PM$_{2.5}$ SIP Evaluation Report:
Lhoist North America – Grantsville Facility

Salt Lake PM$_{2.5}$ Serious Nonattainment Area

Utah Division of Air Quality

Major New Source Review Section

July 1, 2018

$PM_{2.5}$ SERIOUS SIP EVALUATION REPORT
Lhoist North America – Grantsville Facility

1.0 Introduction

The following is part of the Technical Support Documentation for Section IX, Part H.13 of the Utah SIP; to address the Salt Lake $PM_{2.5}$ Serious Nonattainment Area. This document specifically serves as an evaluation of the Lhoist North America Grantsville Facility.

1.1 Facility Identification

Name: Lhoist North America – Grantsville Facility
Address: P.O. Box 357, Grantsville, Utah 84029, Tooele County
Owner/Operator: Lhoist North America
UTM coordinates: 4,504.8 kilometers Northing; 369.0 kilometers Easting; Zone 12

1.2 Facility Process Summary

The operations at Chemical Lime Company (Lhoist North America (LNA) – Grantsville Facility) consist of a lime production facility. The Grantsville lime facility consists of the Grantsville Quarry and Grantsville Lime Plant. The kiln operations were placed in temporary care and maintenance mode on November 14, 2008 with support operations having had limited operation since that date. Permitted activities at the facility include mining, limestone processing, operation of a rotary kiln, post-kiln lime processing, lime hydration equipment, bagging facilities, and load out operations. Limestone ore is mined from the quarry area and the low-grade limestone is stored near the quarry. The remaining ore is processed through various crushing and screening processes. Limestone chat from the process is separated out and used for quarry floor and road maintenance, reclamation and sales. The high quality crushed limestone is sent to the rotary kiln that heats the crushed limestone ore and converts it into quicklime (CaO) which can be sold as product or sent on for further processing to hydrated lime ($Ca(OH)_2$). The facility produces a variety of products including quicklime, hydrate, aggregate kiln-grade limestone, overburden/low-grade limestone, and chat. Emissions activities from the facility include drilling/blasting, road dust emissions (hauling), loading/unloading, crushing/screening, storage, kiln firing/operations, and transfer point fugitives.

1.3 Facility Criteria Air Pollutant Emissions Sources

The following is a list of the permitted significant emitting equipment and process equipment addressed as part of the BACT:

1. Rotary Kiln System (consists of Pre-kiln limestone handling, a preheater, a rotary kiln, lime cooler, and an electro dry scrubber);
2. Rotary kiln shaft motor;
3. Lime hydrator;
4. Mining;

5. Limestone and lime processing (crushing, screening, conveying);
6. Bagging facilities;
7. Load out facilities;
8. Forklift;
9. Unpaved roads;
10. Petroleum storage tanks

1.4 Facility 2016 Baseline Actual Emissions and Current PTE

In 2016, LNA Grantsville's baseline actual emissions were determined to be the following (in tons per year):

Table 1: Actual Emissions

Pollutant	Actual Emissions (Tons/Year)
$PM_{2.5}$	0.25
SO_2	0.02
NO_x	0.21
VOC	0.14
NH_3	0.00

The current PTE values for Lhoist, as established by the most recent AO issued to the source (DAQE-AN0707015-06) are as follows:

Table 2: Current Potential to Emit

Pollutant	Potential to Emit (Tons/Year)
$PM_{2.5}$	131.14
SO_2	8.87
NO_x	328.66
VOC	3.01
NH_3	*

* No allowable emissions or PTE were ever determined for this facility

2.0 Modeled Emission Values

The base year for all modeling was set as 2016.

LNA Grantsville's temporary care and maintenance mode status allowed the DAQ to assume no growth to the 2016 inventory through REMI growth factors. Therefore LNA Grantsville's projected inventory growth was held to zero.

For LNA Grantsville, a summary of the modified emission totals for 2017 are shown below in Table 3.

Table 3: Modeled Emission Values (Plant-Wide)*

Pollutant	2017 Projected Actual Emissions (Tons/Year)
$PM_{2.5}$	0.25
SO_2	0.02
NO_x	0.21

VOC	0.14
NH_3	**

* Lhoist, no additional changes in equipment took place between 2016 and 2017 – Facility is still in temporary care and maintenance mode.

** No allowable emissions or PTE were ever determined for this facility

Finally, the effects of BACT were then applied during the appropriate projection year. BACT applied between 2016 and 2017, was previously taken into account during the 2017 adjustment shown above. For future BACT, meaning those items expected to be coming online between today and the regulatory attainment date, the effects of those changes would be applied during the 2019 projection year.

3.0 BACT Selection Methodology

The general procedure for identifying and selecting BACT is through use of a process commonly referred to as the "top-down" BACT analysis. The top-down process consists of five steps which consecutively identify control measures, and gradually eliminate less effective or infeasible options until only the best option remains. This process is performed for each emission unit and each pollutant of concern. The five steps are as follows:

1. Identify All Existing and Potential Emission Control Technologies: UDAQ evaluated various resources to identify the various controls and emission rates. These include, but are not limited to: federal regulations, Utah regulations, regulations of other states, the RBLC, recently issued permits, and emission unit vendors.

2. Eliminate Technically Infeasible Options: Any control options determined to be technically infeasible are eliminated in this step. This includes eliminating those options with physical or technological problems that cannot be overcome, as well as eliminating those options that cannot be installed in the projected attainment timeframe.

3. Evaluate Control Effectiveness of Remaining Control Technologies: The remaining control options are ranked in the third step of the BACT analysis. Combinations of various controls are also included.

4. Evaluate Most Effective Controls and Document Results: The fourth step of the BACT analysis evaluates the economic feasibility of the highest ranked options. This evaluation includes energy, environmental, and economic impacts of the control option.

5. Selection of BACT: The fifth step in the BACT analysis selects the "best" option. This step also includes the necessary justification to support the UDAQ's decision.

Should a particular step reduce the available options to zero (0), no additional analysis is required. Similarly, if the most effective control option is already installed, no further analysis is needed.

4.0 BACT for Rotary Kiln System

The Rotary Kiln System was installed at the LNA Grantsville facility in 1960 and currently has a production rate limit of 100,000 tons per year on a rolling 12-month basis (i.e., Condition II.B.3.d of Title V Operating Permit #4500005003). The Rotary Kiln System consists of pre-kiln limestone handling, a preheater, a rotary kiln, and a lime cooler. Four fuels can be used in the kiln. Natural gas is available to the kiln through a 5-inch feed line. Fuel oil for the kiln is stored in a storage tank and is used on an as-needed-basis when natural gas delivery is curtailed. Fuel oil can also be used as a primary fuel. On-specification used oil is used to supplement both natural gas and fuel oil on an as-needed-basis. On-specification used oil can also be used as a primary fuel. Tire derived fuel (TDF) is also used to supplement natural gas and fuel oil on an as-needed basis; additionally, TDF is approved as a primary fuel source. Gases from used tires are generated in an external chamber and directed to the kiln firing hood for combustion.

During pre-kiln limestone handling, limestone is conveyed from a kiln-feed stockpile to a bucket elevator via a belt conveyor. Approximately 20 percent of the limestone from the kiln feed stockpile is processed by a scalping screen prior to being discharged to the bucket elevator. The bucket elevator transfers the limestone to a stone bin, which is located on top of the kiln preheater. Stone is gravity fed from the bin through four discharge chutes which position the rock above and in front of four hydraulic rams in the preheater. The rams are used to push the limestone into the rotary kiln.

In the kiln preheater the limestone is heated by hot gases that flow countercurrent to the flow of the limestone. In the kiln, the limestone is heated to high temperatures whereby it is converted to quicklime. From the kiln the quicklime is passed through an air contact cooler where the quicklime is cooled and where kiln combustion air is preheated. The quicklime produced by the kiln is either sold to customers directly from the kiln as pebble lime, sized to customer specifications in the Front and Back Lime Handling Systems, or processed in the Hydrate System.

Particulate emissions from the Rotary Kiln System consist of fuel burning particulate emissions and dust emissions from the crushed limestone that is entrained in the exhaust stream during the firing process. The particulate emissions from the Rotary Kiln System are currently controlled by an Electro Dry Scrubber. The scrubber consists of a cyclone, which encloses a moving gravel bed, and an electro grid. The electro grid is used to charge the particles resulting in greater retention in the gravel bed. The control efficiency of the Electro Dry Scrubber for $PM_{2.5}$ is 70%. The control efficiency is based on information in AP-42, Table B.2-3 for a low efficiency electrostatic precipitator. The particle size collection efficiencies of a low efficiency electrostatic precipitator are most representative of the Electro Dry Scrubber.

The Rotary Kiln System also has the potential to emit SO_2, NO_X, VOC, and NH_3 emissions. The potential and actual annual emissions from the Rotary Kiln System as controlled by the Electro Dry Scrubber are presented in Table 3.1.0 of the BACT analysis provided by Lhoist North America (Lhoist North America, 2017a).

4.1 PM2.5

4.1.1 Available Control Technology

Controls for particulate emissions ($PM_{2.5}$) are identified as follows:

Baghouse (Fabric Filter) – Pulse Jet Type
Baghouse (Fabric Filter) – Mechanical Shaker Type
Baghouse (Fabric Filter) – Reverse Air Cleaned Type
Baghouse (Fabric Filter) – Paper/Nonwoven filters – Cartridge Collector Type
Baghouse (Fabric Filter) – Ceramic/Fiberglass Bag Type
Wet Electrostatic Precipitator – Wire Plate Type

Dry Electrostatic Precipitator – Wire Plate Type
Electro Dry Scrubber
Wet Scrubber
Cyclone Separator
Gravel Bed Filter
Good Combustion Practices/Burner/Process Optimization

4.1.2 Evaluation of Technical Feasibility of Available Controls

All of the practices/technologies available to control $PM_{2.5}$ from the Rotary Kiln System presented in Section 4.1.1 are considered technically feasible with the exception of a Baghouse utilizing Ceramic/Fiberglass bags.

Ceramic filters are effective across a range of particle sizes, but are most often used when there is a large fraction of $PM_{2.5}$ and submicron particulates and/or high temperatures. They have the same efficiency as fabric filter bags but are designed to withstand much higher temperatures. The typical operating temperature for ceramic filters is within the range of 300 degrees Fahrenheit (°F) to 1,650°F. For applications with temperatures below 400°F, fabric filters are less costly than ceramic filters with no loss in control efficiency.

It should be noted that ceramic filters can be designed with catalyst embedded in the filter walls to provide control of both PM and nitrogen oxides (NO_x) emissions. However, ammonia/urea injection and possible temperature adjustments would still be necessary upstream of the ceramic filters. The operating range for NO_x removal is 350˚F to 950˚F, with the best results occurring at temperatures of 450°F and above.

In the lime manufacturing industry, the use of ceramic filters to control $PM_{2.5}$ emissions is unproven technology for kilns. There are operational unknowns including if the lime will have a coating effect on the ceramic filters and what the frequency and costs are for replacement/regeneration of the catalyst (when also controlling NO_x). (Lhoist North America, 2017b)

4.1.3 Evaluation and Ranking of Technically Feasible Controls

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts is as follows:

Control Practice/Technology	Percent Controlled	$/Ton $PM_{2.5}$ Removed
Baghouse – Pulse Jet	99 – 99.5%	$ 283.95
Baghouse – Mechanical Shaker	99 – 99.5%	$ 306.55
Baghouse – Reverse Air Cleaned	99 – 99.5%	$ 360.23
Baghouse – Paper/Nonwoven Filters	99 – 99.5%	$ 344.68
Wet Electrostatic Precipitator	95 – 99.5%	$ 588.61
Dry Electrostatic Precipitator	95%	$ 291.35
Electro Dry Scrubber	70%	Currently Installed
Wet Scrubber	20% – 90%	BACT Cost Not Submitted*
Cyclone Separator	10% - 80%	BACT Cost Not Submitted*
Gravel Bed Filter	0%	BACT Cost Not Submitted*
Good Combustion Practices	0%	No Cost/Current Work Practice

*Note: No costs were available in the EPA CoST System for these sources.
The cost effectiveness values presented in the EPA CoST system are average values. Site-specific cost effectiveness values for fabric filter baghouses and wet scrubbers however are significantly higher. The August 2013 RACT/BACT analysis for $PM_{2.5}$ determined that installation of a baghouse would be $91,642/ton removed and installation of a scrubber would be $71,617/ton of $PM_{2.5}$ removed.

4.1.4 Further Evaluation of Most Effective Controls

The top three control practices/technologies are all types of fabric filter baghouses with identical control efficiencies and similar economic impacts. Because LNA Grantsville proposes to choose a fabric filter baghouse as BACT, further evaluation of the other controls is not necessary.

4.1.5 Selection of BACT controls

The UDAQ proposes BACT to be a type of fabric filter baghouses (pulse jet, mechanical shaker, or reverse air cleaned). Due to the facility currently being in care and maintenance mode, LNA Grantsville shall make a decision on the type of fabric filter baghouse at a later date. However, because of the identical control efficiencies of the different types of fabric filter baghouses, the delayed decision should not affect establishment of emission limitations and monitoring requirements.

4.1.5 Consideration of Startup and Shutdown Operations

Emissions from the Rotary Kiln System will be exhausted through the fabric filter baghouse during startup and shutdown. No startup and shutdown requirements are necessary for the fabric filter baghouse technology.

4.2 SO_2

4.2.1 Available Control Technology

The practices/technologies available to control SO_2 from the Rotary Kiln System are presented in BACT Analysis for the Rotary Kiln Table 3.4 (Lhoist North America, 2017a). These technologies are identified as:

1. Flue Gas Desulfurization and;
2. Good Combustion Practices, Burner/Process Optimization, Inherent Control (current control practice used at the source).

For reference purposes, the cost effectiveness range for flue gas desulfurization presented in Table 3.4 (Lhoist North America, 2017a) is from an EPA Air Pollution Control Fact Sheet. However, based on experience at other LNA facilities, the costs of implementing flue gas desulfurization on the LNA Grantsville Rotary Kiln System would be greater than the high end of the range presented in the EPA Air Pollution Control Fact Sheet for Flue Gas Desulfurization. For example, the site specific cost effectiveness value for implementing dry sorbent injection (i.e., a low cost type of flue gas desulfurization) on the LNA Grantsville Rotary Kiln System was determined to be approximately $80,000/ton of SO2 reduced. Determination of the cost effectiveness value is presented in Appendix A (Lhoist North America, 2017a). Because dry sorbent injection systems are known to have significantly lower capital and annual costs compared to wet systems, the cost effectiveness values for wet systems installed on the LNA Grantsville Rotary Kiln System are expected to be greater than the $80,000/ton of SO2 determined for dry sorbent injection.

4.2.2 Elimination of Technically Infeasible Control Options

All the control practices/technologies identified in 4.2.1

4.2.3 Ranking of Technically Feasible Control Technologies

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts, is:

Control Practice/Technology	Percent Controlled	\$/Ton SO_2 Removed
1. Flue Gas Desulfurization	50-90%	$17,031
2. Good Combustion Practices	0%	$ No Additional Costs

This information is presented in Table 3.5 (Lhoist North America, 2017a).

The economic impact presented in Table 3.5 for flue gas desulfurization is based on the median of the cost effectiveness values presented in an EPA Air Pollution Control Fact Sheet. However, as previously mentioned, the costs of implementing dry sorbent injection (i.e., a low cost type of flue gas desulfurization) on the LNA Grantsville Rotary Kiln System would be greater than the values presented in the EPA Air Pollution Control Fact Sheet for Flue Gas Desulfurization. For example, the site-specific economic impact of implementing dry sorbent injection was determined to be approximately $495,000/year. Determination of the economic impact is presented in Appendix A. Because dry sorbent injection systems are known to have significantly lower capital and annual costs compared to wet systems, the economic impacts of wet systems installed on the LNA Grantsville Rotary Kiln System are expected to be greater than the $495,000/year determined for dry sorbent injection.

4.2.4 Further Evaluation of Most Effective Controls

SO_2 emissions from the Rotary Kiln System are mainly due to the presence of sulfur contained in the fuel used in the kiln. The sulfur combines with oxygen in the combustion air to form SO_2. A search of comparable facilities in EPA's RBLC indicates a wide variety of limitations for the sulfur content of fuel as well as sulfur emission rates. However, the most prevalent control BACT Analysis for the Rotary Kiln System method listed in EPA's RBLC for SO_2 emissions are fuel sulfur limitations and "inherent" sulfur control. It is well known that the alkaline properties of limestone tend to neutralize acid gases and that limestone has a scrubbing effect that reduces SO_2 emissions. Lime kilns with preheat create conditions for this scrubbing effect to occur thereby serving as an inherent control mechanism. Add-on SO_2 controls, such as flue gas desulfurization (which actually employ lime to control SO_2 emissions) have been effectively employed at sources such as coal-fired power plants which have relatively high SO2 concentrations in the flue gas. The Rotary Kiln System at the LNA Grantsville facility does not utilize coal.

The sulfur content of the fuel used in LNA Grantsville's Rotary Kiln System varies from nearly zero for natural gas (pipeline quality) to 1.2% (by weight) for Tire Derived Fuel (TDF). Additionally, the sulfur content of fuel oil (diesel) and on-specification used oil is limited to 0.85 lb per million British Thermal Units (MMBtu) and 0.5% (by weight), respectively, by Conditions

II.B.1.d and II.B.3.e of Title V Operating Permit #4500005003. Source testing performed during pilot testing of the TDF burning system indicates that emissions of SO_2 are greatest when burning natural gas and SO_2 was not present within detection limits during any tests performed while burning TDF. It is assumed that the conditions under which tires are combusted produces highly reactive sulfur compounds that are absorbed by the lime as it comes in contact with the combustion gases. Consequently, because it is known that the fuel burned in in LNA Grantsville's Rotary Kiln System produces SO_2 emission rates much lower than coal-fired lime kilns, the use of an add on control device such as flue gas desulfurization would result in little added benefit due to relatively low SO_2 concentration in the flue gas stream.

4.2.5 Selection of BACT

Due to the economic, environmental, and energy impacts of flue gas desulfurization with only minimal reductions in SO_2 emissions, the UDAQ proposes good combustion practices, burner/process optimization, and inherent control as BACT for SO_2 from the kiln process.

4.2.6 Consideration of Startup and Shutdown Operations

No startup and shutdown provisions are required for use of good combustion practices, burner/process optimization, and inherent control.

4.3 NOx

4.3.1 The technologies available to control NO_X from the Rotary Kiln System are (in order of effectiveness):

1. Low Nox Burner System
2. Selective Catalytic Reduction
3. Selective Non-Catalytic Reduction
4. Good Combustion Practices.

The control technologies are presented in Table 3.6. (Lhoist North America, 2017a) In order to efficiently compare a variety of control practices/technologies, the cost effectiveness values presented in Table 3.6 are average values from EPA's CoST System.

However, based on experience at various LNA facilities, the costs of implementing the NO_X control practices/technologies on a Rotary Kiln System are significantly greater than the average values presented in the EPA CoST System. For example, the site-specific cost effectiveness value for implementing selective non-catalytic reduction control was determined in LNA Grantsville's previous RACT Analysis dated August 2013 to be $3,977/ton of NO_X reduced. Site-specific cost effectiveness values for low NO_X burner systems and selective catalytic reduction (although determined to be infeasible for the LNA Grantsville facility) are also expected to be significantly greater than the average values in EPA's CoST System.

4.3.2 Evaluation of Technical Feasibility of Available Controls

Low NO_X burner systems and selective catalytic reduction are considered technically infeasible and are discussed in more detail below. Selective non-catalytic reduction and good combustion practices/optimization are considered technically feasible.

Low NO_X Burner Systems

Low NO_X burner systems control NO_X emissions by lowering the peak burner flame temperature and staging the mixing of the fuel and combustion air. By design, low NO_X burner systems operate at lower flame temperature than conventional burners. The lower flame temperature may cause carry-over of unburned carbon into the limestone which could have adverse effects on product quality. Additionally, lowering the flame temperature can result in an increase in carbon monoxide (CO) emissions. Low NO_X burner systems require precise control of fuel/air mixture to lower the flame temperature while maintaining efficient burner operation.

UDAQ has indicated that "the EPA and UDAQ view low-NOx burners as a control option for this activity," however, current technical documentation does not support the use of low NO_X burner systems for the type of kiln at the LNA Grantsville facility. NO_X emission reductions of up to 30% have been claimed, but these reductions cannot be universally achieved. The LNA Grantsville Rotary Kiln System is over 40 years old; is small in size; and is equipped to burn natural gas, fuel oil, used oil, and tires as fuel. The few kilns that have successfully employed low NO_X burner systems are substantially larger, newer, and typically use only one type of fuel.

