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Trinity Consultants

VIA E-MAIL: chenrikson@mt.gov

September 30, 2019

Mr. Craig Henrikson
Air Quality Bureau
Montana Department of Environmental Quality
1520 E 6th Avenue
Helena, MT 59601

RE: GCC Three Forks, LLC Trident Plant Four-Factor Analysis

Dear Mr. Henrikson:

Trinity Consultants, Inc. (Trinity) is submitting the attached four-factor analysis on behalf of GCC Three Forks, LLC. (GCC) and its Portland cement plant near Three Forks, MT (Trident plant). This analysis is provided in response to a formal request from the Montana Department of Environmental Quality (MDEQ) Air Quality Bureau (AQB) on April 19, 2019 requesting that GCC provide assistance in developing information for the reasonable progress analysis for Montana's State Implementation Plan (SIP) for the second implementation period of the federal Regional Haze Program.

The purpose of this report is to provide information to MDEQ regarding potential NO_X emission reduction options for the Trident plant's long wet cement kiln. Based on the Regional Haze Rule, associated EPA guidance, and MDEQ's request, GCC understands that MDEQ will only move forward with requiring emission reductions from the GCC Trident cement kiln if the emission reductions can be demonstrated to be needed to show reasonable progress and provide the most cost effective controls among all options available to MDEQ. In other words, control options are only relevant for the Regional Haze Rule if they result in a reduction in the existing visibility impairment in a Class I area needed to meet reasonable progress goals.

If you have any questions or comments about the information presented in this letter, please do not hesitate to call me at (253) 867-5600 or Greg Gannon (GCC) at (406) 285-4977.

Sincerely,

Anna Henolson
Digitally signed by Anna Henolson
DN: cn=Anna Henolson, o=Trinity Consultants, ou=Seattle, email=ahenolson@trinityconsultants.com, c=US
Date: 2019.09.30 16:08:01 -07'00'

Anna Henolson
Managing Consultant

Attachments: Reasonable Progress Four-Factor Analysis: Graymont Western US Inc. (PDF)

cc: Ms. Rhonda Payne, MDEQ AQB (Helena, MT)
Mr. Greg Gannon, GCC (Three Forks, MT)
Ms. Gina Lotito, GCC (Pueblo, CO)
Mr. Vineet Masuraha, Trinity Consultants, Inc. (Irvine, CA)
Mr. Sam Najmolhoda, Trinity Consultants, Inc. (Kent, WA)

ATTACHMENT 1

Reasonable Progress Four-Factor Analysis

REGIONAL HAZE 2ND IMPLEMENTATION PERIOD FOUR-FACTOR ANALYSIS

GCC Trident > Three Forks, MT

Trident Plant Four-Factor Analysis

Prepared By:

Anna Henolson – Managing Consultant
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September 2019

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1. EXECUTIVE SUMMARY

GCC Three Forks, Inc. (GCC) operates a long wet cement kiln at its Trident plant in Three Forks, MT. The following report represents GCC's response to a request by the Montana Department of Environmental Quality (MDEQ) for a four-factor analysis of potential NO_X reduction options for the cement kiln at GCC Trident plant. MDEQ requested only NO_X emissions be addressed in the analysis. GCC's Trident plant, previously owned and operated by Holcim and Oldcastle, was subject to Best Available Retrofit Technology (BART) review for the first planning period of the Regional Haze program, at which time the current emission limits for oxides of nitrogen (NO_X) and sulfur dioxide (SO_2) were established (7.6 and 1.3 pounds of pollutant per ton of clinker produced, respectively). The effective date for the new controls and limits resulting from the BART program was October 18, 2017.

