tpy respectively and is therefore required to provide an ambient air impact analysis for ozone.

Ozone site-specific modeling is not typically completed for single source permitting because of its complexity. Ozone is a secondarily formed pollutant that is known to be caused by the regional emissions of VOC and NO_X in combination with meteorological parameters (temperature, rainfall, solar insolation, etc.). Ambient ozone levels in Duval County are well within attainment of the NAAQS. Despite significant increases in population and motor vehicle activity, ambient ozone air quality in Florida has improved over the last 5 years due to improvements in motor vehicle emissions rates. Continued reductions in average motor fleet emissions would be expected to further improve ozone air quality. In addition, implementation of CAIR has resulted in significant actual reductions in existing power plant NO_X emissions throughout Florida.

5.4.6. Secondary $PM_{2.5}$

Secondary $PM_{2.5}$ is formed through chemical reactions between gaseous precursors such as SO_2 and NO_X. Projects that involve a potential increase in these precursor pollutants above their SER require an analysis of the potential impact of secondary $PM_{2.5}$ formation; however, current regulatory air dispersion and transport models, such as the EPA recommended AERMOD modeling system used in this analysis, do not account for this process. Per EPA guidance, for projects "where precursor emissions levels are marginally higher than the level of the SERs, monitored background levels are very low, and the primary $PM_{2.5}$ impacts are also very low or not correlated in space and time with secondary formation such that the combination of the background and primary impacts are still well below the level of the NAAQS" a qualitative only assessment of secondary $PM_{2.5}$ formation is sufficient.

The Jacksonville Lime project may increase emissions of SO_2 by 157 tpy, NO_X by 343 tpy, and VOC by 19 tpy. The formation of secondary $PM_{2.5}$ from these increased emissions is expected to be minimal. Secondary $PM_{2.5}$ occurs slowly through time; thus, impacts from this pollutant are more widespread and diffuse than from direct $PM_{2.5}$. As previously mentioned, statewide (and local) emissions of NO_X and SO_2 have decreased dramatically in the past decade. The statewide trend is illustrated in **Figure 26**.

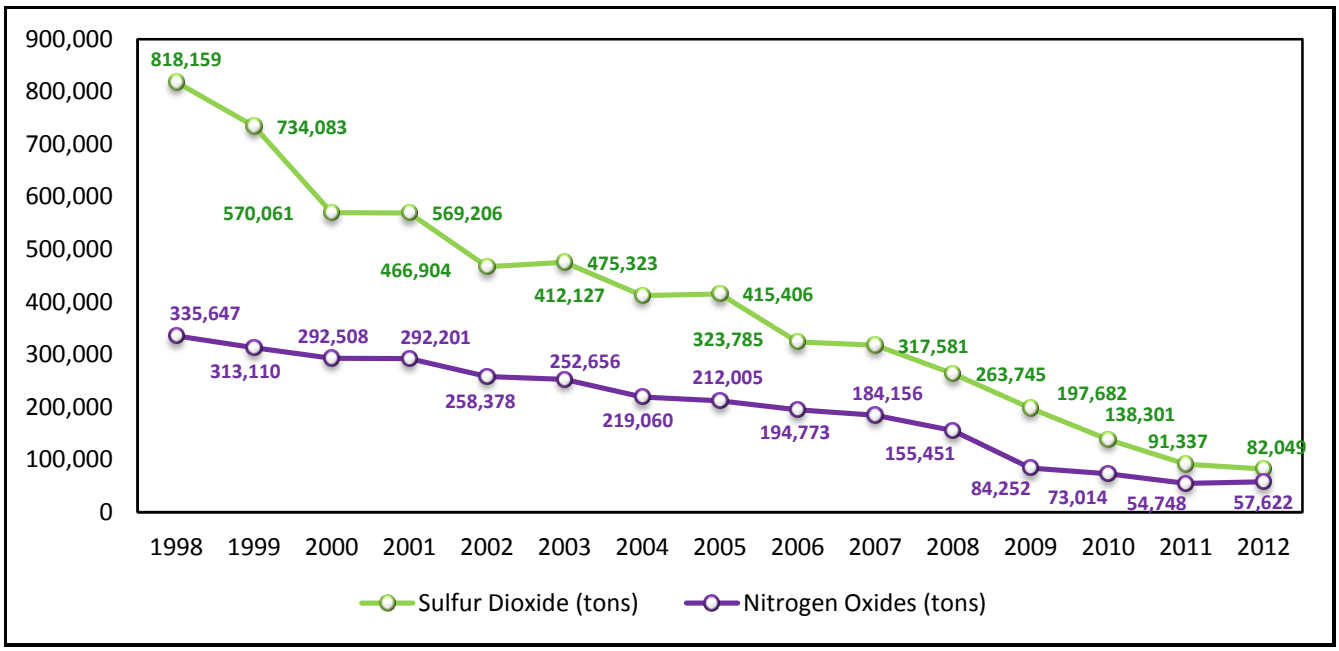


Figure 26 - Statewide NO_X and SO_2 Emissions from Acid Rain Units 1998-2012.