The main principle of the low NO_X burner systems is stepwise or staged combustion and localized exhaust gas recirculation (i.e., at the flame). Low NO_X burner systems are designed to reduce flame turbulence, delay fuel/air mixing, and establish fuel-rich zones for initial BACT Analysis for the Rotary Kiln System combustion. The longer, less intense flames resulting from the staged combustion lower the flame temperatures and reduce thermal NO_X formation. However, the use of low NO_X burner systems in lime kilns is not a widely used control technology, and past use of bluff body low NO_X burner systems at other LNA facilities was not successful. The burners wore out in approximately six months, impacted production, caused brick damage, and resulted in unscheduled shutdowns of the kilns. Consequently, LNA Grantsville and UDAQ discount the use of bluff body low NO_X burner systems, and does not have evidence to support that changing the burners will reduce NO_X emissions by any specific percentage, and does not see low NO_X burner systems as a proven technology for shorter, preheater rotary kilns like the LNA Grantsville Rotary Kiln System.

Installation of low NO_X burners on the LNA Grantsville Rotary Kiln System would also require extensive conversion of the fuel handling system, duct work, and burner system to accommodate the precise control required for maintaining viable burner performance and NO_X control. Additionally, the BART VISTAS program (Best Available Retrofit Technology – Visibility Improvement State and Tribal Association of the Southeast) no longer lists low NO_X burner systems as a NO_X control option for lime kilns. Furthermore, one of the energy sources for the LNA Grantsville Rotary Kiln System is from the combustion of whole tires and this process is not amenable to low NO_X burners.

The UDAQ reviewed recent permitting activities to determine whether low NO_X burner systems had been permitted as BACT in the lime industry. UDAQ and LNA Grantsville conducted a search of the EPA's RBLC for lime kiln permits issued since 2003 to understand whether there were permits issued for lime kilns that required low NO_X burner systems. None of the recent permitting actions have determined low NO_X burner systems to be BACT, except the permitting action shown for the Western Lime Corporation. While the RBLC database indicates low NO_X burner systems were determined to be BACT for a Western Lime kiln, the low NO_X burner systems used by Western Lime in practice consist of a straight pipe with a bluff body. As stated above, LNA has experimented with bluff body low NO_X burner systems and was not successful.

The UDAQ LNA has no data to suggest that NO_X reductions are achievable from changing to burners classified as low-NOx burners for a kiln with the same design features as the LNA Grantsville Rotary Kiln System. EPA has indicated that a 14 percent reduction in NOx emissions may be anticipated in switching from a direct-fired standard burner to an indirect-fired Low NO_X burner system in a Portland cement kiln (NO_X Control Technologies for the Cement Industry, EC/R Incorporated, Chapel Hill, NC, USA, U.S. EPA Contract No. 68-D98-025, U.S. EPA RTP, September 19, 2000). EPA has determined, however, that "the [emission reduction] contribution of the low-NOx burner itself and of the firing system conversion [from direct to indirect] cannot be isolated from the limited data available." Further, Portland cement kilns are different than lime kilns and it would not be appropriate to make the generalization that an anticipated reduction in a Portland cement kiln is directly transferable to a lime kiln due to BACT Analysis for the Rotary Kiln System the different temperatures and operating conditions, which would be expected to impact NOx generation rates.

Overall, because there is significant uncertainly with respect to the ability of a burner retrofit to reduce NOx emissions, UDAQ considers low NO_X burner systems to be technically infeasible.

Selective Catalytic Reduction

Selective catalytic reduction is an add-on control device utilizing an ammonia injection system in conjunction with a catalyst impregnated grid to convert NO_X into nitrogen and water via a reduction reaction on the catalyst surface. Selective catalytic reduction systems have been effectively used to control NO_x emissions on power plants and other sources and can achieve very high removal efficiencies, particularly on steady-state systems.

However, selective catalytic reduction systems must operate in a specific temperature range (typically 600°F to 750°F) to effectively remove NO_X. If the temperature is too low, the reduction reaction will not proceed to completion resulting in higher NO_X emissions and the escape of NH_3 (i.e., ammonia slip). If the temperature is too high, ammonia can be oxidized to nitrogen oxide (NO) resulting in higher NO_X emissions. The stack temperature of the lime kiln is in the range of 345°F which is too low for effective selective catalytic reduction operation. This would necessitate the installation of a heat exchanger system to raise the exhaust stream temperature to the required range of operation for a selective catalytic reduction system. Such a heat exchanger system would greatly increase the cost of installing a selective catalytic reduction system.

Additionally, there is the potential that particulate emissions would be generated from SO_2 in the exhaust stream reacting with ammonia, causing an increase in fine particulate emissions (i.e., $PM_{2.5}$) and increasing the potential for ammonium salt deposits on the catalyst, reducing efficiency. There is also the potential for SO_2 in the gas stream to react on the catalyst forming sulfur trioxide (SO_3) emissions. An EPA RBLC search for lime kilns indicates that no selective catalytic reduction systems have been installed to control NO_X emissions. In addition, Prevention of Significant Deterioration (PSD) permitting decisions have determined that selective catalytic reduction is technically infeasible for a lime kiln (Lhoist North America, 2017a). For these reasons, UDAQ considers the installation of a selective catalytic reduction system for NO_X controls to be technically infeasible.

4.3.3 Evaluation and Ranking of Technically Feasible BACT Controls

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts, is:

Control Practice/Technology	Percent Controlled	\$/Ton NO_X Removed

Selective Non-Catalytic Reduction	25 - 50%	$151,897
Good Combustion Practices	0%	$ No Additional Costs

This information is presented in Table 3.7 (Lhoist North America, 2017a).

The economic impact presented in Table 3.7 for selective non-catalytic reduction is based on the average cost effectiveness value from EPA's CoST System. However, as previously mentioned, the costs of implementing the NO_X control practices/technologies on a Rotary Kiln System are significantly greater than the average values presented in the EPA CoST System based on experience at various LNA facilities. For example, the site-specific economic impact of implementing selective non-catalytic reduction was determined in UDAQ's previous RACT analysis for LNA Grantsville dated August 2013 to be $163,324/year. Site-specific economic impacts for low NO_X burner systems and selective catalytic reduction (although determined to be infeasible for the LNA Grantsville facility) are also expected to be significantly greater than the average values in EPA's CoST System.

4.3.4 Further Evaluation of Most Effective Controls

The top remaining control technology is selective non-catalytic reduction. Because LNA Grantsville has proposed to choose selective non-catalytic reduction as BACT, further evaluation of the final control is not necessary.

4.3.5 Selection of BACT Controls

The UDAQ proposes Selective Non-Catalytic Reduction as BACT.

4.3.6 Consideration of Startup and Shutdown Operations

Selective non-catalytic reduction technology is based on a gas-phase homogeneous reaction between NO_X in the exhaust gas and either injected ammonia or urea. The reaction must occur within a specified temperature range in order to properly convert the NO_x gases into gaseous nitrogen and water vapor. The approximate temperature range where selective non-catalytic reduction is effective is 1,600 - 2,100 degrees Fahrenheit, with ammonia injection being more effective at the lower portion of this range and urea injection being more effective in the upper portion of this range.

Operation at lower temperatures results in unreacted ammonia slip, and at higher temperatures, NO_X emissions can actually be increased. The limited temperature range in which selective non-catalytic reduction is effective prohibits its use during startup until the flue gas temperatures reaches the appropriate range in which it becomes effective. Shutdown procedures include either a controlled reduction or a cessation of fuel combustion which reduces or ceases NO_X generation due to fuel combustion. Shutdown also reduces the temperature at which selective non-catalytic reduction is effective.

Consequently, startup/shutdown provisions for selective non-catalytic reduction technology is proposed to correspond to:

• No ammonia or urea injection during startup until the combustion gases exiting the kiln reach the temperature when NOx reduction is effective; and

• No ammonia or urea injection during shutdown.

Recordkeeping requirements are proposed to be used to ensure that these provisions are enforceable. Requirements may include keeping records of ammonia or urea injection in an operations log. The operations log would need to include all periods of startup/shutdown and subsequent beginning and ending times of ammonia or urea injection.

4.4 VOC

4.4.1 Available Control Technology

The technologies available to control VOC from the Rotary Kiln System are limited to Good Combustion Practices and Burner/Process Optimization.

The practices/technologies available to control VOC from the Rotary Kiln System are presented in Table 3.8 (Lhoist North America, 2017a). A search of EPA's RBLC and other references indicate no add-on controls are available.

4.4.2 Evaluation of Technical Feasibility of Available Controls

Good Combustion Practices and Burner/Process Optimization are a Technically feasible option.

4.4.3 Evaluation and Ranking of Technically Feasible Controls

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts, is:

Control Practice/Technology	Percent Controlled	$/Ton VOC Removed
Good Combustion Practices and Burner/Process Optimization	0%	No Additional Costs

4.4.4 Further Evaluation of Most Effective Controls

Further evaluation of the existing controls is not required as there is only one option; Good Combustion Practices and Burner/Process Optimization is suggested as BACT for VOC emission.

4.4.5 Selection of BACT

UDAQ proposes Good Combustion Practices and Burner/Process Optimization as BACT for VOC emission from the Rotary Kiln System.

4.4.6 Startup and Shutdown

No startup and shutdown provisions are necessary for the use of Good Combustion Practices and Burner/Process Optimization.

4.5 NH_3

4.5.1 Available Control Technology

The technologies available to control NH_3 from the Rotary Kiln System are limited to Good Combustion Practices and Burner/Process Optimization. A search of EPA's RBLC and other references indicate no add-on controls are available.

4.5.2 Evaluation of Technical Feasibility of Available Controls

Good Combustion Practices and Burner/Process Optimization are a Technically feasible option.

4.5.3 Evaluation and Ranking of Technically Feasible Controls

Control Practice/Technology	Percent Controlled	\$/Ton NH_3 Removed
Good Combustion Practices and Burner/Process Optimization	0%	No Additional Costs

4.5.4 Further Evaluation of Most Effective Controls

Further evaluation of the existing controls is not required as there is only one option; Good Combustion Practices and Burner/Process Optimization is suggested as BACT for NH_3 emission.

4.5.5 Selection of BACT

UDAQ proposes Good Combustion Practices and Burner/Process Optimization as BACT for VOC emission from the Rotary Kiln System.

4.5.6 Startup and Shutdown

No startup and shutdown provisions are necessary for the use of Good Combustion Practices and Burner/Process Optimization.

5.0 BACT for the Pressure Hydrator

The Pressure Hydrator is used at the LNA Grantsville facility to convert quicklime into hydrated lime (i.e., calcium hydroxide). It currently has a production rate limit of 126,000 tons/year on a rolling 12-month basis (i.e., Condition II.B.4.c of Title V Operating Permit #4500005003). To begin operations, quicklime is mixed with water and pumped as a slurry into the Pressure Hydrator. Within the Pressure Hydrator, the calcium oxide component of the quicklime and water react exothermically to produce calcium hydroxide. The heat that is released converts excess water to steam which in turn raises the pressure within the Pressure Hydrator. As the pressure increases, magnesium oxide reacts with the superheated steam to form magnesium hydroxide.

Once the pressure reaches the operating range, the outlet valve of the Pressure Hydrator opens to allow the hydrated quicklime to blow out into a collector where the hydrated lime is separated from the superheated steam. The steam is vented from the top of the collector into a natural gas fired burner hot baghouse (Baghouse HBY-1HY). The natural gas burner is used on an as-needed-basis to maintain the temperature of the flue gas above the dew point to keep the steam from condensing on the bags. Any dust that is pulled into the baghouse collects on the outside of the bags where it is purged and fed back into the hydrated lime stream. The cleaned steam is pulled from Baghouse HBY-1HY by an induced draft fan and blown up a stack that is vented to the atmosphere.

Particulate emissions from the Pressure Hydrator consist of fuel burning particulate emissions and dust emissions from the hydration process. Baghouse HBY-1HY is estimated to have a control efficiency of 99.25% for $PM_{2.5}$ based on the median value for the range of control efficiencies presented in EPA's CoST System for fabric filter baghouses. The Pressure Hydrator also has the potential to emit SO_2, NO_X, VOC, and NH_3 emissions due to the associated natural gas fired, baghouse burner. The potential and actual annual emissions from the Pressure Hydrator as controlled by Baghouse HBY-1HY are presented in Table 4.1 (Lhoist North America, 2017a).

5.1 $PM_{2.5}$

5.1.1 Available Control Technology

Controls for particulate emissions ($PM_{2.5}$) are identified as follows:

Baghouse (Fabric Filter) – Pulse Jet Type
Baghouse (Fabric Filter) – Mechanical Shaker Type
Baghouse (Fabric Filter) – Reverse Air Cleaned Type
Baghouse (Fabric Filter) – Paper/Nonwoven filters – Cartridge Collector Type
Baghouse (Fabric Filter) – Ceramic/Fiberglass Bag Type
Wet Electrostatic Precipitator – Wire Plate Type
Dry Electrostatic Precipitator – Wire Plate Type
Good Combustion Practices/Burner/Process Optimization

5.1.2 Evaluation of Technical Feasibility of Available Controls

All of the practices/technologies available to control $PM_{2.5}$ from the Rotary Kiln System resented in Section 5.1.1 are considered technically feasible.

5.1.3 Evaluation and Ranking of Technically Feasible Controls

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts is as follows:

Control Practice/Technology	Percent Controlled	$/Ton $PM_{2.5}$ Removed
Baghouse – Pulse Jet	99 – 99.5%	$ 62,640
Baghouse – Mechanical Shaker	99 – 99.5%	$ 67,625
Baghouse – Reverse Air Cleaned	99 – 99.5%	$ 79,468
Baghouse – Paper/Nonwoven Filters	99 – 99.5%	$ 75,848
Wet Electrostatic Precipitator	95 – 99.5%	$ 127,238
Dry Electrostatic Precipitator	95%	$ 61,522
Good Combustion Practices	0%	No Cost/Current Work Practice

5.1.4 Further Evaluation of Most Effective Controls

The top three control practices/technologies are all types of fabric filter baghouses with identical control efficiencies and similar economic impacts. UDAQ proposes to select a fabric filter baghouse as BACT. Further evaluation is not required.

5.1.5 Selection of BACT

UDAQ proposes BACT to be a fabric filter baghouse. A pulse jet type fabric filter baghouse (i.e., Baghouse HBH-1HY) is currently used to control $PM_{2.5}$ emissions from the Pressure Hydrator. Continued operation of this baghouse meets the proposed BACT requirement.

5.1.6 Consideration of Startup and Shutdown Operations

Emissions from the Pressure Hydrator will be exhausted through the fabric filter baghouse during startup and shutdown. Therefore, startup and shutdown requirements are not necessary for this baghouse.

5.2 SO_2, NO_X, VOC, and NH_3

As demonstrated in Section 1.1 and Table 4.1 (Lhoist North America, 2017a)., SO_2, NO_X, VOC, and NH_3 emissions from the Pressure Hydrator represent a very small portion of the total gaseous emissions from the LNA Grantsville facility. Consequently, additional analyses will not be performed for these pollutants. NO_X, VOC, and NH_3 emissions will continue to be primarily controlled by good combustion practices to maintain a proper air to fuel ratio. SO_2 emissions are dependent on the sulfur content of the fuel. Pipeline quality natural gas will continue to be used in the baghouse burner, as it has a very low sulfur content due to sulfur limitations to maintain pipeline integrity.

Additionally, SO_2, NO_X, VOC, and NH_3 emissions will be naturally limited by: (a) the baghouse burner only being used when necessary to maintain the temperature of the flue gas above the dew point; and (b) Condition II.B.4.c of Title V Operating Permit #4500005003, which limits the production of hydrate in the Pressure Hydrator to 126,000 tons/year (rolling 12-month total).

6.0 BACT for Baghouse DC-3HB

Baghouse DC-3HB controls a variety of emission points within LNA Grantsville's Hydrate System, including screw conveyors, bucket elevators, separators, and a bagger. The particulate emissions controlled by Baghouse DC-3HB are generated from the material transfer and size classification of hydrated lime. Baghouse DC-3HB is estimated to have a control efficiency of 99.25% for $PM_{2.5}$ based on the median value for the range of control efficiencies presented in EPA's CoST System for fabric filter baghouses. The potential and actual annual emissions from Baghouse DC-3HB are presented in Table 5.1 (Lhoist North America, 2017a).

6.1.1 Available Control Technology

Controls for particulate emissions ($PM_{2.5}$) are identified as follows:

Baghouse (Fabric Filter) – Pulse Jet Type
Baghouse (Fabric Filter) – Mechanical Shaker Type
Baghouse (Fabric Filter) – Reverse Air Cleaned Type
Baghouse (Fabric Filter) – Paper/Nonwoven filters – Cartridge Collector Type
Wet Electrostatic Precipitator – Wire Plate Type
Dry Electrostatic Precipitator – Wire Plate Type
Good Combustion/Management Practices

6.1.2 Evaluation of Technical Feasibility of Available Controls

All of the control practices/technologies identified in 6.1.2 above are technically feasible.

6.1.3 Evaluation and Ranking of Technically Feasible Controls

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts is as follows:

Control Practice/Technology	Percent Controlled	$/Ton $PM_{2.5}$ Removed
Baghouse – Pulse Jet	99 – 99.5%	$ 39,596
Baghouse – Mechanical Shaker	99 – 99.5%	$ 42,747
Baghouse – Reverse Air Cleaned	99 – 99.5%	$ 50,233
Baghouse – Paper/Nonwoven Filters	99 – 99.5%	$ 47,944
Wet Electrostatic Precipitator	95 – 99.5%	$ 80,429
Dry Electrostatic Precipitator	95%	$ 38,889
Good Combustion Practices	0%	No Additional Cost

6.1.4 Further Evaluation of Most Effective Controls

The top three control practices/technologies are all types of fabric filter baghouses with identical control efficiencies and similar economic impacts. Because LNA Grantsville proposes to choose a fabric filter baghouse as BACT, further evaluation of the other controls is not necessary.

6.1.5 Selection of BACT

The UDAQ proposes BACT to be a fabric filter baghouse. A pulse jet type fabric filter baghouse (i.e., Baghouse DC-3HB) is currently used to control $PM_{2.5}$ emissions from the emission points within LNA Grantsville's Hydrate System. Because the different types of fabric filter baghouses have identical control efficiencies, continued operation of Baghouse DC-3HB meets the proposed BACT.

6.1.6 Consideration of Startup and Shutdown Operations

Emission points within LNA Grantsville's Hydrate System will be exhausted through the fabric filter baghouse (i.e., Baghouse DC-3HB) during startup and shutdown. Consequently, no unique startup and shutdown provisions are necessary for Baghouse DC-3HB.

6.2 SO_2, NO_X, VOC, and NH_3

Baghouse DC-3HB does not have the potential to emit SO_2, NO_X, VOC, or NH_3. Consequently, a BACT analysis for these pollutants is not required.

6.3 Extension to Remaining Baghouses

The UDAQ has determined that only one BACT Analysis is needed for the baghouses controlling nonhydrator emission points at the LNA Grantsville facility. It is assumed that the BACT Analysis for Baghouse DC-3HB (i.e., the largest baghouse in terms of exhaust air flow rate) will also represent the BACT Analysis for the smaller baghouses (i.e., Baghouses DC-1QS, DC-2QP, DC-4LO, DC-5LO, DC-6KD, DC-8KD, and DC-10FF).

This is confirmed by reviewing the practices/technologies available to control $PM_{2.5}$ from the emission points within LNA Grantsville's Front Lime Handling System, Back Lime Handling System, Hydrate System, Bagging System, and Dust Handling System. The most effective practices/technologies are fabric filter baghouses. This is the same result produced during the full BACT Analysis for Baghouse DC-3HB presented in Section 6.0 above.

Consequently, the BACT Analysis for Baghouse DC-3HB, as presented in Section 6.0, also applies to Baghouses DC-1QS, DC-2QP, DC-4LO, DC-5LO, DC-6KD, DC-8KD, and DC-10FF. The UDAQ recommends continued operation of these baghouses to meet the proposed BACT.

7.0 BACT Analysis for the Kiln Shaft Motor

The Kiln Shaft Motor is gasoline fired and rated at 100 horsepower. It is an auxiliary unit used for backup powering of the Rotary Kiln System during outages. It does not typically run for more than 100 hours per year. The Kiln Shaft Motor has the potential to emit $PM_{2.5}$, SO_2, NO_X, and VOC emissions.