The United States Environmental Protection Agency's (U.S. EPA's) guidelines in 40 CFR Part 51.308 are used to evaluate additional reduction measures for the cement kiln at the GCC Trident plant. In establishing a reasonable progress goal for any mandatory Class I Federal area within the State, the State must consider the following four factors and include a demonstration showing how these factors are taken into consideration in selecting the goal. 40 CFR 51. 308(d)(1)(i)(A):

1. The costs of compliance
2. The time necessary for compliance
3. The energy and non-air quality environmental impacts of compliance
4. The remaining useful life of any potentially affected sources

The purpose of this report is to provide information to the MDEQ and the Western Regional Air Partnership (WRAP), regarding potential nitrogen oxide (NO_X) emission reduction options for the GCC Trident Portland cement kiln. Based on the Regional Haze Rule, associated U.S. EPA guidance, and MDEQ's request, GCC understands that MDEQ will only move forward with requiring emission reductions from the GCC Trident kiln if MDEQ determines that the emission reductions are needed to show reasonable progress and to provide the most cost effective controls among all options available. In other words, control reductions should be imposed under the Regional Haze Rule only if these potential measures result in a reduction in the existing visibility impairment in a Class I area needed to meet reasonable progress goals. GCC is submitting this report to provide preliminary results of the four factor analysis and to discuss the feasibility or infeasibility of these potential options further.

The GCC Trident kiln is an older kiln, constructed in 1972, yet despite its age and the associated technical concerns for emissions control, it has installed several emission reduction technologies that are still being optimized today.

As shown in this analysis, three NO_X emission reduction measures are determined to be available for the GCC Trident kiln: low-NO_X burner, selective non-catalytic reduction (SNCR), and selective catalytic reduction (SCR). The GCC Trident kiln currently employs low-NO_X burner technology and SNCR. Therefore, SCR is the only remaining available control to be evaluated.

While SNCR has been installed and is in operation, the optimal conditions for operating the SNCR to minimize both NO_X emissions and ammonia slip are still being determined.

In the case of SCR, there are significant technical barriers associated with using a catalyst in a cement kiln because constant cleaning is required to accommodate the heavy dust loading of a cement kiln. Constant cleaning and catalyst-fouling chemicals contained in the Portland cement raw materials severely limit catalyst life. Furthermore, there is currently only one cement kiln in the U.S. that has installed and operated this control technology, and the details of its cost, installation, and success remain confidential. Considering that the age and type of the GCC Trident kiln is different than the cement kiln that has employed SCR, this technology is considered unproven and therefore not available and technically infeasible.

2. INTRODUCTION AND BACKGROUND

In the 1977 amendments to the Clean Air Act (CAA), Congress set a national goal to restore national parks and wilderness areas to natural conditions by preventing any future, and remedying any existing, man-made visibility impairment. On July 1, 1999, the U.S. EPA published the final Regional Haze Rule (RHR). The objective of the RHR is to restore visibility to natural conditions in 156 specific areas across with United States, known as Class I areas. The Clean Air Act defines Class I areas as certain national parks (over 6000 acres), wilderness areas (over 5000 acres), national memorial parks (over 5000 acres), and international parks that were in existence on August 7, 1977.

The RHR requires States to set goals that provide for reasonable progress towards achieving natural visibility conditions for each Class I area in their state. In establishing a reasonable progress goal for a Class I area, the state must (40 CFR 51.308(d)(1)(i)):

(A) consider the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of any potentially affected sources, and include a demonstration showing how these factors were taken into consideration in selecting the goal.

(B) Analyze and determine the rate of progress needed to attain natural visibility conditions by the year 2064. To calculate this rate of progress, the State must compare baseline visibility conditions to natural visibility conditions in the mandatory Federal Class I area and determine the uniform rate of visibility improvement (measured in deciviews) that would need to be maintained during each implementation period in order to attain natural visibility conditions by 2064. In establishing the reasonable progress goal, the State must consider the uniform rate of improvement in visibility and the emission reduction.