These decreases are orders of magnitude larger than the small increase in emissions from the proposed Jacksonville Lime project. In addition, the monitored $PM_{2.5}$ design values in the vicinity are well within attainment (**Figure 22**) and modeling results from the 24-hour $PM_{2.5}$ NAAQS analysis show that emissions from Jacksonville Lime are not correlated in time or space with other major sources

Given these factors, DEP has reasonable assurance that the proposed Jacksonville Lime project will not significantly contribute to or cause any violation of a NAAQS with respect to secondary $PM_{2.5}$ formation.

5.5. Additional Impacts Analysis

5.5.1. Growth-Related Impacts Due to the Proposed Project

According to the applicant, growth impacts associated with the construction of the Jacksonville Lime project will be minor. Construction will occur over just 14-16 months and will employ on average 20 workers during that time frame and no more than 30. The impacts associated with the temporary increase in vehicular traffic are expected to be negligible. Approximately 22 fulltime employees will operate the facility after construction resulting in an insignificant increase in daily traffic. This increase in traffic is not expected to cause any adverse effects.

The lime product will be sold on the open market and therefore no secondary growth effects are expected. The operation of the Jacksonville Lime site will result in an increased demand for natural gas and fuels in the local market but the effects from this increase are expected to be negligible.

5.5.2. Impact on Soils, Vegetation, and Wildlife

Emissions of pollutants have the potential to negatively affect soils, vegetation and wildlife near the project site. The concentrations of pollutants emitted will be low and dispersed over a wide area. As previously mentioned, this will result in the project's maximum potential air quality impacts remaining below the NAAQS and PSD increments for all pollutants and thus the project's impacts on soils and vegetation in the vicinity are expected to be negligible.

Impacts to wildlife in the vicinity of the project are expected to be negligible as well. Conservative estimates of the project's pollutant emissions are expected to be below the applicable NAAQS and PSD increments. Combined with the mobility of wildlife, these low concentrations are not expected to directly or indirectly contribute to any adverse effects on wildlife in the area.

5.5.3. Class I Area Impacts- Air Quality Related Values (AQRV)

According to the U.S. Department of the Interior, an AQRV is defined as "all those values possessed by an area except those that are not affected by changes in air quality and include all those assets of an area whose vitality, significance, or integrity is dependent in some way upon the air environment." An analysis of a project's impacts on AQRV in Class 1 areas is required as part of an application for an air construction permit.

In October 2010, the FLM, consisting of the National Park Service, U.S. Forest Service, and U.S. Fish and Wildlife Service, issued the Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report- Revised (2010). Based on the report, the FLM recommended initial screening criteria that would exempt a source from AQRV impact review based on a source's annual emissions and distance from a Class I area.

The FLM will consider a source located greater than 50 km from a Class I area to have negligible impacts with respect to Class I AQRV if its total SO_2, NO_X, PM_{10}, and sulfuric acid mist (SAM) annual emissions in tpy (based on 24-hour maximum allowable emissions), divided by the distance (km) from the Class I area (Q/D) is 10 or less. The FLM would not request any further Class I AQRV impact analyses from such sources. As shown in **Table 29**, the Q/D values for all five Class I areas within 300 km of the project site are less than the screening criterion; therefore, AQVR analyses is not required.

Table 29 – FLAG Guidance Screening Analysis.

Pollutant	NO_x	SO_2	SAM	PM_{10}	Total
Potential Emissions (Q) (tpy)	344.7	156.8	1.6	61.5	564.6
Class I area	Okefenokee	Wolf Island	Chassahowitzka	St. Marks	Bradwell Bay
Minimum Distance (D) (km)	55	112	215	254	280
FLAG screening ratio (Q/D) (tpy/km)	10	5	3	2	2
Greater than FLAG guidance (10)?	No	No	No	No	No

5.6. Conclusion

Based on the results presented in the air quality analysis, DEP has reasonable assurance that the increased pollutant emissions associated with this project will not cause or significantly contribute to any violation of a NAAQS or PSD increment. In addition, DEP finds that there will be no adverse impact on soils, vegetation, wildlife, or, in Class I areas, any AQRV.

6. PRELIMINARY DETERMINATION

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 application, reasonable assurances provided by the applicant, and the conditions specified in the Draft Permit. Leigh Ann Pell is the project engineer responsible for reviewing the application and drafting the permit. Brian Himes is the meteorologist responsible for reviewing and approving the ambient air quality analyses. Additional details of this analysis may be obtained by contacting the project engineer at the Department's Office of Permitting and Compliance at Mail Station #5505, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400.