Emissions from the Kiln Shaft Motor are estimated as follows:

Pollutant	Tons Per Year
$PM_{2.5}$	0.02
SO_2,	0.01
NO_X	0.29
VOC	0.53

Emissions from the Kiln Shaft Motor represent a very small portion of the total emissions from the LNA Grantsville facility. Because of the low emission rates, limited operation, and lack of add-on controls for an engine of this size that could be retrofitted to the unit, additional analyses will not be required and has been addressed through the PM2.5 Serious SIP – BACT for Small Sources document (PM2.5 Serious SIP – BACT for Small Sources, 2017).

$PM_{2.5}$, NO_X, and VOC emissions will continue to be primarily controlled by good combustion practices to maintain a proper air to fuel ratio. SO_2 emissions are dependent on the sulfur content of the fuel. Gasoline will continue to be used in the Kiln Shaft Motor and it has a very low sulfur content.

8.0 BACT for Crushing/Screening/Conveying Processes

8.1 PM2.5

8.1.1 Available Control Technology

UDAQ agreed that it was acceptable to analyze the crusher, screen, or conveying process with the greatest uncontrolled $PM_{2.5}$ emissions and apply the results to the remaining processes. It was decided, instead, to analyze the process with the greatest uncontrolled $PM_{2.5}$ emissions in each process category (crusher, screen, and conveying process) and apply the results to the remaining processes in that category.

Identification of the crushing, screening, and conveying processes at the LNA Grantsville facility are provided as follows:

Controls for particulate emissions ($PM_{2.5}$) are identified as follows:

Baghouse (Fabric Filter) – Pulse Jet Type
Baghouse (Fabric Filter) – Mechanical Shaker Type
Baghouse (Fabric Filter) – Reverse Air Cleaned Type
Baghouse (Fabric Filter) – Paper/Nonwoven filters – Cartridge Collector Type
Wet Electrostatic Precipitator – Wire Plate Type
Dry Electrostatic Precipitator – Wire Plate Type
Wet Scrubber
Water Sprays

These processes were considered for the BACT analysis and highlights the crusher, screen, and conveying process with the highest uncontrolled potential emissions. Processes that are sealed or located in tunnels beneath stockpiles were not included in the analysis because they already achieve maximum control (assumed 99% control efficiency for the purpose of potential emission calculations).

The potential and actual annual emissions from the crusher, screen, and conveying process with the highest uncontrolled potential emissions (i.e., Crusher CP-JCrush as controlled by water sprays, Screen CP-Screen as controlled by a cover, and conveying process K-Belt/K-Screen to K-Elev1 as controlled by water sprays) are presented in Table A.2 (Lhoist North America, 2017b).

8.1.2 Evaluation of Technical Feasibility of Available Controls

All of the control practices/technologies identified in 8.1.1 above are technically feasible.

8.1.3 Evaluation and Ranking of Technically Feasible Controls

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts for the crushers are as follows:

Crusher/Control Practice/Technology	Percent Controlled	$/Ton $PM_{2.5}$ Removed
Baghouse – Pulse Jet	99 – 99.5%	$ 1,124,363
Baghouse – Mechanical Shaker	99 – 99.5%	$ 891,196
Baghouse – Reverse Air Cleaned	99 – 99.5%	$ 860,088
Baghouse – Paper/Nonwoven Filters	99 – 99.5%	$ 2,174,580
Wet Electrostatic Precipitator	95 – 99.5%	$ 3,944,297
Dry Electrostatic Precipitator	95%	$ 4,726,436
Wet Scrubber	20-90%	$ 831,123
Water Sprays*	82%	No Additional Cost

*Note: Currently being implemented at the source.

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts for the screens are as follows:

Screen Control Practice/Technology	Percent Controlled	$/Ton $PM_{2.5}$ Removed
Baghouse – Pulse Jet	99 – 99.5%	$ 1,458,706
Baghouse – Mechanical Shaker	99 – 99.5%	$ 1,055,048
Baghouse – Reverse Air Cleaned	99 – 99.5%	$ 1,019,060
Baghouse – Paper/Nonwoven Filters	99 – 99.5%	$ 3,151,954
Wet Electrostatic Precipitator	95 – 99.5%	$ 5,830,676
Dry Electrostatic Precipitator	95%	$ 4,171,220
Wet Scrubber	20-90%	$ 272,689
Water Sprays*	82%	$ *
Covers	70%	No Additional Costs

*Note: Currently being implemented at the source.

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts for the crushers are as follows:

Conveyor/Control Practice/Tech.	Percent Controlled	$/Ton $PM_{2.5}$ Removed
Baghouse – Pulse Jet	99 – 99.5%	$ 804,196
Baghouse – Mechanical Shaker	99 – 99.5%	$ 736,064
Baghouse – Reverse Air Cleaned	99 – 99.5%	$ 712,689
Baghouse – Paper/Nonwoven Filters	99 – 99.5%	$ 1,211,118
Wet Electrostatic Precipitator	95 – 99.5%	$ 2,037,880
Dry Electrostatic Precipitator	95%	$ 4,677,516
Wet Scrubber	20-90%	$ 632,881
Water Sprays*	82%	No Additional Cost
Covers	70%	Less effective than current.

Note: Currently being implemented at the source.

8.1.4 Further Evaluation of Most Effective Controls

Because uncontrolled $PM_{2.5}$ emissions from the crusher, screen, and conveying processes are low, the potential reduction in $PM_{2.5}$ emissions is also low resulting in cost effectiveness values that exceed any known agency thresholds (the highest known BACT cost effectiveness threshold for PM_{10} is from the Sacramento Metropolitan Air Quality Management District (SMAQMD) at $11,400/ton of PM_{10}). Each control practices/technology evaluated as part of this BACT analysis had a cost effectiveness value in excess of $259,000/ton of $PM_{2.5}$ reduced.

Furthermore, because emissions from the crusher, screen, and conveying processes are already controlled by either water sprays or covers, the additional reduction in $PM_{2.5}$ emissions that would be realized for a change in control technology would be insignificant compared to the cost of a new system. For instance, Crusher CP-JCrush is currently controlled by water sprays. Potential emissions from this process as currently controlled are 0.0144 tons/yr. Replacing the water spray system with a pulse-jet fabric filter would further reduce potential emissions from this process to 0.00062 tons/yr. The economic impact of installing and operating a pulse-jet fabric filter to reduce $PM_{2.5}$ emissions by an additional 0.0138 tons/yr (27.6 pounds) is unreasonable.

8.1.5 Selection of BACT

Due to the economic impacts of all other remaining control practices/technologies, the UDAQ proposes the existing controls of water sprays and covers as BACT for the crushing, screening, and conveying processes with the highest uncontrolled potential emissions. As previously explained, this conclusion extends to the remaining crushing, screening, and conveying processes at the LNA Grantsville facility that are not already sealed or located in tunnels beneath stockpiles. Continued operation of the water sprays and covers meets the proposed BACT.

8.1.6 Consideration of Startup and Shutdown Operations

The crushing, screening, and conveying processes at the LNA Grantsville facility that are not already sealed or located in tunnels beneath stockpiles will be controlled by water spray systems and covers during startup and shutdown. No additional startup and shutdown provisions are necessary.

9.0 Consideration of Ammonia

A lime plant typically does not have an ammonia source. But in the case of Lhoist Grantsville plant, if and when the plant becomes active again, SNCR is required for NO_x control. This provides the opportunity for ammonia or urea storage. The option of using ammonia or urea in the SNCR process can yield ammonia slip if over injected. Ideally, a stoichiometric amount of ammonia would be added – just enough to fully reduce the amount of NO_x present in the exhaust stream. However, some amount of ammonia will always pass through the process unreacted; and because the process possesses some degree of variability, a small amount of additional ammonia or urea would be added to account for minor fluctuations. The ammonia which passes through the process unreacted and exits in the exhaust stream is termed "slip" (sometimes "ammonia slip"). The amount varies from facility to facility, but ranges from almost zero to as high as 30 ppm in poorly controlled systems.

The unreacted ammonia can be treated as a $PM_{2.5}$ precursor.

7.1 Available Control Technology

There is only one control technique considered available for ammonia emissions. Monitoring of ammonia slip emissions and setting a "not to exceed" emission rate limitation. This allows for setting up a feedback process where the source can adjust ammonia injection rates based on both parameters: NO_x emission reduction levels and ammonia slip levels. Should catalyst activity, over time, degrade to the point where both parameters cannot be met, then the SCR catalyst should be replaced.

7.2 Evaluation of Technical Feasibility of Available Controls

This represents a work practice standard, and is inherently technically feasible.

7.3 Evaluation and Ranking of Technically Feasible Controls

A review of recently issued permits for SCR units at large combustion turbine installations reveals NH_4 emission limits ranging between 2.0 ppm and 5.0 ppm.

7.5 Selection of BACT

The UDAQ recommends a design parameter of 10 ppm as a limitation is recommended as BACT. Existing work-practice standards should suffice to minimize emissions.

9.0 Additional Feasible Measures and Most Stringent Measures

Additional Feasible Measures and Most Stringent Measures were not addressed by LNA North America

10.0 New $PM_{2.5}$ SIP – Lhoist North America – Grantsville Plant Limitations

The Lhoist North America specific conditions in Section IX.H.12.c address those limitations and requirements that apply only to the Lhoist North America – Grantsville Plant.

Lime Production Kiln

IX.H.c.i. No later than January 1, 2019, or upon source start-up, whichever comes later, SNCR technology shall be installed on the Lime Production Kiln.

a. Effective January 1, 2019, or upon source start-up, whichever comes later, NO_X emissions shall not exceed 56.25 lb/hr.

b. Compliance with the above emissions limit shall be determined by stack testing as outlined in Section IX Part H.11.e of this SIP.

IX.H.c.ii. No later than January 1, 2019, or upon source start-up, whichever comes later, a baghouse control technology shall be installed and operating on the Lime Production Kiln.

a. Effective January 1, 2019, or upon source start-up, whichever comes later, PM emissions shall not exceed 0.12 pounds per ton (lb/ton) of stone feed.

b. Effective January 1, 2019, or upon source start-up, whichever comes later, $PM_{2.5 (filterable + condensable)}$ emissions shall not exceed 1.5 lbs/ton of stone feed.

c. Compliance with the above emission limits shall be determined by stack testing as outlined in Section IX Part H.11.e of this SIP and in accordance with 40 CFR 63 Subpart AAAAA.

IX.H.c.iii. An initial compliance test is required no later than January 1, 2019 (if start-up occurs on or before January 1, 2019) or within 180 days of source start-up (if start-up occurs after January 1, 2019)

IX.H.c.iv. Upon plant start-up kiln emissions shall be exhausted through the baghouse during all startup, shutdown, and operations of the kiln.

IX.H.c.v. Start-up/shut-down provisions for SNCR technology be as follows:

a. No ammonia or urea injection during startup until the combustion gases exiting the kiln reach the temperature when NO_X reduction is effective, and

b. No ammonia or urea injection during shutdown.

c. Records of ammonia or urea injection shall be documented in an operations log. The operations log shall include all periods of start-up/shut-down and subsequent beginning and ending times of ammonia or urea injection which documents v.a and v.b above.

12.0 References

Lhoist North America – Grantsville Facility (2017a, April 5) BACT Analysis

Lhoist North America – Grantsville Facility (2017b, August 25) Supplement to Lhoist North America Grantsville Facility BACT Analysis

PM2.5 Serious SIP – BACT for Small Sources. (2017, August 11). Utah DAQ Minor Source NSR.

Additional references reviewed during UDAQ BACT research:

Summary of proposed bact technologies/emission limits, p.36, Houston American Cement, Georgia DNR;
https://epd.georgia.gov/air/sites/epd.georgia.gov.air/files/related_files/document/1530056pd.pdf

Dry Electrostatic Precipitator-Wire Plate Type, (95%) At a glance control measure document, pg. 1221, EPA CoST,
https://www3.epa.gov/ttn/ecas/docs/cost/CMDB_At_A_Glance_Report_2016-10-11.pdf

Baghouse; Permit Summary – Addition of a Kiln and Related Operations At CEMEX Facility in Clinchfield, GA;
https://www.epa.gov/sites/production/files/2015-01/documents/cement_permit_summary.pdf

Baghouse, p. 35,56,73;
https://www.adeq.state.ar.us/downloads/WebDatabases/PermitsOnline/Air/0045-AOP-R7.pdf

Nox
Low Nox Burner, (30%) At a glance control measure document, pg 365, EPA CoST
https://www3.epa.gov/ttn/ecas/docs/cost/CMDB_At_A_Glance_Report_2016-10-11.pdf

SCC, NH3 SNCR, Low Nox burner; Permit Summary – Addition of a Kiln and Related Operations At CEMEX Facility in Clinchfield, GA;
https://www.epa.gov/sites/production/files/2015-01/documents/cement_permit_summary.pdf

Proper kiln design/ops, p.35, 56, 73;
https://www.adeq.state.ar.us/downloads/WebDatabases/PermitsOnline/Air/0045-AOP-R7.pdf

Optimized combustion/combustion control, good mixing of fuel and air, Low-Nox burner, Fuel selection/low-N fuel; Reduction of nitrogen oxide emissions in lime kiln;
https://www.doria.fi/bitstream/handle/10024/102230/Reduction%20of%20nitrogen%20oxide%20emissions%20in%20lime%20kiln_doria.pdf?sequence=2

Comments on Ozone Transport Commission draft nox control measure summary for lime kilns, National Lime Assoc;
http://www.otcair.org/upload/Interest/StationaryArea%20Sources/NLA%20Comments.pdf

SO2
Inherent dry scrubbing, raw material mgmt.; Permit Summary – Addition of a Kiln and Related Operations At CEMEX Facility in Clinchfield, GA;
https://www.epa.gov/sites/production/files/2015-01/documents/cement_permit_summary.pdf

Natural dry scrubbing in kiln/bh, p.35, 56, 73;

http://www.adeq.state.ar.us/downloads/WebDatabases/permitsOnline/Air/0045-AOP-R7.pdf

VOC

Equipment design and combustion process management with good operating practices (i.e., adequate combustion temperature, residence time and excess air), and judicious selection/use of raw materials; permit Summary – Addition of a Kiln and Related Operations At CEMEX Facility in Clinchfield, GA;

https://www.epa.gov/sites/production/files/2015-01/documents/cement_permit_summary.pdf

Guidance document on control techniques for emissions of Sulphur, Nox, VOCs, dust (including PM10, PM2.5 and black carbon) from stationary sources (gen reduction info, not lime kiln specific) p.33

https://www.unece.org/fileadmin/DAM/env/documents/2012/EB/Informal_document_7_EGTEI_guidance-document_on_stationary_sources_tracked_changes_compared_with_WGSR_version.pdf

Lhoist North America – Grantsville Facility

BACT Analysis

Title V Operating Permit #4500005003

Grantsville, Utah

Prepared for:

Lhoist North America – Grantsville Facility
P.O. Box 357
Grantsville, Utah 84029
Contact: 602.321.6752

Prepared by:

Stantec Consulting Services Inc.
1553 West Elna Rae Street, Suite 101
Tempe, Arizona 85281
Contact: 480.829.0457

Submitted to:

Utah Department of Environmental Quality
Division of Air Quality, Operating Permit Section
P.O. Box 144820
Salt Lake City, Utah 84114-4820

April 5, 2017

Sign-off Sheet

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Prepared by: ______________________________
(signature)

Amber Summers

Reviewed by: ______________________________
(signature)

Mannie L. Carpenter, P.E.

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ABBREVIATIONS

BACM	Best Available Control Measure
BACT	Best Available Control Technology
BART VISTAS	Best Available Retrofit Technology – Visibility Improvement State and Tribal Association of the Southeast
CaO	Calcium Oxide
$Ca(OH)_2$	Calcium Hydroxide
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CoST	The Control Strategy Tool
CRF	Capital Recovery Factor
EC	Equipment Costs
EPA	Environmental Protection Agency
gr/dscf	Grains per Dry Standard Cubic Foot
HAP	Hazardous Air Pollutant
hr	Hour
lb/hour	Pounds per Hour
lb/ton	Pounds per Ton
lb/tsf	Pounds per Ton of Stone Feed
LNA	Lhoist North America
MMBtu	Million British Thermal Units
NH_3	Ammonia
NO	Nitrogen Oxide
NO_x	Nitrogen Oxides
PEC	Purchased Equipment Cost
PM	Particulate Matter
PM_{10}	Particulate Matter Less Than or Equal to 10 Microns in Aerodynamic Diameter
$PM_{2.5}$	Particulate Matter Less Than or Equal to 2.5 Microns in Aerodynamic Diameter

ABBREVIATIONS (cont'd)

PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
RBLC	RACT/BACT/LAER Clearinghouse
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SO_3	Sulfur Trioxide
TCI	Total Capital Investment
TDF	Tire Derived Fuel
tons/hour	Tons per Hour
tons/year	Tons per Year
tsf	Ton of Stone Feed
TSP	Total Suspended Particulate
UDAQ	Utah Division of Air Quality
VOC	Volatile Organic Compounds

1 INTRODUCTION AND BACKGROUND INFORMATION

1.1 INTRODUCTION

Lhoist North America (LNA) currently owns and operates a quarry and lime processing plant located nine miles northwest of Grantsville, Utah in accordance with Title V Operating Permit #4500005003, issued by the Utah Division of Air Quality (UDAQ) on December 30, 2015. As presented in its February 2014 Operating Permit Renewal Application, LNA Grantsville has the following potential to emit (PTE) for particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$) and $PM_{2.5}$ precursors (i.e., sulfur dioxide [SO_2], nitrogen oxides [NO_X], volatile organic compounds [VOC], and ammonia [NH_3]):

- $PM_{2.5}$ = 46.40 tons per year (tpy) (does not include all condensable emissions);
- SO_2 = 8.88 tpy;
- NO_X = 332.74 tpy;
- VOC = 6.29 tpy; and
- NH_3 = 1.52 tpy (NH_3 emissions were not presented in the renewal application).

On January 23, 2017, UDAQ sent a letter to LNA Grantsville explaining that they have begun work on a serious nonattainment control plan for $PM_{2.5}$, as required by 40 Code of Federal Regulations (CFR) 51, Subpart Z. According to the regulation, UDAQ must identify, adopt, and implement best available controls (i.e., Best Available Control Measure [BACM] or Best Available Control Technology [BACT]) on major sources of $PM_{2.5}$ and $PM_{2.5}$ precursors. The major source threshold in an area of serious nonattainment for $PM_{2.5}$ is 70 tpy for both $PM_{2.5}$ and any $PM_{2.5}$ precursors.

Because LNA Grantsville has a PTE greater than 70 tpy for NO_X, it is considered a major source. Therefore, the emission units at the LNA Grantsville facility will need to be addressed in UDAQ's serious nonattainment control plan for $PM_{2.5}$. UDAQ has requested that LNA Grantsville complete a BACT Analysis, which is to include a "detailed, written justification of each available control strategy, taking into account technological and economic feasibility, and including documentation to justify the elimination of any available controls." UDAQ specifies that the BACT Analysis also include a control technology implementation schedule and "propose appropriate limits and monitoring requirements for each emitting unit, along with a justification for the adequacy of [the] suggested measures."

This documents represents LNA Grantsville's BACT Analysis for $PM_{2.5}$ and $PM_{2.5}$ precursors.

1.2 BACKGROUND INFORMATION

1.2.1 Site and Company/Owner Name

The LNA Grantsville facility is owned and operated by Lhoist North America, previously known as Chemical Lime Company. The facility is located nine miles northwest of Grantsville, Utah in a part of Tooele County that has been designated as serious non-attainment for $PM_{2.5}$. The location of the facility is designated as attainment for particulate matter less than or equal to 10 microns in aerodynamic diameter (PM_{10}), ozone, and all other criteria pollutants.

1.2.2 General Description of the Facility

The LNA Grantsville facility consists of the Grantsville Quarry and Grantsville Lime Plant. Activities at the facility include mining, limestone processing, one rotary kiln, post-kiln lime processing, lime hydration equipment, bagging facilities, and load out facilities.

Limestone ore is mined from the Grantsville Quarry with low-grade limestone being stored near the quarry and the remaining limestone being processed through various crushing and screening operations of the Grantsville Lime Plant. During processing, limestone chat is separated out and used for quarry floor and road maintenance, reclamation, and sales. The high quality crushed limestone is sent to the rotary kiln, which heats the crushed limestone and converts it into quicklime (calcium oxide [CaO]). The quicklime can be sold as product or sent on for further processing into hydrated lime (calcium hydroxide [$Ca(OH)_2$]).