On April 19, 2019, MDEQ sent a letter to GCC requesting that they assist in "developing information for the reasonable haze progress analysis" for the kiln at GCC's Trident plant.[1] MDEQ requested only NO_X emissions be addressed in the analysis. GCC Trident understands that the information provided in a four-factor review of control options will be used by MDEQ in their evaluation of reasonable progress goals for Montana. Based on the RHR, associated U.S. EPA guidance, and MDEQ's request, GCC understands that MDEQ will only move forward with requiring emission reductions from the GCC Trident kiln if MDEQ determines that the emission reductions are needed to show reasonable progress and provide the most cost effective controls among all options available. In other words, control reductions should be imposed by the RHR only if they result in a reduction in the existing visibility impairment in a Class I area needed to meet reasonable progress goals. The purpose of this report is to provide information to MDEQ and WRAP regarding NO_X emission reduction measures that could or could not be achieved for the GCC Trident kiln, if the emission reduction measures are determined by MDEQ to be necessary to meet the reasonable progress goals.

The information presented in this report considers the following four factors for the emission reductions:

Factor 1. Costs of compliance
Factor 2. Time necessary for compliance
Factor 3. Energy and non-air quality environmental impacts of compliance
Factor 4. Remaining useful life of the kiln

[1] Refer to letter from MDEQ to GCC Trident dated April 19, 2019.

Factors 1 and 3 (cost and non-air quality impacts) of the four-factor analysis are considered by conducting a step-wise review of emission reduction options in a top-down fashion. The steps are as follows:

- Step 1. Identify all available retrofit control technologies
- Step 2. Eliminate technically infeasible control technologies
- Step 3. Evaluate the control effectiveness of remaining control technologies
- Step 4. Evaluate impacts and document the results

Cost (Factor 1) and energy / non-air quality impacts (Factor 3) are key impacts determined in Step 4 of the step-wise review. However, timing for compliance (Factor 2) and remaining useful life (Factor 4) are also discussed in Step 4 to fully address all four factors as part of the discussion of impacts. When applicable, Factor 4 is addressed in the context of the costing of emission reduction options and whether any capitalization of expenses would be impacted by a limited equipment life.

The baseline NO_X emission rates that are used in the NO_X four-factor analysis are summarized in Table 4-1. The basis of the emission rates is provided in Section 4 of this report. The kiln currently has a low-NO_X burner and SNCR installed, which are considered BACT for new rotary kilns being permitted today.[2]

A review of the four factors for NO_X can be found in Sections 5 of this report. Section 4 of this report includes information on the GCC Trident kiln's existing/baseline emissions.

[2] BACT determinations are included in the RACT/BACT/LAER Clearinghouse (RBLC) search results contained in Appendix A.

3. SOURCE DESCRIPTION

The GCC Trident plant is located near Three Forks, Montana. The nearest Class I area to the plant is the Gates of the Mountains Wilderness Area, which is approximately 65 miles away.

The facility operates a long wet kiln, and was acquired by GCC in 2018, with the Notice of Intent to Transfer Ownership submitted to MDEQ in September of 2018. The Trident plant, formally owned and operating by Holcim (US) Inc., underwent a complete Best Available Retrofit Technology (BART) analysis in 2012 for control of SO_2 and NO_X emissions. After deliberations between Holcim and the Environmental Protection Agency (U.S. EPA), it was determined that BART for the Trident plant did not include any additional controls for SO_2 and the installation of selective non-catalytic reduction (SNCR) equipment for NO_X control. Emissions limits of 1.3 lb SO_2 per ton clinker and 7.6 lb NO_X per ton clinker were established with an effective date of October 18, 2017.

The GCC Trident kiln uses a low-NO_X burner. The SNCR was commissioned in 2017 as required by the FIP, and indirect coal firing was commissioned in 2018, resulting in further reductions in NO_X emissions.[3] GCC Trident is currently in the process of determining ideal operating conditions that minimize both NO_X emissions and ammonia slip. This optimization is an important goal given the significant fluctuations in operations inherent in an older Portland cement kiln that can lead to excessive ammonia slip and the adverse impacts to both the health of members of the community and local visibility impairment that could result from the ammonia emissions.

[3] After initially withdrawing efforts to adopt a state implementation plan (SIP) in 2006, the RHR requirements for the state of Montana were carried out under a Federal Implementation Plan (FIP) developed by the EPA through 2018. MDEQ is now transitioning back to a SIP for addressing the requirements for regional haze under 40 CFR 51.308.