The LNA Grantsville facility produces a variety of products including quicklime, hydrate, aggregate kiln-grade limestone, overburden/low-grade limestone, and chat. Emission activities from the facility include drilling/blasting, road dust emissions (hauling), loading/unloading, crushing/screening, storage, kiln firing, hydrating, and transfer point fugitives.

1.2.3 Recent Permitting Action

The LNA Grantsville facility has been in operation since 1960. Title V Operating Permit #4500005003 was last renewed on December 30, 2015. The most recent Approval Order was issued August 14, 2006. There are no more recent permitting actions.

BACT was determined for the Rotary Kiln for total suspended particulate (TSP), PM_{10}, NO_x, and certain hazardous air pollutants (HAPs) in a historical permitting decision (Permit Conditions II.B.3.a, II.B.3.b, II.B.3.c, II.B.3.d, II.B.3.e of Title V Operating Permit #4500005003). BACT was also applied to the Pressure Hydrator for TSP and PM_{10} (Permit Conditions II.B.4.a, II.B.4.b, II.B.4.c, and II.B.4.d of Title V Operating Permit #4500005003) in the same permitting action. Similarly, opacity limits were established as BACT (Permit Conditions II.B.2.a, II.B.2.b, II.B.5.a and II.B.6.a of Title V Operating Permit #4500005003) in addition to limits on sulfur in fuel oil (Permit

Condition II.B.1.d of Title V Operating Permit #4500005003). These BACT limits pre-date the original 1995 Title V permit application.

Because the location of the LNA Grantsville facility has not been designated nonattainment for any pollutant other than $PM_{2.5}$, no previous state implementation plans (SIPs) have included the LNA Grantsville facility. Only the areas of Tooele County above 5,600 feet in elevation have historically been the subject of a SIP (for SO_2).

1.2.4 Current Operational State

Operations at the LNA Grantsville facility were placed in temporary care and maintenance mode on November 14, 2008. This means that the facility is still undergoing basic day-to-day activities such as security, plant clean-up operations, maintenance, etc. to remain in compete "ready mode," but that there is no lime being manufactured and the Rotary Kiln is not being operated (i.e., there is no fuel source being fired to keep the kiln heated). The only other operations currently ongoing at the LNA Grantsville facility is the shipping of previously stockpiled material to offsite locations.

2 IDENTIFICATION OF EMISSION UNITS REQUIRING A BACT ANALYSIS

On February 2, 2017, LNA Grantsville contacted UDAQ to receive clarification on what emission units at the facility require a BACT Analysis. John Black of UDAQ specified that a BACT Analysis is required only for the point sources at the facility. The point sources at the LNA Grantsville facility are identified in Table 2.1. Table 2.1 also identifies if the point sources emit $PM_{2.5}$ or any $PM_{2.5}$ precursors.

The following sections present the BACT Analyses completed for $PM_{2.5}$ and the $PM_{2.5}$ precursors emitted by each point source. Section 3 presents the BACT Analysis for the Rotary Kiln, as currently controlled by Electro Dry Scrubber DS1RK. Section 4 presents the BACT Analysis for the Pressure Hydrator, as currently controlled by Baghouse HBH-1HY. Section 5 presents the BACT Analysis for Baghouse DC-3HB, which currently controls the hydrate system screw conveyors, bucket elevators, separators, and hydrate bagger. As clarified by John Black, only one BACT Analysis is needed for the non-hydrator baghouses, as it can be assumed that the BACT Analysis for the largest baghouse (i.e., in terms of exhaust air flow rate) will also represent the BACT Analysis for the smaller baghouses. Consequently, the BACT Analysis for Baghouse DC-3HB, as presented in Section 5, is assumed to apply to Baghouses DC-1QS, DC-2QP, DC-4LO, DC-5LO, DC-6KD, DC-8KD, and DC-10FF. Finally, Section 6 presents the BACT Analysis for the Kiln Shaft Motor.

LNA Grantsville has limited information about the cost effectiveness and economic impacts of the various control technologies/practices identified in the BACT analyses. Consequently, the EPA Control Strategy Tool (CoST) System was primarily used to compare the cost effectiveness of the different control technologies/practices. Because the EPA CoST System presents average values for all control technologies/practices, it allows comparisons to be made on a level playing field. However, when site-specific information is available, it has been identified in the BACT analyses and should be considered in the determination of BACT.

Table 2.1 Point Sources Located at the LNA Grantsville Facility

Point Source Identification [a]	Manufacturer	Exit Air Flow Rate (acfm)	Emission Units Controlled	Identification of Pollutants Emitted				
				$PM_{2.5}$	SO_2	NO_X	VOC	NH_3
Electro Dry Scrubber DS1RK	Combustion Power Co.	29,100	Rotary Kiln (including associated processes)	Yes	Yes	Yes	Yes	Yes
Baghouse HBH-1HY	Mikropul	2,000	Pressure Hydrator (including the baghouse burner)	Yes	Yes	Yes	Yes	Yes
Baghouse DC-1QS	Mikropul	5,000	Front Lime Handling System Product Bins (FL-1Bin, FL-9Bin, FL-10Bin) and Universal Crusher (FL-Ucrush)	Yes	No	No	No	No
Baghouse DC-2QP	Mikropul	12,500	Front Lime Handling System Bins (FL-2Bin, FL-3Bin, FL-8Bin), Screens, and Belt Conveyors; Back Lime Handling System Product Bins (BL-4Bin, BL-5Bin); and Hydrate System Surge Bin (H-Sbin)	Yes	No	No	No	No
Baghouse DC-3HB	Mikropul	13,900	Hydrate System Screw Conveyors, Bucket Elevators, Separators (H-1Sprtr, H-2Sprtr), and Hydrate Bagger	Yes	No	No	No	No
Baghouse DC-4LO	DLM	550	Back Lime Handling System Loadout Rotary Screen, Rail Loadout and Screw Conveyor, and Hydrate System Bulk Loadout	Yes	No	No	No	No

Table 2.1 Point Sources Located at the LNA Grantsville Facility

Point Source Identification [a]	Manufacturer	Exit Air Flow Rate (acfm)	Emission Units Controlled	Identification of Pollutants Emitted				
				$PM_{2.5}$	SO_2	NO_x	VOC	NH_3
Baghouse DC-5LO	Mikropul	2,200	Back Lime Handling System Transfer Point to Belt Conveyor and Hydrate System Bulk Loadout Screw Conveyor	Yes	No	No	No	No
Baghouse DC-6KD	Fabri-Jet	1,000	Pneumatic Dust Transfer System Located Between Dust Bins (K-DBin1, K-DBin2)	Yes	No	No	No	No
Baghouse DC-8KD	Fuller	875	25 ton Dust Storage Bin (K-DBin2)	Yes	No	No	No	No
Baghouse DC-10FF	Not Available	3,000	Second Bagging Line Bagger (Bagger-2), 120 ton Silo (H-3Silo), Belt Conveyor (H-Belt3), and Screw Conveyor (H-Screw22)	Yes	No	No	No	No
Kiln Shaft Motor (backup power)	100 hp (gasoline)	Not Applicable	Not Applicable	Yes	Yes	Yes	Yes	No

[a] The LNA Grantsville facility includes two additional baghouses (DC-7SC and DC-9HY). Because they do not have the potential to emit air pollutants, they do not need to be addressed in this BACT Analysis.

3 BACT ANALYSIS FOR THE ROTARY KILN SYSTEM

The Rotary Kiln System was installed at the LNA Grantsville facility in 1960 and currently has a production rate limit of 100,000 tons per year on a rolling 12-month basis (i.e., Condition II.B.3.d of Title V Operating Permit #4500005003). The Rotary Kiln System consists of pre-kiln limestone handling, a preheater, a rotary kiln, and a lime cooler. Four fuels can be used in the kiln. Natural gas is available to the kiln through a 5-inch feed line. Fuel oil for the kiln is stored in a storage tank and is used on an as-needed-basis when natural gas delivery is curtailed. Fuel oil can also be used as a primary fuel. On-specification used oil is used to supplement both natural gas and fuel oil on an as-needed-basis. On-specification used oil can also be used as a primary fuel. Tire derived fuel (TDF) is also used to supplement natural gas and fuel oil on an as-needed basis; additionally, TDF is approved as a primary fuel source. Gases from used tires are generated in an external chamber and directed to the kiln firing hood for combustion.

During pre-kiln limestone handling, limestone is conveyed from a kiln-feed stockpile to a bucket elevator via a belt conveyor. Approximately 20 percent of the limestone from the kiln-feed stockpile is processed by a scalping screen prior to being discharged to the bucket elevator. The bucket elevator transfers the limestone to a stone bin, which is located on top of the kiln preheater. Stone is gravity fed from the bin through four discharge chutes which position the rock above and in front of four hydraulic rams in the preheater. The rams are used to push the limestone into the rotary kiln.

In the kiln preheater the limestone is heated by hot gases that flow countercurrent to the flow of the limestone. In the kiln, the limestone is heated to high temperatures whereby it is converted to quicklime. From the kiln the quicklime is passed through an air contact cooler where the quicklime is cooled and where kiln combustion air is preheated. The quicklime produced by the kiln is either sold to customers directly from the kiln as pebble lime, sized to customer specifications in the Front and Back Lime Handling Systems, or processed in the Hydrate System.

Particulate emissions from the Rotary Kiln System consist of fuel burning particulate emissions and dust emissions from the crushed limestone that is entrained in the exhaust stream during the firing process. The particulate emissions from the Rotary Kiln System are currently controlled by an Electro Dry Scrubber. The scrubber consists of a cyclone, which encloses a moving gravel bed, and an electro grid. The electro grid is used to charge the particles resulting in greater retention in the gravel bed. The control efficiency of the Electro Dry Scrubber for $PM_{2.5}$ is 70%. The control efficiency is based on information in AP-42, Table B.2-3 for a low efficiency electrostatic precipitator. The particle size collection efficiencies of a low efficiency electrostatic precipitator are most representative of the Electro Dry Scrubber.

The Rotary Kiln System also has the potential to emit SO_2, NO_x, VOC, and NH_3 emissions (among other pollutants). The potential and actual annual emissions from the Rotary Kiln System as controlled by the Electro Dry Scrubber are presented in Table 3.1.

Table 3.1 Annual Emissions from the Rotary Kiln System (Electro Dry Scrubber DS1RK)

Emission Category	Controlled or Uncontrolled	Annual Emissions (tons/year)				
		$PM_{2.5}$	SO_2	NO_x	VOC	NH_3
Potential Emissions	Controlled	32.56	8.85	328.50	3.00	1.39
	Uncontrolled [a]	108.54	8.85	328.50	3.00	1.39
2013 Actual Emissions	Controlled	0	0	0	0	0
	Uncontrolled [a]	0	0	0	0	0
2011 Actual Emissions	Controlled	0	0	0	0	0
	Uncontrolled [a]	0	0	0	0	0
2008 Actual Emissions [b]	Controlled	12.05	13.08	85.75	9.83	0.48
	Uncontrolled [a]	40.16	13.08	85.75	9.83	0.48
2005 Actual Emissions [c]	Controlled	7.11	2.65	31.31	1.09	Not Determined
	Uncontrolled [a]	23.69	2.65	31.31	1.09	Not Determined

[a] Uncontrolled emissions of $PM_{2.5}$ are back calculated using a control efficiency of 70%. Uncontrolled emissions of the remaining pollutants are assumed equal to controlled emissions because they are controlled only by good combustion practices and inherent sulfur contents (i.e., assumed control efficiency of 0%).

[b] Except for fuel oil combustion, $PM_{2.5}$ emissions were assumed equal to PM_{10} emissions in the submitted 2008 annual emission inventory. For consistency, this table calculates $PM_{2.5}$ emissions assuming they are 30% of the reported PM_{10} emissions in 2008. This is the same $PM_{2.5}$ to PM_{10} ratio used in LNA Grantsville's 2014 renewal application.

[c] $PM_{2.5}$ emissions were not determined in the submitted 2005 annual emission inventory. Consequently, $PM_{2.5}$ emissions have been estimated in this table assuming they are 30% of the reported PM_{10} emissions in 2005. This is the same $PM_{2.5}$ to PM_{10} ratio used in LNA Grantsville's 2014 renewal application.

3.1 $PM_{2.5}$

3.1.1 Top-Down Approach

3.1.1.1 Identification of All Available Control Technologies

The practices/technologies available to control $PM_{2.5}$ from the Rotary Kiln System are presented in Table 3.2. In order to efficiently compare a variety of control practices/technologies, the cost effectiveness values presented in Table 3.2 are average values from EPA's CoST System. However, based on experience at various LNA facilities, the costs of implementing the $PM_{2.5}$ control practices/technologies on a Rotary Kiln System are significantly greater than the average values presented in the EPA CoST System. For example, the site-specific cost effectiveness value for implementing baghouse control was determined in LNA Grantsville's previous RACT Analysis dated August 2013 to be $91,642/ton of $PM_{2.5}$ reduced. Likewise, the site-specific cost effectiveness value for implementing wet scrubber control was determined to be $71,617/ton of $PM_{2.5}$ reduced. Site-specific cost effectiveness values for the remaining $PM_{2.5}$ control practices/technologies are also expected to be significantly greater than the average values in EPA's CoST System.

3.1.1.2 Elimination of Technically Infeasible Control Options

All the control practices/technologies identified in Table 3.2 are technically feasible.

3.1.1.3 Ranking of Remaining Control Technologies

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts, is presented in Table 3.3. The economic impacts presented in Table 3.3 are based on the average cost effectiveness values from EPA's CoST System. However, as previously mentioned, the costs of implementing the $PM_{2.5}$ control practices/technologies on a Rotary Kiln System are significantly greater than the average values presented in the EPA CoST System based on experience at various LNA facilities. For example, the site-specific economic impact of implementing baghouse control was determined in LNA Grantsville's previous RACT Analysis dated August 2013 to be $996,145/year. Likewise, the site-specific economic impact for implementing wet scrubber control was determined to be $534,627/year. Site-specific economic impacts for the remaining $PM_{2.5}$ control practices/technologies are also expected to be significantly greater than the average values in EPA's CoST System.

3.1.1.4 Evaluation of Most Effective Controls

The top three control practices/technologies are all types of fabric filter baghouses with identical control efficiencies and similar economic impacts. Because LNA Grantsville proposes to choose a fabric filter baghouse as BACT, further evaluation of the other controls is not necessary.

3.1.1.5 Selection of BACT

LNA Grantsville proposes BACT to be a type of fabric filter baghouses (pulse jet, mechanical shaker, or reverse air cleaned). Due to the facility currently being in care and maintenance mode, LNA Grantsville would prefer to make a decision on the type of fabric filter baghouse at a later date. However, because of the identical control efficiencies of the different types of fabric filter baghouses, the delayed decision should not affect establishment of emission limitations and monitoring requirements.

3.1.2 Proposed Emission Limits and Monitoring Requirements

3.1.2.1 Emission Limits

Particulate matter (PM) emission limits are established in 40 CFR 63, Subpart AAAAA for lime manufacturing plants that are major sources of HAPs. The PM emission limit for new lime kilns is 0.10 pounds per ton of stone feed (lb/tsf), while the PM emission limit for existing kilns (that did not have a wet scrubber installed and operating prior to January 5, 2004) is 0.12 lb/tsf. These emission limits are for filterable PM emissions only. If LNA Grantsville was a major source of HAPs and subject to 40 CFR 63, Subpart AAAAA, the Rotary Kiln System would be considered an existing kiln.

Although LNA Grantsville is not a major source of HAPs, it is proposed to use the PM emission limit for existing kilns in 40 CFR 63, Subpart AAAAA to assist with establishing the filterable portion of a $PM_{2.5}$ emission limit. This strategy is used because the PM emission limits for lime kilns in 40 CFR 63, Subpart AAAAA are heavily reflected in the Environmental Protection Agency's (EPA's) RACT/BACT/LAER Clearinghouse (RBLC) results.

The $PM_{2.5}$ filterable fraction of emissions from LNA Grantsville's Rotary Kiln System is estimated to be 27% of PM emissions based on information for Rotary Kilns controlled by fabric filters in AP-42, Table 11.17-7. Consequently, using the PM emission limit in 40 CFR 63, Subpart AAAAA for existing lime kilns and a 27% $PM_{2.5}$ particle size distribution results in a $PM_{2.5}$ filterable emission limit of 0.0324 lb/tsf.

A condensable $PM_{2.5}$ emission limit can be estimated using results from testing performed at different LNA facilities. Because of very limited testing, the highest representative value for condensable $PM_{2.5}$ was chosen to account for variability in individual unit operation. The value of condensable $PM_{2.5}$ was prorated to the filterable PM standard in 40 CFR 63, Subpart AAAAA using corresponding filterable PM test results to yield an adjusted condensable $PM_{2.5}$ value of 1.4 lb/tsf. When added to the filterable $PM_{2.5}$ emission limit, the proposed total $PM_{2.5}$ (i.e., filterable plus condensable) emission limit becomes 1.4324 lb $PM_{2.5}$/tsf.

3.1.2.2 Monitoring Requirements

LNA Grantsville proposes monitoring to consist of performance testing requirements. An initial performance test is recommended no later than January 1, 2019 (if startup occurs on or before

January 1, 2019) or within 180 days of source startup (if startup occurs after January 1, 2019). Subsequent performance tests are recommended every three years following the initial performance test, which is based on current Condition II.B.3.b.1.(a)(1) of Title V Operating Permit #4500005003.

Test Methods 201a and 202 from 40 CFR 51, Appendix M (or other EPA approved testing methods acceptable to UDAQ) are recommended for use during performance testing. The back half condensables should be used when demonstrating compliance with the total $PM_{2.5}$ (i.e., filterable plus condensable) emission limit. If a method other than 201a is used, the portion of the front half of the catch considered $PM_{2.5}$ shall be based on information in AP-42, Table 11.17-7 or other data acceptable to UDAQ.

3.1.3 Consideration of Startup and Shutdown Operations

Emissions from the Rotary Kiln System will be exhausted through the fabric filter baghouse during startup and shutdown. Consequently, no unique startup and shutdown provisions are necessary for the fabric filter baghouse technology.

3.1.4 Control Technology Implementation Schedule

As discussed in Section 1.2.4, the LNA Grantsville facility is currently in temporary care and maintenance mode. Resumption of operations of the LNA Grantsville facility depends upon market conditions such that a certain restart date cannot be estimated at this time. Taking into consideration solicitation and selection of an engineering firm to design the fabric filter baghouse system, the design process, and construction of the fabric filter baghouse, the following implementation schedule is suggested:

- If startup occurs on or before January 1, 2019, BACT requirements will become effective on January 1, 2019; or
- If startup occurs after January 1, 2019, BACT requirements will become effective upon startup.

Table 3.2 $PM_{2.5}$ Control Technologies for the Rotary Kiln System

Control Practice/Technology	Control Efficiency [a]		Average Cost Effectiveness	
	Percent Controlled	Reference	$/Ton $PM_{2.5}$ Reduced	Reference
Fabric Filter - Pulse Jet Type	99-99.5%	EPA CoST [b] System	272.55 [d]	EPA CoST System [c]
Fabric Filter - Mechanical Shaker Type	99-99.5%	EPA CoST System	294.24 [d]	EPA CoST System [c]
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	EPA CoST System	345.77 [d]	EPA CoST System [c]
Paper/Nonwoven Filters - Cartridge Collector Type	99%	EPA CoST System	330.85	EPA CoST System [c]
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	EPA CoST System	565.00	EPA CoST System [c]
Dry Electrostatic Precipitator - Wire Plate Type	95%	EPA CoST System	279.66	EPA CoST System [c]
Electro Dry Scrubber (current control technology used at LNA Grantsville)	70%	Estimated from AP-42, Table B.2-3 for Low Efficiency Electrostatic Precipitator	Not included in the EPA CoST System	
Wet Scrubber	20-90%	AP-42, Table B.2-3 for Wet Scrubber	Not included in the EPA CoST System [d]	

Table 3.2 $PM_{2.5}$ Control Technologies for the Rotary Kiln System

Control Practice/Technology	Control Efficiency [a]		Average Cost Effectiveness	
	Percent Controlled	Reference	$/Ton $PM_{2.5}$ Reduced	Reference
Cyclone Separator	10-80%	AP-42, Table B.2-3 for Centrifugal Collector	Not included in the EPA CoST System	
Gravel Bed Filter	0%	AP-42, Table B.2-3 for Gravel Bed Filter	Not included in the EPA CoST System	
Good Combustion Practices and Burner/Process Optimization	0%	Assumed	No Additional Costs	Assumed

[a] Control efficiencies are for filterable emissions only.