4. EXISTING EMISSIONS

This section summarizes emission rates that are used as baseline rates in the four factor analysis presented in Sections 5 of this report.

4.1. BASELINE EMISSION RATES

Baseline emission rates of NO_X in tons per year are needed in the four-factor analysis. These baseline NO_X rates are used in the control cost-effectiveness analysis to determine the annual dollars of control cost per ton of pollutant reduced.

Reported emission rates for the GCC Trident facility do not accurately represent baseline emission rates for this four factor analysis. Considering changes to equipment and operations at the facility, the actual emissions over the last several years are not indicative of what will likely be the long-term operating conditions for the facility. Prior to October 18th, 2017, the kiln did not have an SNCR. NO_X emission rates after October 2017 are expected to be substantially lower due to ammonia injection. October 18th, 2017 was the effective start date for SNCR on the GCC Trident kiln. While this SNCR operation resulted in some reduction in NO_X emissions, current levels are not indicative of what will be achievable in the long term for the plant. In order to achieve current NO_x limit of 7.6 lb per ton of clinker, GCC Trident has been injecting a substantial amount of ammonia, resulting in excessive ammonia slip. This excessive ammonia injection will continue to result in high rates of ammonia slip beyond the range considered good operation of SNCR —a consequence with a direct impact on visibility impairment in the region. For this reason, the current permitted limit of 7.6 lb per ton clinker is not sustainable, and is potentially negatively impacting efforts by Trident and MDEQ to reduce visibility impairment in the region. This NO_x limit was developed assuming approximately 40% control efficiency over historical baseline emissions evaluated under BART review. Achieving 40% control efficiency requires stable kiln operations and optimum temperature ranges, which are difficult to maintain for an older kiln. Based on GCC's experience with other older kilns, achieving 20% to 30% control efficiency is a more realistic efficiency to provide effective NO_X control while maintaining desirable ammonia slip.

Given the lack of an accurate baseline emission level for NO_X, the reported value provided to MDEQ in the response to a request for future year 2028 on-the-books or on-the-way (OTB/OTW) emissions is assumed to be the baseline rate for the purposes of the four-factor analysis.[4] While these rates likely will not ultimately represent the long term conditions at the plant, they are the best available information for analyzing the state of control technologies at the plant. The baseline emission rates used in this analysis are expressed in terms of tons of pollutant per year (tpy) in Table 4-1, below. In addition to the use of the last three years of production data to determine a 3-year average for NO_X emissions and clinker production, GCC is also providing the permitted potential limits for both values. This approach is consistent with the information provided to MDEQ in response to their request for OTB/OTW emissions information. GCC once again notes that the currently-underway optimization of the kiln will likely impact NO_X emissions from the kiln, and the NO_X levels are therefore subject to change.

[4] See letter from GCC Trident Plant to MDEQ Air Resource Management Bureau, dated August 20, 2019.

Table 4-1. Annual Emissions Summary

Year	2016	2017	2018	Average	Permit Maximum
Clinker Production (tons)	311,734	291,754	322,383	308,624	425,000
Reported NO_X (tons)[a]	1,608	1,328	1,080	1,338	1,615

[a] GCC Trident began operating the SNCR under the BART limit in October of 2017.

5. NO_X FOUR FACTOR EVALUATION

As described in Section 2, Factors 1 and 3 (cost and non-air quality impacts) of the four-factor analysis are considered by conducting a step-wise review of emission reduction options in a top-down fashion. The steps are as follows:

Step 1. Identify all available retrofit control technologies
Step 2. Eliminate technically infeasible control technologies
Step 3. Evaluate the control effectiveness of remaining control technologies
Step 4. Evaluate impacts and document the results

Cost (Factor 1) and energy / non-air quality impacts (Factor 3) are key impacts determined in Step 4 of the step-wise review. However, timing for compliance (Factor 2) and remaining useful life (Factor 4) are also discussed in Step 4 to fully address all four factors as part of the discussion of impacts. When applicable, Factor 4 is addressed in the context of the costing of emission reduction options and whether any capitalization of expenses would be impacted by a limited equipment life.