[b] CoST: The Control Strategy Tool

[c] Average cost effectiveness is for Reference Year 2013.

[d] The cost effectiveness values presented in the EPA CoST system are average values. Site-specific cost effectiveness values for fabric filter baghouses and wet scrubbers are discussed in Section 2.1.3 of LNA Grantsville's previous RACT Analysis dated August 2013. A fabric filter baghouse was determined to have a site-specific cost effectiveness value of $91,642/ton of $PM_{2.5}$ reduced. A wet scrubber was determined to have a site-specific cost effectiveness value of $71,617/ton of $PM_{2.5}$ reduced. Site-specific cost effectiveness values for the remaining $PM_{2.5}$ control practices/technologies are also expected to be similarly greater than the average values in EPA's CoST System.

Table 3.3 Ranking of Remaining $PM_{2.5}$ Control Efficiencies

Control Practice/Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Fabric Filter - Pulse Jet Type	99-99.5%	0.81	107.72	29,359.73 [e]	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)
Fabric Filter - Mechanical Shaker Type	99-99.5%	0.81	107.72	31,696.23 [e]		
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	0.81	107.72	37,247.17 [e]		
Paper/Nonwoven Filters - Cartridge Collector Type	99%	1.09	107.45	35,550.18		
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	2.98	105.55	59,636.68		
Dry Electrostatic Precipitator - Wire Plate Type	95%	5.43	103.11	28,835.63		
Electro Dry Scrubber (current control technology used at LNA Grantsville)	70%	32.56	75.98	Not Determined		
Wet Scrubber	20-90%	48.84	59.70	Not Determined [e]		

Table 3.3 Ranking of Remaining $PM_{2.5}$ Control Efficiencies

Control Practice/Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Cyclone Separator	10-80%	59.70	48.84	Not Determined	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)
Gravel Bed Filter	0%	108.54	0	Not Determined		
Good Combustion Practices and Burner/Process Optimization	0%	108.54	0	No Additional Costs		

[a] Control efficiencies are for filterable emissions only.

[b] Calculated using the uncontrolled potential $PM_{2.5}$ emission rate in Table 3.1 and the expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies. The uncontrolled potential $PM_{2.5}$ emission rate in Table 3.1 includes only filterable emissions.

[c] Calculated by subtracting the expected controlled $PM_{2.5}$ emission rates from the uncontrolled potential $PM_{2.5}$ emission rate in Table 3.1.

[d] Calculated by multiplying the average cost effectiveness presented in Table 3.2 by the amount of $PM_{2.5}$ reduced per year.

[e] The economic impacts are based on cost effectiveness values presented in the EPA CoST system, which are average values. Site-specific economic impacts for fabric filter baghouses and wet scrubbers are discussed in Section 2.1.3 of LNA Grantsville's previous RACT Analysis dated August 2013. A fabric filter baghouse was determined to have a site-specific economic impact of $996,145/year. A wet scrubber was determined to have a site-specific economic impact of $534,627/year. Site-specific economic impacts for the remaining $PM_{2.5}$ control practices/technologies are also expected to be similarly greater than the average values in EPA's CoST System.

3.2 SO_2

3.2.1 Top-Down Approach

3.2.1.1 Identification of All Available Control Technologies

The practices/technologies available to control SO_2 from the Rotary Kiln System are presented in Table 3.4. For reference purposes, the cost effectiveness range for flue gas desulfurization presented in Table 3.4 is from an EPA Air Pollution Control Fact Sheet. However, based on experience at other LNA facilities, the costs of implementing flue gas desulfurization on the LNA Grantsville Rotary Kiln System would be greater than the high end of the range presented in the EPA Air Pollution Control Fact Sheet for Flue Gas Desulfurization. For example, the site-specific cost effectiveness value for implementing dry sorbent injection (i.e., a low cost type of flue gas desulfurization) on the LNA Grantsville Rotary Kiln System was determined to be approximately $80,000/ton of SO_2 reduced. Determination of the cost effectiveness value is presented in Appendix A. Because dry sorbent injection systems are known to have significantly lower capital and annual costs compared to wet systems, the cost effectiveness values for wet systems installed on the LNA Grantsville Rotary Kiln System are expected to be greater than the $80,000/ton of SO_2 determined for dry sorbent injection.

3.2.1.2 Elimination of Technically Infeasible Control Options

All the control practices/technologies identified in Table 3.4 are technically feasible.

3.2.1.3 Ranking of Remaining Control Technologies

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts, is presented in Table 3.5. The economic impact presented in Table 3.5 for flue gas desulfurization is based on the median of the cost effectiveness values presented in an EPA Air Pollution Control Fact Sheet. However, as previously mentioned, the costs of implementing dry sorbent injection (i.e., a low cost type of flue gas desulfurization) on the LNA Grantsville Rotary Kiln System would be greater than the values presented in the EPA Air Pollution Control Fact Sheet for Flue Gas Desulfurization. For example, the site-specific economic impact of implementing dry sorbent injection was determined to be approximately $495,000/year. Determination of the economic impact is presented in Appendix A. Because dry sorbent injection systems are known to have significantly lower capital and annual costs compared to wet systems, the economic impacts of wet systems installed on the LNA Grantsville Rotary Kiln System are expected to be greater than the $495,000/year determined for dry sorbent injection.

3.2.1.4 Evaluation of Most Effective Controls

SO_2 emissions from the Rotary Kiln System are mainly due to the presence of sulfur contained in the fuel used in the kiln. The sulfur combines with oxygen in the combustion air to form SO_2. A search of comparable facilities in EPA's RBLC indicates a wide variety of limitations for the sulfur content of fuel as well as sulfur emission rates. However, the most prevalent control method listed in EPA's RBLC for SO_2 emissions are fuel sulfur limitations and "inherent" sulfur control. It is well known that the alkaline properties of limestone tend to neutralize acid gases and that limestone has a scrubbing effect that reduces SO_2 emissions. Lime kilns with preheat create conditions for this scrubbing effect to occur thereby serving as an inherent control mechanism. Add-on SO_2 controls, such as flue gas desulfurization (which actually employ lime to control SO_2 emissions) have been effectively employed at sources such as coal-fired power plants which have relatively high SO_2 concentrations in the flue gas. The Rotary Kiln System at the LNA Grantsville facility does not utilize coal.

The sulfur content of the fuel used in LNA Grantsville's Rotary Kiln System varies from nearly zero for natural gas (pipeline quality) to 1.2% (by weight) for TDF. Additionally, the sulfur content of fuel oil (diesel) and on-specification used oil is limited to 0.85 lb per million British Thermal Units (MMBtu) and 0.5% (by weight), respectively, by Conditions II.B.1.d and II.B.3.e of Title V Operating Permit #4500005003. Source testing performed during pilot testing of the TDF burning system indicates that emissions of SO_2 are greatest when burning natural gas and SO_2 was not present within detection limits during any tests performed while burning TDF. It is assumed that the conditions under which tires are combusted produces highly reactive sulfur compounds that are absorbed by the lime as it comes in contact with the combustion gases.

Consequently, because it is known that the fuel burned in in LNA Grantsville's Rotary Kiln System produces SO_2 emission rates much lower than coal-fired lime kilns, the use of an add-on control device such as flue gas desulfurization would result in little added benefit due to relatively low SO_2 concentration in the flue gas stream.

3.2.1.5 Selection of BACT

Due to the economic, environmental, and energy impacts of flue gas desulfurization with only minimal reductions in SO_2 emissions, LNA Grantsville proposes good combustion practices, burner/process optimization, and inherent control as BACT.

3.2.2 Proposed Emission Limits and Monitoring Requirements

3.2.2.1 Emission Limits

Because the proposed BACT is the practice/technology currently used at the LNA Grantsville facility, it is not necessary to establish new limitations. As previously mentioned, SO_2 emissions from the Rotary Kiln System are mainly due to the presence of sulfur contained in the fuel used in the kiln. The sulfur content of diesel fuel oil and on-specification used oil is already limited by Title V Operating Permit #4500005003. Furthermore, the sulfur content of pipeline quality natural gas is limited by tariffs set forth to maintain pipeline integrity. Finally, the sulfur content of TDF is approximately 1.2% (by weight), but source testing showed SO_2 emissions are not within detection limits while burning TDF. Therefore, the existing sulfur limits in Title V Operating Permit #4500005003 along with the inherent sulfur contents of pipeline quality natural gas and TDF is sufficient to enforce the proposed BACT.

3.2.2.2 Monitoring Requirements

Monitoring requirements for the sulfur content of diesel fuel oil and on-specification used oil are already established in Conditions II.B.1.d.1 and II.B.3.e.1 of Title V Operating Permit #4500005003. Monitoring requirements for the sulfur content of pipeline quality natural gas is unnecessary since it is limited by tariffs. Because source testing showed SO_2 emissions are not within detection limits while burning TDF, it is also unnecessary to establish monitoring requirements for the sulfur content of TDF.

3.2.3 Consideration of Startup and Shutdown Operations

No unique startup and shutdown provisions are necessary for use of good combustion practices, burner/process optimization, and inherent control.

3.2.4 Control Technology Implementation Schedule

Continued use of good combustion practices, burner/process optimization, and inherent control can begin immediately upon start-up of the LNA Grantsville facility.

Table 3.4 SO_2 Control Technologies for the Rotary Kiln System

Control Practice/Technology	Control Efficiency		Average Cost Effectiveness	
	Percent Controlled	Reference	\$/Ton SO_2 Reduced	Reference
Flue Gas Desulfurization [a]	50-90%	EPA CoST System	500-5,000	EPA Air Pollution Control Fact Sheet for Flue Gas Desulfurization [b]
Good Combustion Practices, Burner/Process Optimization, Inherent Control (current control practice used at LNA Grantsville)	0%	Assumed	No Additional Costs	Assumed

[a] LNA conducted a cost effectiveness analysis for dry sorbent injection (i.e., a type of flue gas desulfurization) for kilns located at one of their other facilities that are fired by coal and petroleum coke. The cost effectiveness of dry sorbent injection on the coal/coke kilns was determined to be approximately \$5,000-\$5,500/tons of SO_2 reduced. Assuming the same equipment, installation, and operational costs (adjusted for sorbent usage), a dry sorbent injection system installed on the LNA Grantsville Rotary Kiln System would have a cost effectiveness of approximately \$80,000/tons of SO_2 reduced (see Appendix A). The higher cost effectiveness value is due to the minimal amount of SO_2 emitted by the LNA Grantsville Rotary Kiln System and therefore, the limited available reduction in SO_2 emissions. Furthermore, because dry sorbent injection systems are known to have significantly lower capital and annual costs compared to wet systems, the cost effectiveness values for wet systems installed on the LNA Grantsville Rotary Kiln System are expected to be greater than the \$80,000/ton of SO_2 determined for dry sorbent injection.

[b] Average cost effectiveness is for Reference Year 2001. Because the EPA Air Pollution Control Fact Sheet for Flue Gas Desulfurization is primarily applicable to stationary coal and oil-fired combustion units, the average cost effectiveness values are lower than what would be expected for LNA Grantsville's Rotary Kiln System, which has an uncontrolled potential to emit of only 8.85 tons/year.

Table 3.5 Ranking of Remaining SO_2 Control Efficiencies

Control Practice/Technology	Control Efficiency	Expected Controlled SO_2 Emission Rate (tons/year) [a]	Expected SO_2 Emission Reduction (tons/year) [b]	Economic Impacts ($/year) [c]	Environmental Impacts	Energy Impacts
Flue Gas Desulfurization [d]	50-90%	2.65	6.19	17,031.63	Waste disposal would be necessary	Additional electricity demand
Good Combustion Practices, Burner/Process Optimization, Inherent Control (current control practice used at LNA Grantsville)	0%	8.85	0	No Additional Costs	None	No additional energy use

[a] Calculated using the uncontrolled potential SO_2 emission rate in Table 3.1 and the expected SO_2 control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies.

[b] Calculated by subtracting the expected controlled SO_2 emission rates from the uncontrolled potential SO_2 emission rate in Table 3.1.

[c] Calculated by multiplying the average cost effectiveness presented in Table 3.4 by the amount of SO_2 reduced per year. When there is a range of cost effectiveness, economic impacts are calculated using the median of the cost effectiveness.

[d] As previously described, LNA conducted a cost effectiveness analysis for dry sorbent injection (i.e., a type of flue gas desulfurization) for coal/coke kilns located at one of their other facilities. The corresponding economic impacts of dry sorbent injection on the coal/coke kilns was determined to be approximately $3,350,000-$5,076,000/year. Assuming the same equipment, installation, and operational costs (adjusted for sorbent usage), a dry sorbent injection system installed on the LNA Grantsville Rotary Kiln System would have an economic impact of approximately $495,000/year (see Appendix A). The lower economic impact is due to the lower amount of sorbent needed to reduce the minimal amount of SO_2 emitted by the LNA Grantsville Rotary Kiln System. Because dry sorbent injection systems are known to have significantly lower capital and annual costs compared to wet systems, the economic impacts of wet systems installed on the LNA Grantsville Rotary Kiln System are expected to be greater than the $495,000/year determined for dry sorbent injection.

3.3 NO_X

3.3.1 Top-Down Approach

3.3.1.1 Identification of All Available Control Technologies

The technologies available to control NO_X from the Rotary Kiln System are presented in Table 3.6. In order to efficiently compare a variety of control practices/technologies, the cost effectiveness values presented in Table 3.6 are average values from EPA's CoST System. However, based on experience at various LNA facilities, the costs of implementing the NO_X control practices/technologies on a Rotary Kiln System are significantly greater than the average values presented in the EPA CoST System. For example, the site-specific cost effectiveness value for implementing selective non-catalytic reduction control was determined in LNA Grantsville's previous RACT Analysis dated August 2013 to be $3,977/ton of NO_X reduced. Site-specific cost effectiveness values for low NO_X burner systems and selective catalytic reduction (although determined to be infeasible for the LNA Grantsville facility) are also expected to be significantly greater than the average values in EPA's CoST System.

3.3.1.2 Elimination of Technically Infeasible Control Options

Low NO_X burner systems and selective catalytic reduction are considered technically infeasible and are discussed in more detail below. Selective non-catalytic reduction and good combustion practices/optimization are considered technically feasible.

Low NO_X Burner Systems

Low NO_X burner systems control NO_X emissions by lowering the peak burner flame temperature and staging the mixing of the fuel and combustion air. By design, low NO_X burner systems operate at lower flame temperature than conventional burners. The lower flame temperature may cause carry-over of unburned carbon into the limestone which could have adverse effects on product quality. Additionally, lowering the flame temperature can result in an increase in carbon monoxide (CO) emissions. Low NO_X burner systems require precise control of fuel/air mixture to lower the flame temperature while maintaining efficient burner operation.

UDAQ has indicated that "the EPA and UDAQ view low-NO_X burners as a control option for this activity," however, current technical documentation does not support the use of low NO_X burner systems for the type of kiln at the LNA Grantsville facility. NO_X emission reductions of up to 30% have been claimed, but these reductions cannot be universally achieved. The LNA Grantsville Rotary Kiln System is over 40 years old; is small in size; and is equipped to burn natural gas, fuel oil, used oil, and tires as fuel. The few kilns that have successfully employed low NO_X burner systems are substantially larger, newer, and typically use only one type of fuel.

The main principle of the low NO_X burner systems is stepwise or staged combustion and localized exhaust gas recirculation (i.e., at the flame). Low NO_X burner systems 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 the flame temperatures and reduce thermal NO_x formation. However, the use of low NO_x burner systems in lime kilns is not a widely used control technology, and past use of bluff body low NO_x burner systems at other LNA facilities was not successful. The burners wore out in approximately six months, impacted production, caused brick damage, and resulted in unscheduled shutdowns of the kilns. Consequently, LNA Grantsville discounts the use of bluff body low NO_x burner systems, does not have reason to believe changing the burners will reduce NO_x emissions by any specific percentage, and does not see low NO_x burner systems as proven technology for shorter, preheater rotary kilns like the LNA Grantsville Rotary Kiln System.

Installation of low NO_x burners on the LNA Grantsville Rotary Kiln System would also require extensive conversion of the fuel handling system, duct work, and burner system to accommodate the precise control required for maintaining viable burner performance and NO_x control. Additionally, the BART VISTAS program (Best Available Retrofit Technology – Visibility Improvement State and Tribal Association of the Southeast) no longer lists low NO_x burner systems as a NO_x control option for lime kilns. Furthermore, one of the energy sources for the LNA Grantsville Rotary Kiln System is from the combustion of whole tires and this process is not amenable to low NO_x burners.

LNA Grantsville reviewed recent permitting activity to achieve a better understanding of whether low NO_x burner systems had been permitted as BACT in the lime industry. LNA Grantsville conducted a search of the EPA's RBLC for lime kiln permits issued since 2003 to understand whether there were permits issued for lime kilns that required low NO_x burner systems. None of the recent permitting actions have determined low NO_x burner systems to be BACT, except the permitting action shown for the Western Lime Corporation. While the RBLC database indicates low NO_x burner systems were determined to be BACT for a Western Lime kiln, the low NO_x burner systems used by Western Lime in practice consist of a straight pipe with a bluff body. As stated above, LNA has experimented with bluff body low NO_x burner systems and was not successful.

LNA Grantsville has no data to suggest that NO_x reductions are achievable from changing to burners classified as low-NO_x burners for a kiln with the same design features as the LNA Grantsville Rotary Kiln System. EPA has indicated that a 14 percent reduction in NO_x emissions may be anticipated in switching from a direct-fired standard burner to an indirect-fired Low NO_x burner system in a Portland cement kiln (NO_x Control Technologies for the Cement Industry, EC/R Incorporated, Chapel Hill, NC, USA, U.S. EPA Contract No. 68-D98-025, U.S. EPA RTP, September 19, 2000). EPA has determined, however, that "the [emission reduction] contribution of the low-NO_x burner itself and of the firing system conversion [from direct to indirect] cannot be isolated from the limited data available." Further, Portland cement kilns are different than lime kilns and it would not be appropriate to make the generalization that an anticipated reduction in a Portland cement kiln is directly transferable to a lime kiln due to the different temperatures and operating conditions, which would be expected to impact NO_x generation rates.

Overall, because there is significant uncertainly with respect to the ability of a burner retrofit to reduce NO_x emissions, LNA Grantsville considers low NO_x burner systems to be technically infeasible.

Selective Catalytic Reduction

Selective catalytic reduction is an add-on control device utilizing an ammonia injection system in conjunction with a catalyst impregnated grid to convert NO_x into nitrogen and water via a reduction reaction on the catalyst surface. Selective catalytic reduction systems have been effectively used to control NO_x emissions on power plants and other sources and can achieve very high removal efficiencies, particularly on steady-state systems.

However, selective catalytic reduction systems must operate in a specific temperature range (typically 600°F to 750°F) to effectively remove NO_x. If the temperature is too low, the reduction reaction will not proceed to completion resulting in higher NO_x emissions and the escape of NH_3 (i.e., ammonia slip). If the temperature is too high, ammonia can be oxidized to nitrogen oxide (NO) resulting in higher NO_x emissions. The stack temperature of the lime kiln is in the range of 345°F which is too low for effective selective catalytic reduction operation. This would necessitate the installation of a heat exchanger system to raise the exhaust stream temperature to the required range of operation for a selective catalytic reduction system. Such a heat exchanger system would greatly increase the cost of installing a selective catalytic reduction system.

Additionally, there is the potential that particulate emissions would be generated from SO_2 in the exhaust stream reacting with ammonia, causing an increase in fine particulate emissions (i.e., $PM_{2.5}$) and increasing the potential for ammonium salt deposits on the catalyst, reducing efficiency. There is also the potential for SO_2 in the gas stream to react on the catalyst forming sulfur trioxide (SO_3) emissions. An EPA RBLC search for lime kilns indicates that no selective catalytic reduction systems have been installed to control NO_x emissions. In addition, Prevention of Significant Deterioration (PSD) permitting decisions have determined that selective catalytic reduction is technically infeasible for a lime kiln[1]. For these reasons, LNA Grantsville considers the installation of a selective catalytic reduction system for NO_x controls to be technically infeasible.

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[1] PSD Review of Weyerhauser - Flint River Operations Located in Macon County, Georgia. Preliminary Determination, State of Georgia DNR. March 2003. Project Summary for an Application for a Construction Permit/PSD Approval from Mississippi Lime Company for a Lime Manufacturing Plant in Prairie Du Rocher, Illinois. Illinois EPA. 2010.