The baseline NO_X emission rates that are used in the NO_X four-factor analysis are summarized in Table 4-1. The basis of the emission rates is provided in Section 4 of this report. The kiln currently has a low-NO_X burner and SNCR installed, which are considered BACT for new rotary kilns being permitted today.[5]

5.1. STEP 1: IDENTIFICATION OF AVAILABLE RETROFIT NO_X CONTROL TECHNOLOGIES

NO_x emissions are produced during fuel combustion when nitrogen contained in the fuel and combustion air is exposed to high temperatures. The origin of the nitrogen (i.e. fuel vs. combustion air) has led to the use of the terms "thermal" NO_X and "fuel" NO_X when describing NO_X emissions from the combustion of fuel. Thermal NO_X emissions are produced when elemental nitrogen in the combustion air is admitted to a high temperature zone and oxidized. Fuel NO_X emissions are created during the rapid oxidation of nitrogen compounds contained in the fuel. Many variables can affect the equilibrium in the kiln system, which in turn affects the creation of NO_x.[6]

Most of the NO_X formed within a rotary cement kiln is classified as thermal NO_X. Virtually all of the thermal NO_X is formed in the region of the flame at the highest temperatures, approximately 3,000°F. A small portion of NO_X is formed from nitrogen in the fuel that is liberated and reacts with the oxygen in the combustion air.

Step 1 of the top-down control review is to identify available retrofit control options for NO_X. The available NO_X retrofit control technologies for the Trident kiln are summarized in Table 5-1.

[5] See RBLC search results in Appendix A.

[6] Alternative Control Techniques Document Update - NOx Emissions from New Cement Kilns, U.S. Environmental Protection Agency, November 2007 (EPA-453/R-07-006), p. 3.

Table 5-1. Available NO_X Control Technologies for the Trident Kiln

NO_x Control Technologies	
Combustion Controls	Low NO_x Burners (LNB) (Base case)
Post-Combustion Controls	Selective Catalytic Reduction (SCR) Selective Non-Catalytic Reduction (SNCR) (Base case)

NO_X emissions controls, as listed in Table 5-1 can be categorized as combustion or post-combustion controls. Combustion controls reduce the peak flame temperature and excess air in the kiln burner, which minimizes NO_X formation. Post-combustion controls, such as selective catalytic reduction (SCR) and SNCR convert NO_X in the flue gas to molecular nitrogen and water.

5.1.1. Combustion Controls

5.1.1.1. Low NO_X Burners

LNBs reduce the amount of NO_X initially formed in the flame. The principle of all LNBs is the same: stepwise or staged combustion and localized exhaust gas recirculation (i.e., at the flame). LNBs are designed to reduce flame turbulence, delay fuel/air mixing, and establish fuel-rich zones for initial combustion. The longer, less intense flames resulting from the staged combustion lower flame temperatures and reduce thermal NO_X formation. Some of the burner designs produce a low pressure zone at the burner center by injecting fuel at high velocities along the burner edges. Such a low pressure zone tends to recirculate hot combustion gas which is retrieved through an internal reverse flow zone around the extension of the burner centerline. The recirculated combustion gas is deficient in oxygen, thus producing the effect of flue gas recirculation. Reducing the oxygen content of the primary air creates a fuel-rich combustion zone that then generates a reducing atmosphere for combustion. Due to fuel-rich conditions and lack of available oxygen, formation of thermal NO_X and fuel NO_X are minimized.[7]

The facility currently operates a low-NO_X burner in its cement kiln, and low-NO_X burners are therefore not considered an additional available NO_X emission control measure for this facility. Baseline emissions are based on the operation of this Low-NO_X burner. All alternative methods of NO_X control in this analysis will assume that the kiln continues to operate this burner.

5.1.2. Post Combustion Controls

5.1.2.1. Selective Catalytic Reduction

SCR is an exhaust gas treatment process in which ammonia (NH_3) is injected into the exhaust gas upstream of a catalyst bed. On the catalyst surface, NH_3 and nitric oxide (NO) or nitrogen dioxide (NO_2) react to form diatomic nitrogen and water. The overall chemical reactions can be expressed as follows:

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[7] USEPA, Office of Air Quality Planning and Standards. Alternative Control Technologies Document – NOx Emissions from Cement Manufacturing. EPA-453/R-94-004, Page 5-5 to 5-8.

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

$$2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6H_2O$$

When operated within the optimum temperature range of 480˚F to 800˚F, the reaction can result in removal efficiencies between 70 and 90 percent.[8] The GCC Trident kiln is older, with less stable operating temperatures. If it were technically feasible to implement SCR on the kiln; the removal efficiency would likely be in the lower end of the range, near 70 percent. The rate of NO_X removal via SCR increases with temperature up to a maximum removal rate at a temperature between 700˚F and 750˚F. As the temperature increases above the optimum temperature, the NO_X removal efficiency begins to decrease. The application of SCR is extremely limited in the U.S. cement industry, as only one cement plant has installed SCR (in 2015) and the specifics of its installation, use, and success remain confidential.

5.1.2.2. Selective Non-Catalytic Reduction

In SNCR systems, a reagent is injected into the flue gas within an appropriate temperature window. The NO_X and reagent (ammonia or urea) react to form nitrogen and water. A typical SNCR system consists of reagent storage, multi-level reagent-injection equipment, and associated control instrumentation. The SNCR reagent storage and handling systems are similar to those for SCR systems. Though the Portland Cement Association reports that SNCR use, when optimized, can achieve control efficiencies approaching the lower end of SCR efficiencies, there is consensus that the efficacy of the control technology is highly site-dependent, with a variety of factors having the potential to heavily influence the quantities of NO_X controlled.[9] SNCR is not considered an additional available control technology because it is already installed on this kiln, and therefore will not be evaluated further.

5.2. STEP 2: ELIMINATE TECHNICALLY INFEASIBLE NO_X CONTROL TECHNOLOGIES

Step 2 of the top-down control review is to eliminate technically infeasible NO_X control technologies that were identified in Step 1.

5.2.1. Post Combustion Controls

5.2.1.1. Selective Catalytic Reduction (Tail-Pipe)

Efficient operation of the SCR process requires fairly constant exhaust temperatures (usually ± 200°F).[10] Fluctuation in exhaust gas temperatures reduces removal efficiency. If the temperature is too low, ammonia slip occurs. Ammonia slip is caused by low reaction rates and results in both higher NO_X emissions and appreciable ammonia emissions. If the temperature is too high, oxidation of the NH_3 to NO can occur. Also, at higher removal efficiencies (beyond 80 percent), an excess of NH_3 is necessary, thereby resulting in further ammonia slip. Other emissions possibly affected by SCR include increased PM emissions (from ammonia salts in a detached plume) and increased SO_3 emissions (from oxidation of

[8] Air Pollution Control Cost Manual, Section 4, Chapter 2, Selective Catalytic Reduction, NOx Controls, EPA/452/B-02-001, Page 2-9 and 2-10.

[9] Response to Comments, EPA Air Pollution Control Cost Manual, Section 4, chapter 1, Selective Non-Catalytic Reduction, https://www3.epa.gov/ttn/ecas/docs/SNCR_CostManual_7thEd_RTC.pdf

[10] Ibid, Page 2-11

SO_2 on the catalyst). These ammonia, PM, and ammonia salt emissions contribute negatively to visibility impairment in the region—an effect that is directly counter to the goals of the program. In addition, the emission of ammonia poses significant health risks to the immediate community.