3.3.1.3 Ranking of Remaining Control Technologies

The ranking of the remaining control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts, is presented in Table 3.7. The economic impact presented in Table 3.7 for selective non-catalytic reduction is based on the average cost effectiveness value from EPA's CoST System. However, as previously mentioned, the costs of implementing the NO_x control practices/technologies on a Rotary Kiln System are significantly greater than the average values presented in the EPA CoST System based on experience at various LNA facilities. For example, the site-specific economic impact of implementing selective non-catalytic reduction was determined in LNA Grantsville's previous RACT Analysis dated August 2013 to be $163,324/year. Site-specific economic impacts for low NO_x burner systems and selective catalytic reduction (although determined to be infeasible for the LNA Grantsville facility) are also expected to be significantly greater than the average values in EPA's CoST System.

3.3.1.4 Evaluation of Most Effective Controls

The top remaining control technology is selective non-catalytic reduction. Because LNA Grantsville proposes to choose selective non-catalytic reduction as BACT, further evaluation of the final control is not necessary.

3.3.1.5 Selection of BACT

LNA Grantsville proposes BACT to be selective non-catalytic reduction.

3.3.2 Proposed Emission Limits and Monitoring Requirements

3.3.2.1 Emission Limits

NO_x emissions from the Rotary Kiln System is currently limited to 75.00 pounds per hour (lb/hour) and 650.00 parts per million (ppm) per Condition II.B.3.c of Title V Operating Permit #4500005003. As presented in Table 3.6, LNA Grantsville estimates the NO_x control efficiency for selective non-catalytic reduction to be between 25-50% based on data obtained from a urea injection system operated at another LNA facility and EPA's CoST system. The lower end of the control range would be expected for the LNA Grantsville Rotary Kiln System due to the variety of fuels combusted.

Consequently, using the current NO_x emission limit of 75.00 lb/hour and a control efficiency of 25%, LNA Grantsville proposes a BACT limit of 56.25 lb/hour. Using a maximum kiln capacity of 16.5 ton/hr, the proposed BACT limit converts to 3.41 lb/ton, which is similar to other recently established BACT limits on EPA's RBLC.

3.3.2.2 Monitoring Requirements

LNA Grantsville proposes monitoring to consist of performance testing requirements. An initial performance test is recommended no later than January 1, 2019 (if startup occurs on or before January 1, 2019) or within 180 days of source startup (if startup occurs after January 1, 2019).

Subsequent performance tests are recommended every three years following the initial performance test, which is based on current Condition II.B.3.c.1.(a) of Title V Operating Permit #4500005003.

Test Method 7E from 40 CFR 60, Appendix A (or other EPA approved testing methods acceptable to UDAQ) are recommended for use during performance testing.

3.3.3 Consideration of Startup and Shutdown Operations

Selective non-catalytic reduction technology is based on a gas-phase homogeneous reaction between NO_x in the exhaust gas and either injected ammonia or urea. The reaction must occur within a specified temperature range in order to properly convert the NO_x gases into gaseous nitrogen and water vapor. The approximate temperature range where selective non-catalytic reduction is effective is 1,600 - 2,100 degrees Fahrenheit, with ammonia injection being more effective at the lower portion of this range and urea injection being more effective in the upper portion of this range.

Operation at lower temperatures results in unreacted ammonia slip, and at higher temperatures, NO_x emissions can actually be increased. The limited temperature range in which selective non-catalytic reduction is effective prohibits its use during startup until the flue gas temperatures reaches the appropriate range in which it becomes effective. Shutdown procedures include either a controlled reduction or a cessation of fuel combustion which reduces or ceases NO_x generation due to fuel combustion. Shutdown also reduces the temperature at which selective non-catalytic reduction is effective.

Consequently, startup/shutdown provisions for selective non-catalytic reduction technology is proposed to correspond to:

- No ammonia or urea injection during startup until the combustion gases exiting the kiln reach the temperature when NO_x reduction is effective; and
- No ammonia or urea injection during shutdown.

Recordkeeping requirements are proposed to be used to ensure that these provisions are enforceable. Requirements may include keeping records of ammonia or urea injection in an operations log. The operations log would need to include all periods of startup/shutdown and subsequent beginning and ending times of ammonia or urea injection.

3.3.4 Control Technology Implementation Schedule

As discussed in Section 1.2.4, the LNA Grantsville facility is currently in temporary care and maintenance mode. Resumption of operations of the LNA Grantsville facility depends upon market conditions such that a certain restart date cannot be estimated at this time. Taking into consideration solicitation and selection of an engineering firm to design the selective non-catalytic reduction system, the design process, and the construction of the selective non-catalytic reduction system, the following implementation schedule is suggested:

- If startup occurs on or before January 1, 2019, BACT requirements will become effective on January 1, 2019; or
- If startup occurs after January 1, 2019, BACT requirements will become effective upon startup.

Table 3.6 NO_x Control Technologies for the Rotary Kiln System

Control Practice/Technology	Control Efficiency		Average Cost Effectiveness	
	Percent Controlled	Reference	$/Ton NO_x Reduced	Reference
Low NO_x Burner Systems	30%	EPA CoST System	896.77	EPA CoST System [a]
Selective Catalytic Reduction	90%	EPA CoST System	2,829.98	EPA CoST System [a]
Selective Non-Catalytic Reduction	25-50%	EPA CoST System and Data from a Different LNA Facility	1,233.06 [b]	EPA CoST System [a]
Good Combustion Practices and Burner/Process Optimization (current control practice used at LNA Grantsville)	0%	Assumed	No Additional Costs	Assumed

[a] Average cost effectiveness is for Reference Year 2013.

[b] The cost effectiveness value presented in the EPA CoST system is an average value. A site-specific cost effectiveness value for selective non-catalytic reduction is discussed in Section 3.1.3 of LNA Grantsville's previous RACT Analysis dated August 2013. Selective non-catalytic reduction was determined to have a site-specific cost effectiveness value of $3,977/ton of NO_x reduced. Site-specific cost effectiveness values for low NO_x burner systems and selective catalytic reduction (although determined to be infeasible for the LNA Grantsville facility) are also expected to be similarly greater than the average values in EPA's CoST System.

Table 3.7 Ranking of Remaining NO_x Control Efficiencies

Control Practice/Technology	Control Efficiency	Expected Controlled NO_x Emission Rate (tons/year) [a]	Expected NO_x Emission Reduction (tons/year) [b]	Economic Impacts ($/year) [c]	Environmental Impacts	Energy Impacts
Selective Non-Catalytic Reduction	25-50%	205.31	123.19	151,897.58 [d]	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)
Good Combustion Practices and Burner/Process Optimization (current control practice used at LNA Grantsville)	0%	328.50	0	No Additional Costs		

[a] Calculated using the uncontrolled potential NO_x emission rate in Table 3.1 and the expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies.

[b] Calculated by subtracting the expected controlled NO_x emission rates from the uncontrolled potential NO_x emission rate in Table 3.1.

[c] Calculated by multiplying the average cost effectiveness presented in Table 3.6 by the amount of NO_x reduced per year.

[d] The economic impact is based on a cost effectiveness value presented in the EPA CoST system, which is an average value. A site-specific economic impact for selective non-catalytic reduction is discussed in Section 3.1.3 of LNA Grantsville's previous RACT Analysis dated August 2013. Selective non-catalytic reduction was determined to have a site-specific economic impact of $163,324/year. Site-specific economic impacts for low NO_x burner systems and selective catalytic reduction (although determined to be infeasible for the LNA Grantsville facility) are also expected to be similarly greater than the average values in EPA's CoST System.

3.4 VOC

3.4.1 Top-Down Approach

3.4.1.1 Identification of All Available Control Technologies

The practices/technologies available to control VOC from the Rotary Kiln System are presented in Table 3.8. A search of EPA's RBLC and other references indicate no add-on controls are available.

3.4.1.2 Elimination of Technically Infeasible Control Options

All the control practices/technologies identified in Table 3.8 are technically feasible.

3.4.1.3 Ranking of Remaining Control Technologies

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts, is presented in Table 3.9.

3.4.1.4 Evaluation of Most Effective Controls

The top (and only) control practice/technology is good combustion practices and burner/process optimization. Because LNA Grantsville proposes to choose this option as BACT, further evaluation is not necessary.

3.4.1.5 Selection of BACT

LNA Grantsville proposes BACT to be good combustion practices and burner/process optimization.

3.4.2 Proposed Emission Limits and Monitoring Requirements

3.4.2.1 Emission Limits

Because the proposed BACT of good combustion practices and burner/process optimization is currently used at the LNA Grantsville facility, emission limits are not necessary. Instead, emissions will be controlled by Condition II.B.3.d of Title V Operating Permit #4500005003, which limits the production of quicklime in the Rotary Kiln System to 12.5 tons per hour (tons/hour) (annual average) and 100,000 tons/year (rolling 12-month total).

3.4.2.2 Monitoring Requirements

Monitoring requirements for the production of quicklime are already established in Condition II.B.3.d.1 of Title V Operating Permit #4500005003. No other monitoring requirements are necessary.

3.4.3 Consideration of Startup and Shutdown Operations

No unique startup and shutdown provisions are necessary for use of good combustion practices and burner/process optimization.

3.4.4 Control Technology Implementation Schedule

Continued use of good combustion practices and burner/process optimization can begin immediately upon start-up of the LNA Grantsville facility.

Table 3.8 VOC Control Technologies for the Rotary Kiln System

Control Practice/Technology	Control Efficiency		Average Cost Effectiveness	
	Percent Controlled	Reference	$/Ton VOC Reduced	Reference
Good Combustion Practices and Burner/Process Optimization (current control practice used at LNA Grantsville)	0%	Assumed	No Additional Costs	Assumed

Table 3.9 Ranking of Remaining VOC Control Efficiencies

Control Practice/Technology	Control Efficiency	Expected Controlled VOC Emission Rate (tons/year) [a]	Expected VOC Emission Reduction (tons/year) [b]	Economic Impacts ($/year)	Environmental Impacts	Energy Impacts
Good Combustion Practices and Burner/Process Optimization (current control practice used at LNA Grantsville)	0%	3.00	0	No Additional Costs	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)

[a] Calculated using the uncontrolled potential VOC emission rate in Table 3.1 and the expected control efficiency.

[b] Calculated by subtracting the expected controlled VOC emission rate from the uncontrolled potential VOC emission rate in Table 3.1.

3.5 NH_3

3.5.1 Top-Down Approach

3.5.1.1 Identification of All Available Control Technologies

The practices/technologies available to control NH_3 from the Rotary Kiln System are presented in Table 3.10. A search of EPA's RBLC and other references indicate no add-on controls are available.

The control practices/technologies presented in Table 3.10 are reflective of NH_3 emissions resulting from the combustion of fuel (i.e., not the NH_3 emissions that may result from the use of NO_X control technology such as selective catalytic reduction or selective non-catalytic reduction). Control of NH_3 emissions due to the use of selective catalytic reduction or selective non-catalytic reduction would be achieved by temperature control and the cessation of ammonia/urea injection during startup and shutdown.

3.5.1.2 Elimination of Technically Infeasible Control Options

All the control practices/technologies identified in Table 3.10 are technically feasible.

3.5.1.3 Ranking of Remaining Control Technologies

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts, is presented in Table 3.11.

3.5.1.4 Evaluation of Most Effective Controls

The top (and only) control practice/technology is good combustion practices and burner/process optimization. Because LNA Grantsville proposes to choose this option as BACT, further evaluation is not necessary.

3.5.1.5 Selection of BACT

LNA Grantsville proposes BACT to be good combustion practices and burner/process optimization.

3.5.2 Proposed Emission Limits and Monitoring Requirements

3.5.2.1 Emission Limits

Because the proposed BACT of good combustion practices and burner/process optimization is currently used at the LNA Grantsville facility, emission limits are not necessary. Instead, emissions will be controlled by Condition II.B.3.d of Title V Operating Permit #4500005003, which limits the production of quicklime in the Rotary Kiln System to 12.5 tons/hour (annual average) and 100,000 tons/year (rolling 12-month total).

3.5.2.2 Monitoring Requirements

Monitoring requirements for the production of quicklime is already established in Condition II.B.3.d.1 of Title V Operating Permit #4500005003. No other monitoring requirements are necessary.

3.5.3 Consideration of Startup and Shutdown Operations

No unique startup and shutdown provisions are necessary for use of good combustion practices and burner/process optimization.

3.5.4 Control Technology Implementation Schedule

Continued use of good combustion practices and burner/process optimization can begin immediately upon start-up of the LNA Grantsville facility.

Table 3.10 NH_3 Control Technologies for the Rotary Kiln System

Control Practice/Technology	Control Efficiency		Average Cost Effectiveness	
	Percent Controlled	Reference	$/Ton NH_3 Reduced	Reference
Good Combustion Practices and Burner/Process Optimization (current control practice used at LNA Grantsville)	0%	Assumed	No Additional Costs	Assumed

Table 3.11 Ranking of Remaining NH_3 Control Efficiencies

Control Practice/Technology	Control Efficiency	Expected Controlled V Emission Rate (tons/year) [a]	Expected NH_3 Emission Reduction (tons/year) [b]	Economic Impacts ($/year)	Environmental Impacts	Energy Impacts
Good Combustion Practices and Burner/Process Optimization (current control practice used at LNA Grantsville)	0%	1.39	0	No Additional Costs	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)

[a] Calculated using the uncontrolled potential NH_3 emission rate in Table 3.1 and the expected control efficiency.

[b] Calculated by subtracting the expected controlled NH_3 emission rate from the uncontrolled potential NH_3 emission rates in Table 3.1.

4 BACT ANALYSIS FOR THE PRESSURE HYDRATOR

The Pressure Hydrator is used at the LNA Grantsville facility to convert quicklime into hydrated lime (i.e., calcium hydroxide). It currently has a production rate limit of 126,000 tons/year on a rolling 12-month basis (i.e., Condition II.B.4.c of Title V Operating Permit #4500005003). To begin operations, quicklime is mixed with water and pumped as a slurry into the Pressure Hydrator. Within the Pressure Hydrator, the calcium oxide component of the quicklime and water react exothermically to produce calcium hydroxide. The heat that is released converts excess water to steam which in turn raises the pressure within the Pressure Hydrator. As the pressure increases, magnesium oxide reacts with the superheated steam to form magnesium hydroxide.

Once the pressure reaches the operating range, the outlet valve of the Pressure Hydrator opens to allow the hydrated quicklime to blow out into a collector where the hydrated lime is separated from the superheated steam. The steam is vented from the top of the collector into a natural gas fired burner hot baghouse (Baghouse HBY-1HY). The natural gas burner is used on an as-needed-basis to maintain the temperature of the flue gas above the dew point to keep the steam from condensing on the bags. Any dust that is pulled into the baghouse collects on the outside of the bags where it is purged and fed back into the hydrated lime stream. The cleaned steam is pulled from Baghouse HBY-1HY by an induced draft fan and blown up a stack that is vented to the atmosphere.

Particulate emissions from the Pressure Hydrator consist of fuel burning particulate emissions and dust emissions from the hydration process. Baghouse HBY-1HY is estimated to have a control efficiency of 99.25% for $PM_{2.5}$ based on the median value for the range of control efficiencies presented in EPA's CoST System for fabric filter baghouses. The Pressure Hydrator also has the potential to emit SO_2, NO_x, VOC, and NH_3 emissions (among other pollutants) due to the associated natural gas fired, baghouse burner. The potential and actual annual emissions from the Pressure Hydrator as controlled by Baghouse HBY-1HY are presented in Table 4.1.

Table 4.1 Annual Emissions from the Pressure Hydrator (Baghouse HBH-1HY)

Emission Category	Controlled or Uncontrolled	Annual Emissions (tons/year)				
		$PM_{2.5}$	SO_2	NO_X	VOC	NH_3
Potential Emissions	Controlled	1.74	0.02	3.01	0.17	0.10
	Uncontrolled [a]	231.57	0.02	3.01	0.17	0.10
2013 Actual Emissions	Controlled	0	0	0	0	0
	Uncontrolled [a]	0	0	0	0	0
2011 Actual Emissions	Controlled	0	0	0	0	0
	Uncontrolled [a]	0	0	0	0	0
2008 Actual Emissions [b]	Controlled	0.39	0	15.15	0.83	0.48
	Uncontrolled [a]	52.19	0	15.15	0.83	0.48
2005 Actual Emissions [c]	Controlled	0.02	0.0002	0.04	0.002	Not Determined
	Uncontrolled [a]	2.85	0.0002	0.04	0.002	Not Determined

[a] Uncontrolled emissions of $PM_{2.5}$ are back calculated using a control efficiency of 99.25% (median value of the range 99-99.5%). Uncontrolled emissions of the remaining pollutants are assumed equal to controlled emissions because they are controlled only by good combustion practices and inherent sulfur contents (i.e., assumed control efficiency of 0%).

[b] $PM_{2.5}$ emissions were assumed equal to PM_{10} emissions in the submitted 2008 annual emission inventory. For consistency, this table calculates $PM_{2.5}$ emissions assuming they are 30% of the reported PM_{10} emissions in 2008. This is the same $PM_{2.5}$ to PM_{10} ratio used in LNA Grantsville's 2014 renewal application.

[c] $PM_{2.5}$ emissions were not determined in the submitted 2005 annual emission inventory. Consequently, $PM_{2.5}$ emissions have been estimated in this table assuming they are 30% of the reported PM_{10} emissions in 2005. This is the same $PM_{2.5}$ to PM_{10} ratio used in LNA Grantsville's 2014 renewal application.

4.1 $PM_{2.5}$

4.1.1 Top-Down Approach

4.1.1.1 Identification of All Available Control Technologies

The practices/technologies available to control $PM_{2.5}$ from the Pressure Hydrator are presented in Table 4.2.

4.1.1.2 Elimination of Technically Infeasible Control Options

All the control practices/technologies identified in Table 4.2 are technically feasible.

4.1.1.3 Ranking of Remaining Control Technologies

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts, is presented in Table 4.3.

4.1.1.4 Evaluation of Most Effective Controls

The top three control practices/technologies are all types of fabric filter baghouses with identical control efficiencies and similar economic impacts. Because LNA Grantsville proposes to choose a fabric filter baghouse as BACT, further evaluation of the other controls is not necessary.

4.1.1.5 Selection of BACT

LNA Grantsville proposes BACT to be a fabric filter baghouse. A pulse jet type fabric filter baghouse (i.e., Baghouse HBH-1HY) is currently used to control $PM_{2.5}$ emissions from the Pressure Hydrator. Because the different types of fabric filter baghouses have identical control efficiencies, continued operation of Baghouse HBH-1HY meets the proposed BACT.

4.1.2 Proposed Emission Limits and Monitoring Requirements

4.1.2.1 Emission Limits

Because the proposed BACT is the practice/technology currently used at the LNA Grantsville facility, it is not necessary to establish a new limitation. Additionally, PM_{10} emissions are currently limited to 1.32 pounds per hour (lb/hour) and 0.060 grains per dry standard cubic foot (gr/dscf) by Condition II.B.4.b of Title V Operating Permit #4500005003. Because $PM_{2.5}$ is a subset of PM_{10}, the existing limit in Condition II.B.4.b of Title V Operating Permit #4500005003 is sufficient to enforce the proposed BACT.

4.1.2.2 Monitoring Requirements

Monitoring requirements for the PM_{10} emission limit are already established in Condition II.B.4.b.1 of Title V Operating Permit #4500005003 and consist of performance testing every three years. No other monitoring requirements are necessary.

4.1.3 Consideration of Startup and Shutdown Operations

Emissions from the Pressure Hydrator will be exhausted through the fabric filter baghouse (i.e., Baghouse HBH-1HY) during startup and shutdown. Consequently, no unique startup and shutdown provisions are necessary for Baghouse HBH-1HY.

4.1.4 Control Technology Implementation Schedule

Continued use of Baghouse HBH-1HY can begin immediately upon start-up of the LNA Grantsville facility.

Table 4.2 $PM_{2.5}$ Control Technologies for the Pressure Hydrator

Control Practice/Technology	Control Efficiency [a]		Average Cost Effectiveness	
	Percent Controlled	Reference	$/Ton $PM_{2.5}$ Reduced	Reference
Fabric Filter - Pulse Jet Type (current control technology used at LNA Grantsville)	99-99.5%	EPA CoST System	272.55	EPA CoST System [b]
Fabric Filter - Mechanical Shaker Type	99-99.5%	EPA CoST System	294.24	EPA CoST System [b]
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	EPA CoST System	345.77	EPA CoST System [b]
Paper/Nonwoven Filters - Cartridge Collector Type	99%	EPA CoST System	330.85	EPA CoST System [b]
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	EPA CoST System	565.00	EPA CoST System [b]
Dry Electrostatic Precipitator - Wire Plate Type	95%	EPA CoST System	279.66	EPA CoST System [b]
Best Combustion/ Management Practices	0%	Assumed	No Additional Costs	Assumed

[a] Control efficiencies are for filterable emissions only.