To reduce fouling in the catalyst bed with the PM in the exhaust stream, an SCR unit can be located downstream of the particulate matter control device (PMCD). However, due to the low exhaust gas temperature exiting the PMCD (approximately 260°F), a heat exchanger system would be required to reheat the exhaust stream to the desired reaction temperature range of between 480°F to 800°F. The source of heat for the heat exchanger would be the combustion of fuel,[11] with combustion products that would enter the process gas stream and generate additional NO_X. Therefore, in addition to storage and handling equipment for the ammonia, the required equipment for the SCR system will include a catalytic reactor, heat exchanger and potentially additional NO_X control equipment for the emissions associated with the heat exchanger fuel combustion.

High dust and semi-dust SCR technologies are still highly experimental. A high dust SCR would be installed prior to the dust collectors, where the kiln exhaust temperature is closer to the optimal operating range for an SCR. It requires a larger volume of catalyst than a tail pipe unit due to the increase in required pitch size (which reduces the surface-area to volume ratio for the catalyst), as well as a mechanism for periodic cleaning of catalyst. A high dust SCR also uses more energy than a tail pipe system due to catalyst cleaning and pressure losses.

A semi-dust system is similar to a high dust system. However, the SCR is placed downstream of an ESP or cyclone, which would therefore result in significant additional capital costs.

Only one cement kiln in the U. S. is using SCR, and the details of its installation, use, and success remain confidential. While several cement kilns in Europe have installed SCR, the cement industries between Europe and the U.S. differ significantly due to the increased sulfur content found in the processed raw materials in U.S. cement kiln operations. The pyritic sulfur found in raw materials used by U.S. cement plants have high SO_3 concentrations that result in high-dust levels and rapid catalyst deactivation. In the presence of calcium oxide and ammonia, SO_3 forms calcium sulfate and ammonium bisulfate via the following reactions:

$$SO_3 + CaO \rightarrow CaSO_4$$

$$SO_3 + NH_3 \rightarrow (NH_4)HSO_4$$

Calcium sulfate can deactivate the catalyst, while ammonium bisulfate can plug the catalyst. Catalyst poisoning can also occur through the exposure to sodium, potassium, arsenic trioxide, and calcium sulfate.[12] This effect directly and negatively impacts SCR effectiveness for NO_X reduction.

Dust buildup on the catalyst is influenced by site-specific raw material characteristics present in the facility's quarry, such as trace contaminants that may produce a stickier particulate than is experienced

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[11] The fuel would likely be propane or diesel. There is no natural gas at the facility, and coal would require an additional dust collector.

[12] Air Pollution Control Cost Manual, Section 4, Chapter 2, Selective Catalytic Reduction, NOx Controls, EPA/452/B-02-001, Page 2-6 and 2-7.

at sites where the technology is being demonstrated. This buildup is typical of cement kilns, resulting in reduced effectiveness, catalyst cleaning challenges, and increased kiln downtime at significant cost.[13]

In the U.S. EPA's guidance for regional haze analysis, the term "available," one of two key qualifiers for technical feasibility in a BART analysis, is clarified with the following statement:

Consequently, you would not consider technologies in the pilot scale testing stages of development as "available" for the purposes of BART review.

The U.S. EPA has also acknowledged, in response to comments made by the Portland Cement Association's (PCA) comments on the latest edition of the Control Cost Manual, that:

For some industrial applications, such as cement kilns where flue gas composition varies with the raw materials used, a slip stream pilot study can be conducted to determine whether trace elements and dust characteristics of the flue gas are compatible with the selected catalyst.

The U.S. EPA guidelines explicitly state that any technology requiring pilot-scale testing for its current stage of development is not considered an available technology for regional haze, and in the U.S. EPA's response to comments made by the PCA, they acknowledged that pilot studies would be required to determine whether the technology was feasible at a cement facility. Based on these conclusions, SCR is not widely available for use with cement kilns, in large part because the site-specificity limits the commercial availability of systems. For this reason, high-dust and semi-dust SCR's are not considered technically feasible for this facility at this time.

5.3. STEP 3: RANK OF TECHNICALLY FEASIBLE NOX CONTROL OPTIONS BY EFFECTIVENESS

Step 3 of the top-down control review is to rank the technically feasible options to effectiveness. Table 5-2 presents potential NOx control technologies for the kiln and their associated control efficiencies.

Table 5-2. Ranking of NO_X Control Technologies by Effectiveness

Pollutant	Control Technology	Potential Control Efficiency (%)
NO_X	SNCR	Base case*
	Low NO_x Burner	Base case*

* The average control efficiency for SNCR, per the EPA Control Cost Manual Table 1.2, "SNCR NOx Reduction Efficiency by Industry and Reagent Type," is approximately 50%. Current operating conditions are likely achieving a control level closer to approximately 30%.

[13] Preamble to NSPS subpart F, 75 FR 54970.

5.4. STEP 4: EVALUATION OF IMPACTS FOR FEASIBLE NO_X CONTROLS

Step 4 of the top-down control review is the impact analysis. The impact analysis considers the:

- Cost of compliance
- The remaining useful life of the source
- Energy impacts
- Non-air quality impacts; and

5.4.1. Cost of Compliance

The currently installed and operating controls are assumed to be cost-effective.

5.4.2. Timing for Compliance

The controls are already installed and operating.

5.4.3. Energy Impacts and Non-Air Quality Impacts

No additional energy or non-air quality impacts are assessed, as no technically feasible and cost effective control measures were identified beyond those currently installed at the facility.

5.4.4. Remaining Useful Life

There are no remaining useful life issues for the source, as GCC has presumed that the source and controls will remain in service for a 20-year amortization period.

5.5. NO_X CONCLUSION

The facility currently uses a low-NO_X burner and an SNCR system to manage NO_X emissions. The use of a low-NO_X burner in combination with SNCR is commonly applied in current BACT determinations for new rotary kilns today. Additionally, SCR should not be considered available for any cement kiln because of the lack of proven application of SCR on cement kilns in the U.S. Furthermore, SCR is particularly technically infeasible at the Trident plant given the concerns of operational and temperature stability with the older kiln. GCC has concluded that no additional options are available for reducing NO_X emissions from the facility.

APPENDIX A : RBLC SEARCH RESULTS

Table A-1. RBLC Search Results, Portland Cement Kilns, Nitrogen Oxides (NO_X)

RBLC ID	FACILITY NAME	CORPORATE OR COMPANY NAME	FACILITY STATE	AGENCY NAME	PERMIT NUMBER	PERMIT ISSUANCE DATE	PROCESS NAME	PRIMARY FUEL	POLLUTANT	CONTROL METHOD DESCRIPTION
IN-0312	LEHIGH CEMENT COMPANY LLC	LEHIGH CEMENT COMPANY LLC	IN	INDIANA DEPT OF ENV MGMT, OFC OF AIR	093-40198-00002	6/27/2019	Kiln	Natural Gas, Coal, Coke, Fuel Oils	Nitrogen Oxides (NOx)	Low NOx Burners and Selective Non-Catalytic Reduction (SNCR)
*KS-0031	ASH GROVE CEMENT COMPANY	ASH GROVE CEMENT COMPANY	KS	KANSAS DEPT. OF HEALTH & ENVIRONMENT, BR. OF AIR & RADIATION, KS	C-13894	7/14/2017	Portland Cement Manufacturing (kilns, mills, clinker cooler, conveyors)	Coal and/or Petroleum Coke, etc.	Nitrogen Oxides (NOx)	Fabric filters are specified in the PSD permit.
IL-0111	UNIVERSAL CEMENT	UNIVERSAL CEMENT	IL	ILLINOIS EPA, BUREAU OF AIR	8120011	12/20/2011	Kiln with In-Line Raw Mill	Coal, Petcoke, Scrap Tires	Nitrogen Oxides (NOx)	Staged Combustion and SNCR
GA-0136	CEMEX SOUTHEAST, LLC	CEMEX, INC.	GA	GEORGIA DEPARTMENT OF NATURAL RESOURCES	3241-153-0003-V-04-3	1/27/2010	Main Kiln Stack K218	Coal	Nitrogen Oxides (NOx)	Staged & Controlled Combustion (SCC), SNCR, Low NOx Burner and Indirect Firing.