[b] Average cost effectiveness is for Reference Year 2013.

Table 4.3 Ranking of Remaining $PM_{2.5}$ Control Efficiencies

Control Practice/Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Fabric Filter - Pulse Jet Type (current control technology used at LNA Grantsville)	99-99.5%	1.74	229.83	62,640.67	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)
Fabric Filter - Mechanical Shaker Type	99-99.5%	1.74	229.83	67,625.72		
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	1.74	229.83	79,468.95		
Paper/Nonwoven Filters - Cartridge Collector Type	99%	2.32	229.25	75,848.33		
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	6.37	225.20	127,238.26		
Dry Electrostatic Precipitator - Wire Plate Type	95%	11.58	219.99	61,522.45		
Best Combustion/ Management Practices	0%	231.57	0	No Additional Costs		

[a] Control efficiencies are for filterable emissions only.

[b] Calculated using the uncontrolled potential $PM_{2.5}$ emission rate in Table 4.1 and the expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies. The uncontrolled potential $PM_{2.5}$ emission rate in Table 4.1 includes only filterable emissions.

[c] Calculated by subtracting the expected controlled $PM_{2.5}$ emission rates from the uncontrolled potential $PM_{2.5}$ emission rate in Table 4.1.

[d] Calculated by multiplying the average cost effectiveness presented in Table 4.2 by the amount of $PM_{2.5}$ reduced per year.

4.2 SO_2, NO_X, VOC, AND NH_3

As demonstrated in Section 1.1 and Table 4.1, SO_2, NO_X, VOC, and NH_3 emissions from the Pressure Hydrator represent a very small portion of the total gaseous emissions from the LNA Grantsville facility. Consequently, additional analyses will not be performed for these pollutants. NO_X, VOC, and NH_3 emissions will continue to be primarily controlled by good combustion practices to maintain a proper air to fuel ratio. SO_2 emissions are dependent on the sulfur content of the fuel. Pipeline quality natural gas will continue to be used in the baghouse burner, as it has a very low sulfur content due to sulfur limitations set forth in tariffs to maintain pipeline integrity.

Additionally, SO_2, NO_X, VOC, and NH_3 emissions will be naturally limited by: (a) the baghouse burner only being used when necessary to maintain the temperature of the flue gas above the dew point; and (b) Condition II.B.4.c of Title V Operating Permit #4500005003, which limits the production of hydrate in the Pressure Hydrator to 126,000 tons/year (rolling 12-month total).

5 BACT ANALYSIS FOR BAGHOUSE DC-3HB

Baghouse DC-3HB controls a variety of emission points within LNA Grantsville's Hydrate System, including screw conveyors, bucket elevators, separators, and a bagger. The particulate emissions controlled by Baghouse DC-3HB are generated from the material transfer and size classification of hydrated lime. Baghouse DC-3HB is estimated to have a control efficiency of 99.25% for $PM_{2.5}$ based on the median value for the range of control efficiencies presented in EPA's CoST System for fabric filter baghouses. The potential and actual annual emissions from Baghouse DC-3HB are presented in Table 5.1.

Table 5.1 Annual Emissions from Baghouse DC-3HB

Emission Category	Controlled or Uncontrolled	Annual Emissions (tons/year)				
		$PM_{2.5}$	SO_2	NO_X	VOC	NH_3
Potential Emissions	Controlled	1.10	--	--	--	--
	Uncontrolled [a]	146.38	--	--	--	--
2013 Actual Emissions	Controlled	0	--	--	--	--
	Uncontrolled [a]	0	--	--	--	--
2011 Actual Emissions	Controlled	0	--	--	--	--
	Uncontrolled [a]	0	--	--	--	--
2008 Actual Emissions	Controlled	0.33	--	--	--	--
	Uncontrolled [a]	43.61	--	--	--	--
2005 Actual Emissions [b]	Controlled	0.04	--	--	--	--
	Uncontrolled [a]	5.45	--	--	--	--

[a] Uncontrolled emissions of $PM_{2.5}$ are back calculated using a control efficiency of 99.25% (median value of the range 99-99.5%).

[b] $PM_{2.5}$ emissions were not determined in the submitted 2005 annual emission inventory. Consequently, $PM_{2.5}$ emissions have been estimated in this table assuming they are 30% of the reported PM_{10} emissions in 2005. This is the same $PM_{2.5}$ to PM_{10} ratio used in LNA Grantsville's 2014 renewal application.

5.1 $PM_{2.5}$

5.1.1 Top-Down Approach

5.1.1.1 Identification of All Available Control Technologies

The practices/technologies available to control $PM_{2.5}$ from the emission points within LNA Grantsville's Hydrate System are presented in Table 5.2.

5.1.1.2 Elimination of Technically Infeasible Control Options

All the control practices/technologies identified in Table 5.2 are technically feasible.

5.1.1.3 Ranking of Remaining Control Technologies

The ranking of the control practices/technologies from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts, is presented in Table 5.3.

5.1.1.4 Evaluation of Most Effective Controls

The top three control practices/technologies are all types of fabric filter baghouses with identical control efficiencies and similar economic impacts. Because LNA Grantsville proposes to choose a fabric filter baghouse as BACT, further evaluation of the other controls is not necessary.

5.1.1.5 Selection of BACT

LNA Grantsville proposes BACT to be a fabric filter baghouse. A pulse jet type fabric filter baghouse (i.e., Baghouse DC-3HB) is currently used to control $PM_{2.5}$ emissions from the emission points within LNA Grantsville's Hydrate System. Because the different types of fabric filter baghouses have identical control efficiencies, continued operation of Baghouse DC-3HB meets the proposed BACT.

5.1.2 Proposed Emission Limits and Monitoring Requirements

5.1.2.1 Emission Limits

Because the proposed BACT is the practice/technology currently used at the LNA Grantsville facility, it is not necessary to establish a new limitation. Additionally, opacity from Baghouse DC-3HB is currently limited by Title V Operating Permit #4500005003. Because opacity is a surrogate for $PM_{2.5}$, the existing opacity limitation in Title V Operating Permit #4500005003 is sufficient to enforce the proposed BACT.

5.1.2.2 Monitoring Requirements

Monitoring requirements for the opacity limitation are already established in Title V Operating Permit #4500005003 and consist of visual observations every month. No other monitoring requirements are necessary.

5.1.3 Consideration of Startup and Shutdown Operations

Emission points within LNA Grantsville's Hydrate System will be exhausted through the fabric filter baghouse (i.e., Baghouse DC-3HB) during startup and shutdown. Consequently, no unique startup and shutdown provisions are necessary for Baghouse DC-3HB.

5.1.4 Control Technology Implementation Schedule

Continued use of Baghouse DC-3HB can begin immediately upon start-up of the LNA Grantsville facility.

Table 5.2 $PM_{2.5}$ Control Technologies for Baghouse DC-3HB

Control Practice/Technology	Control Efficiency [a]		Average Cost Effectiveness	
	Percent Controlled	Reference	\$/Ton $PM_{2.5}$ Reduced	Reference
Fabric Filter - Pulse Jet Type (current control technology used at LNA Grantsville)	99-99.5%	EPA CoST System	272.55	EPA CoST System [b]
Fabric Filter - Mechanical Shaker Type	99-99.5%	EPA CoST System	294.24	EPA CoST System [b]
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	EPA CoST System	345.77	EPA CoST System [b]
Paper/Nonwoven Filters - Cartridge Collector Type	99%	EPA CoST System	330.85	EPA CoST System [b]
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	EPA CoST System	565.00	EPA CoST System [b]
Dry Electrostatic Precipitator - Wire Plate Type	95%	EPA CoST System	279.66	EPA CoST System [b]
Best Combustion/ Management Practices	0%	Assumed	No Additional Costs	Assumed

[a] Control efficiencies are for filterable emissions only.

[b] Average cost effectiveness is for Reference Year 2013.

Table 5.3 Ranking of Remaining $PM_{2.5}$ Control Efficiencies

Control Practice/Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Fabric Filter - Pulse Jet Type (current control technology used at LNA Grantsville)	99-99.5%	1.10	145.28	39,596.03	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)
Fabric Filter - Mechanical Shaker Type	99-99.5%	1.10	145.28	42,747.15		
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	1.10	145.28	50,233.43		
Paper/Nonwoven Filters - Cartridge Collector Type	99%	1.46	144.91	47,944.78		
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	4.03	142.35	80,429.07		
Dry Electrostatic Precipitator - Wire Plate Type	95%	7.32	139.06	38,889.19		
Best Combustion/ Management Practices	0%	146.38	0	No Additional Costs		

[a] Control efficiencies are for filterable emissions only.

[b] Calculated using the uncontrolled potential $PM_{2.5}$ emission rate in Table 5.1 and the expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies. The uncontrolled potential $PM_{2.5}$ emission rate in Table 5.1 includes only filterable emissions.

[c] Calculated by subtracting the expected controlled $PM_{2.5}$ emission rates from the uncontrolled potential $PM_{2.5}$ emission rates in Table 5.1.

[d] Calculated by multiplying the average cost effectiveness presented in Table 5.2 by the amount of $PM_{2.5}$ reduced per year.

5.2 SO_2, NO_X, VOC, AND NH_3

Baghouse DC-3HB does not have the potential to emit SO_2, NO_X, VOC, or NH_3. Consequently, a BACT analysis for these pollutants is not required.

5.3 EXTENSION TO REMAINING BAGHOUSES

As described in Section 2, only one BACT Analysis is needed for the baghouses controlling non-hydrator emission points at the LNA Grantsville facility. It is assumed that the BACT Analysis for Baghouse DC-3HB (i.e., the largest baghouse in terms of exhaust air flow rate) will also represent the BACT Analysis for the smaller baghouses (i.e., Baghouses DC-1QS, DC-2QP, DC-4LO, DC-5LO, DC-6KD, DC-8KD, and DC-10FF).

This is confirmed by reviewing the practices/technologies available to control $PM_{2.5}$ from the emission points within LNA Grantsville's Front Lime Handling System, Back Lime Handling System, Hydrate System, Bagging System, and Dust Handling System. The most effective practices/technologies are fabric filter baghouses. This is the same result produced during the full BACT Analysis for Baghouse DC-3HB presented in Section 5.1.

Consequently, the BACT Analysis for Baghouse DC-3HB, as presented in Section 5.1, also applies to Baghouses DC-1QS, DC-2QP, DC-4LO, DC-5LO, DC-6KD, DC-8KD, and DC-10FF. The continued operation of these baghouses meets the proposed BACT.

6 BACT ANALYSIS FOR THE KILN SHAFT MOTOR

The Kiln Shaft Motor is gasoline fired and rated at 100 horsepower. It is an auxiliary unit used for backup powering of the Rotary Kiln System during outages. It does not typically run for more than 100 hours per year. The Kiln Shaft Motor has the potential to emit $PM_{2.5}$, SO_2, NO_x, and VOC emissions (among other pollutants). The potential emissions from the Kiln Shaft Motor are presented in Table 6.1 using a worst case estimate of 500 hours of operation per year. Emissions from the Kiln Shaft Motor have not been included in recent annual emission inventories.

As demonstrated in Section 1.1 and Table 6.1, $PM_{2.5}$, SO_2, NO_x, and VOC emissions from the Kiln Shaft Motor represent a very small portion of the total emissions from the LNA Grantsville facility. Because of the low emission rates, limited operation, and lack of add-on controls for an engine of this size that could be retrofitted to the unit, additional analyses will not be performed.

$PM_{2.5}$, NO_x, and VOC emissions will continue to be primarily controlled by good combustion practices to maintain a proper air to fuel ratio. SO_2 emissions are dependent on the sulfur content of the fuel. Gasoline will continue to be used in the Kiln Shaft Motor and it has a very low sulfur content.

Table 6.1 Annual Emissions from the Kiln Shaft Motor

Emission Category	Controlled or Uncontrolled	Annual Emissions (tons/year)				
		$PM_{2.5}$	SO_2	NO_x	VOC	NH_3
Potential Emissions	Controlled	0.02	0.01	0.29	0.53	--
	Uncontrolled [a]	0.02	0.01	0.29	0.53	--

[a] Uncontrolled emissions are assumed equal to controlled emissions because the Kiln Shaft Motor utilizes only good combustion practices and inherent sulfur contents to control emissions (i.e., assumed control efficiency of 0%).

APPENDIX A SITE-SPECIFIC COST EFFECTIVENESS AND ECONOMIC IMPACT CALCULATIONS FOR DRY SORBENT INJECTION

Parameter Number	Cost Parameter	Unit	Analysis for Sorbent Type A	Analysis for Sorbent Type B	Reference
Capital Costs					
1	Equipment Costs (EC)	$	1,022,500.00	1,022,500.00	Noltech Quote - May 22, 2013
2	Instrumentation	$	102,250.00	102,250.00	10% of EC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3
3	Sales Taxes	$	30,675.00	30,675.00	3% of EC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3
4	Freight	$	51,125.00	51,125.00	5% of EC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3
5	**Purchased Equipment Cost (PEC)**	**$**	**1,206,550.00**	**1,206,550.00**	**1 + 2 + 3 + 4**
6	Foundation and Supports	$	144,786.00	144,786.00	12% of PEC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3
7	Handling and Erection	$	482,620.00	482,620.00	40% of PEC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3
8	Electrical	$	--	--	Included in EC
9	Piping	$	361,965.00	361,965.00	30% of PEC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3

Parameter Number	Cost Parameter	Unit	Analysis for Sorbent Type A	Analysis for Sorbent Type B	Reference
10	Insulation for Ductwork	$	12,065.50	12,065.50	1% of PEC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3
11	Painting	$	--	--	Included in EC
12	**Direct Installation Costs**	**$**	**1,001,436.50**	**1,001,436.50**	**6 + 7 + 8 + 9 + 10 + 11**
13	Engineering	$	--	--	Included in EC
14	Construction and Field Expenses	$	120,655.00	120,655.00	10% of PEC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3
15	Contractor Fees	$	120,655.00	120,655.00	10% of PEC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3
16	Performance Test	$	12,065.50	12,065.50	1% of PEC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3
17	Contingencies	$	36,196.50	36,196.50	3% of PEC - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.3
18	**Indirect Installation Costs**	**$**	**289,572.00**	**289,572.00**	**13 + 14 + 15 + 16 + 17**
19	**Total Capital Investment (TCI)**	**$**	**2,497,558.50**	**2,497,558.50**	**5 + 12 + 18**

Parameter Number	Cost Parameter	Unit	Analysis for Sorbent Type A	Analysis for Sorbent Type B	Reference
20	Capital Recovery Factor (CRF)	--	0.09	0.09	CRF = [i x (1 + i)^a]/[(1 + i)^a - 1], where i = interest rate (7%), a = equipment life (20 years)
Annual Costs					
21	Tons of Sorbent Needed Per Ton of SO_2 Reduced	tons/ton	9	6.5	Based on testing conducted in June 2013 at LNA's Nelson Facility (9 tons/ton), Based on email from Dustex to Gideon Siringi of LNA dated 04.03.13: "We usually assume 5 pounds per pound of SO_2...", plus a 30% safety factor (6.5 tons/ton)
22	Sorbent Cost	$/ton	250	600	Estimated Price Point
23	Sorbent Transportation Cost	$/ton	260	139	Estimated Trucking Costs
24	Annual Sorbent Cost	$/year	28,427.34	29,749.61	21 * 37 * (22 + 23)
25	Annual Cost for Increased Bag Replacement (3 years vs 5 years)	$/year	60,000	60,000	LNA Estimate of $450,000/Kiln for Bags, Cages, and Labor Over a 20 Year Life
26	General O&M Labor	$/year	8,462.50	8,462.50	LNA Estimate of 0.5 hours/day for Operation and 3 hours/week for Maintenance at $25/hour

Parameter Number	Cost Parameter	Unit	Analysis for Sorbent Type A	Analysis for Sorbent Type B	Reference
27	General O&M Materials	$/year	12,693.75	12,693.75	LNA Estimate of 1.5 times Operating Labor Costs
28	Annual Power Cost	$/year	35,215.20	35,215.20	586,920 kWh/year Based on NolTech Quotation (90 hp blowers = 67 kW) at $0.06/kWh
29	**Total Direct Annual Costs**	**$/year**	**144,798.79**	**146,121.06**	**24 + 25 + 26 + 27 + 28**
30	Overhead	$/year	12,693.75	12,693.75	60% of Labor and Material Costs - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.4
31	Administrative Charges	$/year	49,951.17	49,951.17	2% of TCI - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.4
32	Property Tax	$/year	24,975.59	24,975.59	1% of TCI - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.4
33	Insurance	$/year	24,975.59	24,975.59	1% of TCI - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.4
34	Capital Recovery	$/year	235,751.85	235,751.85	TCI * CRF - EPA Air Pollution Control Cost Manual, Section 5.2, Chapter 1, Table 1.4
35	**Total Indirect Annual Costs**	**$/year**	**348,347.94**	**348,347.94**	**30 + 31 + 32 + 33 + 34**
36	**Total Annual Costs**	**$/year**	**493,146.73**	**494,469.01**	**29 + 35**

Parameter Number	Cost Parameter	Unit	Analysis for Sorbent Type A	Analysis for Sorbent Type B	Reference
37	Tons of SO_2 Reduced	tons/year	6.19	6.19	Table 3.5
38	**Control Cost in Dollars per Ton of SO_2 Reduced**	**$/ton**	**79,625.59**	**79,839.09**	**36 / 37**

Stantec Consulting Services Inc.
1553 West Elna Rae Suite 101
Tempe AZ 85281-5222
Tel: (480) 829-0457

August 25, 2017

Mr. Jon L. Black
Manager, Major New Source Review
Utah Department of Environmental Quality
Division of Air Quality
801-536-4047
jlblack@utah.gov

RE: Supplement to Lhoist North America Grantsville Facility BACT Analysis
Title V Operating Permit #4500005003

Dear Mr. Black:

In response to a letter from the Utah Division of Air Quality (UDAQ) to Lhoist North America (LNA), dated January 23, 2017, Stantec Consulting Services Inc. (Stantec) prepared a Best Available Control Technology (BACT) Analysis for the LNA Grantsville facility in support of UDAQ's serious nonattainment control plan for particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$). The BACT Analysis was submitted to UDAQ on April 6, 2017. On July 13, 2017, LNA and Stantec received an email from UDAQ requesting additional information to complete the assessment of the LNA Grantsville facility. This letter provides the information requested by the email.

1. Evaluation of ceramic/fiberglass high temperature bags for $PM_{2.5}$ emissions from the Rotary Kiln System. (vendor data preferred)

Ceramic filters are effective across a range of particle sizes, but are most often used when there is a large fraction of $PM_{2.5}$ and submicron particulates and/or high temperatures. They have the same efficiency as fabric filter bags but are designed to withstand much higher temperatures. The typical operating temperature for ceramic filters is within the range of 300 degrees Fahrenheit (°F) to 1,650°F. For applications with temperatures below 400°F, fabric filters are less costly than ceramic filters with no loss in control efficiency.

It should be noted that ceramic filters can be designed with catalyst embedded in the filter walls to provide control of both PM and nitrogen oxides (NO_X) emissions. However, ammonia/urea injection and possible temperature adjustments would still be necessary upstream of the ceramic

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filters. The operating range for NO_x removal is 350˚F to 950˚F, with the best results occurring at temperatures of 450°F and above.

In the lime manufacturing industry, the use of ceramic filters to control $PM_{2.5}$ emissions is unproven technology for kilns. There are operational unknowns including if the lime will have a coating effect on the ceramic filters and what the frequency and costs are for replacement/regeneration of the catalyst (when also controlling NO_x). Because the ceramic filters have the same control efficiency as fabric filter bags, LNA Grantsville opts to retain the conclusion of the original BACT Analysis (i.e., use of a type of fabric filter baghouse).

Fiberglass is a thermally stable fabric that can be used in fabric filter baghouses. LNA Grantsville will consider fiberglass as a type of fabric during the design of the fabric filter baghouse.

2. ***Evaluation of ceramic/fiberglass high temperature bags for the $PM_{2.5}$ emission associated with miscellaneous baghouses throughout the facility. If this option is not feasible please provide an explanation or associated cost analysis. (vendor data preferred)***

As stated above, ceramic filters have the same efficiency as fabric filter bags but are designed to withstand much higher temperatures than those observed in the non-kiln process lines at the LNA Grantsville facility. Additionally, ceramic filters must operate above the condensation temperature of water vapor or else the liquid water can inhibit the filter operation. The remaining baghouses located throughout the Grantville facility receive exhaust flow that is below the minimum 300°F typical operating temperature for ceramic filters (as mentioned above) and some processes may, at times, operate below the condensation temperature of water vapor. Furthermore, complete modification of the baghouse tube sheet would be necessary to allow for installation of the ceramic filters and the same air-to-cloth ratio may not be maintained. Due to unsuitable operating conditions, no increase in control efficiency, and necessary modification, ceramic filters are not suitable for the remaining processes currently controlled by baghouses at the LNA Grantsville facility.

The conclusion of the original BACT Analysis (i.e., use of the current fabric filter baghouses) will be retained. Due to the low temperatures of the non-kiln process lines, it is unnecessary to consider fiberglass as a type of fabric to be used in the baghouses.

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3. ***Evaluation of all crushing/screening/conveying processes. Please include evaluation of enclosures, baghouse/binvent capture devices and covered conveyors. This evaluation is necessary as these sources are not considered grandfathered under the $PM_{2.5}$ Serious Nonattainment Demonstration. (include vendor quotes where appropriate)***

UDAQ agreed that it was acceptable to analyze the crusher, screen, or conveying process with the greatest uncontrolled $PM_{2.5}$ emissions and apply the results to the remaining processes. It was decided, instead, to analyze the process with the greatest uncontrolled $PM_{2.5}$ emissions in each process category (crusher, screen, and conveying process) and apply the results to the remaining processes in that category.

Identification of the crushing, screening, and conveying processes at the LNA Grantsville facility are provided in Attachment A. Table A.1 lists only those processes that were considered for this BACT analysis and highlights the crusher, screen, and conveying process with the highest uncontrolled potential emissions. Processes that are sealed or located in tunnels beneath stockpiles were not included in the analysis because they already achieve maximum control (assumed 99% control efficiency for the purpose of potential emission calculations).

The potential and actual annual emissions from the crusher, screen, and conveying process with the highest uncontrolled potential emissions (i.e., Crusher CP-JCrush as controlled by water sprays, Screen CP-Screen as controlled by a cover, and conveying process K-Belt/K-Screen to K-Elev1 as controlled by water sprays) are presented in Table A.2.

Top-Down Approach

Identification of All Available Control Technologies

The practices/technologies available to control $PM_{2.5}$ emissions from the crusher, screen, and conveying process with the highest uncontrolled potential emissions are presented in Tables A.3 through A.5.

Elimination of Technically Infeasible Control Options

All the control practices/technologies identified in Tables A.3 through A.5 are technically feasible for the crusher, screen, and conveying process with the highest uncontrolled potential emissions. However, please note that water sprays are not an option for controlling processes following the kiln. The addition of water to lime starts a chemical reaction with the potential for combustion and destruction of the end product.

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Ranking of Remaining Control Technologies

The ranking of the control practices/technologies from top to bottom by control effectiveness is presented in Tables A.6 through A.8.

Evaluation of Most Effective Controls

Because uncontrolled $PM_{2.5}$ emissions from the crusher, screen, and conveying processes are low, the potential reduction in $PM_{2.5}$ emissions is also low resulting in cost effectiveness values that exceed any known agency thresholds (the highest known BACT cost effectiveness threshold for PM_{10} is from the Sacramento Metropolitan Air Quality Management District (SMAQMD) at $11,400/ton of PM_{10}). Each control practices/technology evaluated as part of this BACT analysis had a cost effectiveness value in excess of $259,000/ton of $PM_{2.5}$ reduced.

Furthermore, because emissions from the crusher, screen, and conveying processes are already controlled by either water sprays or covers, the additional reduction in $PM_{2.5}$ emissions that would be realized for a change in control technology would be insignificant compared to the cost of a new system. For instance, Crusher CP-JCrush is currently controlled by water sprays. Potential emissions from this process as currently controlled are 0.0144 tons/yr. Replacing the water spray system with a pulse-jet fabric filter would further reduce potential emissions from this process to 0.00062 tons/yr. The economic impact of installing and operating a pulse-jet fabric filter to reduce $PM_{2.5}$ emissions by an additional 0.0138 tons/yr (27.6 pounds) is unreasonable.

Selection of BACT

Due to the economic impacts of all other remaining control practices/technologies, LNA Grantsville proposes the existing controls of water sprays and covers as BACT for the crushing, screening, and conveying processes with the highest uncontrolled potential emissions. As previously explained, this conclusion extends to the remaining crushing, screening, and conveying processes at the LNA Grantsville facility that are not already sealed or located in tunnels beneath stockpiles. Continued operation of the water sprays and covers meets the proposed BACT.

Proposed Emission Limits

Because the proposed BACT is the practice/technology currently used at the LNA Grantsville facility, it is not necessary to establish a new limitation. Additionally, opacity from the crushers, screens, and conveying processes are currently limited by Title V Operating Permit #4500005003. Because opacity is a surrogate for $PM_{2.5}$, the existing opacity limitation in Title V Operating Permit #4500005003 is sufficient to enforce the proposed BACT.

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Proposed Monitoring Requirements

Monitoring requirements for the opacity limitation are already established in Title V Operating Permit #4500005003 and consist of visual observations every month. No other monitoring requirements are necessary.

Consideration of Startup and Shutdown Operations

The crushing, screening, and conveying processes at the LNA Grantsville facility that are not already sealed or located in tunnels beneath stockpiles will be controlled by water spray systems and covers during startup and shutdown. Consequently, no unique startup and shutdown provisions are necessary.

Control Technology Implementation Schedule

Continued use of water sprays and covers can begin immediately upon start-up of the LNA Grantsville facility.

4. ***Provide justification as to why EPA CoST Equations Document dated 2013 was used in the BACT determination versus the current version dated March 2016.***

The latest version of the Environmental Protection Agency (EPA) Control Strategy Tool (CoST) System was published on March 20, 2017 (rather than in March 2016 as stated above). Most of the work for the original BACT Analysis, including the emission reduction estimates and associated costs, was completed by March 8, 2017, at which time the 2013 version was still the current version. The final BACT Analysis wasn't submitted to UDAQ until April 6, 2017 due to the time required to prepare the draft document, complete internal and external reviews, and finalize the document.

Nevertheless, Stantec installed the March 2017 version of the EPA CoST System and the costs associated with the different control technologies/practices for the rotary kiln system, pressure hydrator, and baghouse DC-3HB were re-evaluated. Revised tables for each source in the original BACT Analysis that was previously analyzed using EPA's CoST System are provided in Attachment C. The tables provide the average cost effectiveness values for each control technology/ practice in terms of 2016 dollars. Additional revised tables provide the ranking of the control technologies/practices from top to bottom, taking into account control effectiveness, economic impacts, environmental impacts, and energy impacts. The revised analysis results in increases in the economic impacts associated with each control technology/practice with no increase in the expected emission reductions (i.e., control efficiencies remain the same). Consequently, the conclusions from the original BACT Analysis remain the same.

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The EPA CoST System contains a normalized version of the cost per ton for each control measure converted to reference year 2013. The desired cost year can be specified as an input to the strategy. The EPA CoST System, however, only includes conversion options up to cost year 2014. The cost effectiveness value for each control option was converted to the 2016 cost year by applying the same methodology used in CoST and the Gross Domestic Product: Implicit Price Deflator (GDP IPD) for 2016 available from the United States Department of Commerce Bureau of Economic Analysis.

5. ***Provide vendor data to support Appendix A "Site-Specific Cost Effectiveness and Economic Impact Calculations from Dry Sorbent Injection."***

Attachment D contains the quote for two dry sorbent injection (DSI) systems to control sulfur dioxide (SO_2) emissions from the rotary kiln systems at the LNA Nelson facility. Because the LNA Grantsville facility only has one kiln, the equipment costs provided in the original BACT Analysis for the DSI system are based on 50% of the quoted cost for the two systems at LNA Nelson facility.

Although the kilns at the LNA Nelson facility have capacities greater than the LNA Grantsville kiln (approximately 800 tons/day and 1,100 tons/day for the LNA Nelson kilns compared to approximately 260 tons/day for the LNA Grantsville kiln), the costs associated with DSI systems are not expected to be significantly dependent on capacity. Additionally, it is noted that:

- Any financial benefit provided for the purchase of two systems would not be available for the purchase of one system; and
- The equipment costs for a DSI system purchased today are anticipated to exceed the amount provided in the original BACT Analysis because the vendor quote is based on pricing available on May 22, 2013.

Furthermore, the site-specific cost effectiveness evaluation presented in Appendix A of the original BACT Analysis calculated \$/ton of SO_2 reduced assuming 6.19 tons/year of SO_2 would be reduced solely as a result of the use of a DSI system. However, the fabric filter baghouse proposed as BACT for $PM_{2.5}$ emission control (for the kiln) will also reduce SO_2 emissions a minimum of 80%. Consequently, the additional benefit of the use of a DSI system would only reduce SO_2 emissions an insignificant amount compared to the cost of installing and operating the system. If necessary, an additional cost analysis can be provided upon request to demonstrate the true cost effectiveness in \$/ton of SO_2 reduced for the DSI system.

Please feel free to contact Ed Barry of LNA (edward.barry@lhoist.com, 602-321-6752) or me if you have any questions or need any additional information.

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Sincerely,

STANTEC CONSULTING SERVICES INC.

Amber Summers
Engineering Project Specialist
Phone: (480) 829-0457 x240
amber.summers@stantec.com

Attachments:

Attachment A: BACT Evaluation Tables for Crushing/Screening/Conveying Processes
Attachment B: Cost Effectiveness Evaluation Using the EPA Cost Control Manual
Attachment C: Revised BACT Evaluation Tables for the Rotary Kiln System, Pressure Hydrator, and Baghouse DC-3HB
Attachment D: Quote for Two Dry Sorbent Injection Systems for LNA Nelson Facility

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ATTACHMENT A: BACT EVALUATION TABLES FOR THE CRUSHING/ SCREENING/CONVEYING PROCESSES

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Table A.1 Crushing, Screening, and Conveyor Processes Located at the LNA Grantsville Facility

Emission Unit Description	Type of Process	Current Control Type	$PM_{10}/PM_{2.5}$ Control Efficiency	PM_{10} Emissions (tpy)		$PM_{2.5}$ Emissions (tpy)	
				Uncontrolled	Controlled	Uncontrolled	Controlled
Limestone Processing System							
CP-JCrush	Crushing	Water Spray	82.5%	0.42	0.07	0.082	0.014
CP-JCrush to CP-Belt1	Conveying	Cover	70%	0.03	0.01	0.0052	0.0015
CP-Screen	Screening	Cover	70%	2.28	0.69	0.15	0.046
CP-Screen to CP-Belt5	Conveying	Cover	70%	0.009	0.003	0.0013	0.00039
CP-Belt 5 to CP-CBin	Conveying	Cover	70%	0.009	0.003	0.0013	0.00039
Temp Feed Hopper to Temp Tube Screw	Conveying	Cover	70%	0.04	0.01	0.0066	0.0020
CP-GCrush	Crushing	Water Spray	82.5%	0.21	0.04	0.041	0.0072
CP-GCrush to CP-Belt3	Conveying	Cover	70%	0.35	0.10	0.052	0.016
CP-Belt 3 to CP-Belt2	Conveying	Cover	70%	0.02	0.005	0.0026	0.00077
CP-Screen to CP-Belt4	Conveying	Cover	70%	0.03	0.01	0.0052	0.0015

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Table A.1 Crushing, Screening, and Conveyor Processes Located at the LNA Grantsville Facility

Emission Unit Description	Type of Process	Current Control Type	$PM_{10}/PM_{2.5}$ Control Efficiency	PM_{10} Emissions (tpy)		$PM_{2.5}$ Emissions (tpy)	
				Uncontrolled	Controlled	Uncontrolled	Controlled
Rotary Kiln System							
K-Screen	Screening	Water Spray	82.5%	0.20	0.04	0.014	0.0024
K-Screen to Dump Truck	Conveying	Cover	70%	0.02	0.007	0.0033	0.0010
K-Belt/K-Screen to K-Elev1	Conveying	Water Spray	82.5%	0.44	0.08	0.066	0.012
Back Lime Handling System							
BL-WCrush	Crushing	Cover	70%	0.52	0.16	0.030	0.0091
BL-Screen	Screening	Cover	70%	0.18	0.05	0.027	0.0081

* The process with the greatest uncontrolled $PM_{2.5}$ emissions from each category that was used for the BACT analysis is highlighted yellow.

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Table A.2 Annual $PM_{2.5}$ Emissions from Crusher CP-JCrush, Screen CP-Screen, and Conveying Process K-Belt/K-Screen to K-Elev1

Emission Category	Controlled or Uncontrolled	Annual Emissions (tons/year)		
		CP-JCrush	CP-Screen	K-Belt/K-Screen to K-Elev1
Potential Emissions	Controlled	0.014	0.046	0.012
	Uncontrolled [a]	0.082	0.15	0.066
2013 Actual Emissions	Controlled	0	0	0
	Uncontrolled [a]	0	0	0
2011 Actual Emissions	Controlled	0	0	0
	Uncontrolled [a]	0	0	0
2008 Actual Emissions	Controlled [b]	0.0068	0.015	0.0067
	Uncontrolled [a]	0.039	0.048	0.038
2005 Actual Emissions	Controlled [b]	0.0087	0.019	0.0090
	Uncontrolled [a]	0.050	0.062	0.051

[a] Uncontrolled emissions of $PM_{2.5}$ are back calculated using a control efficiency of 82.5% for CP-JCrush and K-Belt/K-Screen to K-Elev1 (i.e., the control efficiency for water sprays) and 70% for CP-Screen (i.e., the control efficiency for a cover).

[b] For consistency, 2005 and 2008 $PM_{2.5}$ emissions are calculated using the same emission factors from LNA Grantsville's 2014 renewal application.

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Table A.3 $PM_{2.5}$ Control Technologies for Crusher CP-JCrush

Control Technology	Control Efficiency [a]		Average Cost Effectiveness [b]	
	Percent Controlled	Reference	$/Ton $PM_{2.5}$ Reduced	Reference
Fabric Filter - Pulse Jet Type	99-99.5%	EPA CoST System	1,124,363	EPA Cost Control Manual
Fabric Filter - Mechanical Shaker Type	99-99.5%	EPA CoST System	891,196	EPA Cost Control Manual
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	EPA CoST System	860,088	EPA Cost Control Manual
Paper/Nonwoven Filters - Cartridge Collector Type	99%	EPA CoST System	2,174,580	EPA Cost Control Manual
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	EPA CoST System	3,944,297	EPA Cost Control Manual
Dry Electrostatic Precipitator - Wire Plate Type	95%	EPA CoST System	4,726,436	EPA Cost Control Manual
Wet Scrubber	20-90%	AP-42, Table B.2-3 for Wet Scrubber	831,123	EPA Cost Control Manual
Water Sprays (current control technology used at LNA Grantsville)	82.5%	Average value from AP-42, page 11.19.1-5 (11/95)	No Additional Costs	Assumed
Cover	70%	Assumed Value	--	Less effective than current control so no need to pursue

[a] Control efficiencies are for filterable emissions only.

[b] Average cost effectiveness is calculated using the economic impacts presented in Table A.6 and dividing by the expected $PM_{2.5}$ emission reductions presented in Table A.6.

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Table A.4 PM$_{2.5}$ Control Technologies for Screen CP-Screen

Control Technology	Control Efficiency [a]		Average Cost Effectiveness [b]	
	Percent Controlled	Reference	$/Ton PM$_{2.5}$ Reduced	Reference
Fabric Filter - Pulse Jet Type	99-99.5%	EPA CoST System	1,458,706	EPA Cost Control Manual
Fabric Filter - Mechanical Shaker Type	99-99.5%	EPA CoST System	1,055,048	EPA Cost Control Manual
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	EPA CoST System	1,019,060	EPA Cost Control Manual
Paper/Nonwoven Filters - Cartridge Collector Type	99%	EPA CoST System	3,151,954	EPA Cost Control Manual
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	EPA CoST System	5,830,676	EPA Cost Control Manual
Dry Electrostatic Precipitator - Wire Plate Type	95%	EPA CoST System	4,171,220	EPA Cost Control Manual
Wet Scrubber	20-90%	AP-42, Table B.2-3 for Wet Scrubber	272,689	EPA Cost Control Manual
Water Sprays	82.5%	Average value from AP-42, page 11.19.1-5 (11/95)	259,816	Engineering Judgement and Information from the EPA Cost Control Manual
Cover (current control technology used at LNA Grantsville)	70%	Assumed Value	No Additional Costs	Assumed

[a] Control efficiencies are for filterable emissions only.

[b] Average cost effectiveness is calculated using the economic impacts presented in Table A.7 and dividing by the expected PM$_{2.5}$ emission reductions presented in Table A.7.

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Table A.5 PM$_{2.5}$ Control Technologies for Conveyor Process K-Belt /K-Screen to K-Elev1

Control Technology	Control Efficiency [a]		Average Cost Effectiveness [b]	
	Percent Controlled	Reference	$/Ton PM$_{2.5}$ Reduced	Reference
Fabric Filter - Pulse Jet Type	99-99.5%	EPA CoST System	804,193	EPA Cost Control Manual
Fabric Filter - Mechanical Shaker Type	99-99.5%	EPA CoST System	736,064	EPA Cost Control Manual
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	EPA CoST System	712,689	EPA Cost Control Manual
Paper/Nonwoven Filters - Cartridge Collector Type	99%	EPA CoST System	1,211,118	EPA Cost Control Manual
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	EPA CoST System	2,037,880	EPA Cost Control Manual
Dry Electrostatic Precipitator - Wire Plate Type	95%	EPA CoST System	4,677,516	EPA Cost Control Manual
Wet Scrubber	20-90%	AP-42, Table B.2-3 for Wet Scrubber	632,881	EPA Cost Control Manual
Water Sprays (current control technology used at LNA Grantsville)	82.5%	Average value from AP-42, page 11.19.1-5 (11/95)	No Additional Costs	Assumed
Cover	70%	Assumed Value	--	Less effective than current control so no need to pursue

[a] Control efficiencies are for filterable emissions only.

[b] Average cost effectiveness is calculated using the economic impacts presented in Table A.8 and dividing by the expected PM$_{2.5}$ emission reductions presented in Table A.8.

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Table A.6 Ranking of Remaining $PM_{2.5}$ Control Efficiencies for Crusher CP-JCrush

Control Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Fabric Filter - Pulse Jet Type	99-99.5%	0.0006	0.082	91,900	Waste disposal may be necessary	Additional electricity demand
Fabric Filter - Mechanical Shaker Type	99-99.5%	0.0006	0.082	72,842	Waste disposal may be necessary	Additional electricity demand
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	0.0006	0.082	70,300	Waste disposal may be necessary	Additional electricity demand
Paper/Nonwoven Filters - Cartridge Collector Type	99%	0.0008	0.082	177,292	Waste disposal may be necessary	Additional electricity demand
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	0.0023	0.080	315,892	Waste disposal may be necessary	Additional electricity demand
Dry Electrostatic Precipitator - Wire Plate Type	95%	0.0041	0.078	369,774	Waste disposal may be necessary	Additional electricity demand
Wet Scrubber	20-90%	0.0082	0.074	37,608	Wastewater	Additional electricity demand

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Table A.6 Ranking of Remaining $PM_{2.5}$ Control Efficiencies for Crusher CP-JCrush

Control Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Water Sprays (current control technology used at LNA Grantsville)	82.5%	0.0144	0.068	No Additional Costs	None	No additional energy use

[a] Control efficiencies are for filterable emissions only.

[b] Calculated using the uncontrolled potential emission rates in Table A.2 and expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies except for a wet scrubber, where it is assumed that a high efficiency system (90% control) would be available.

[c] Calculated by subtracting the expected controlled $PM_{2.5}$ emission rate from the uncontrolled potential emission rates in Table A.2.

[d] Calculated using the EPA Air Pollution Cost Control Manual (see Attachment B). Values were converted from the 1998 to 2016 cost year by applying the Gross Domestic Product: Implicit Price Deflator (GDP IPD) for 2016 available from the United States Department of Commerce Bureau of Economic Analysis.

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Table A.7 Ranking of Remaining $PM_{2.5}$ Control Efficiencies for Screen CP-Screen

Control Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Fabric Filter - Pulse Jet Type	99-99.5%	0.0012	0.15	223,401	Waste disposal may be necessary	Additional electricity demand
Fabric Filter - Mechanical Shaker Type	99-99.5%	0.0012	0.15	161,581	Waste disposal may be necessary	Additional electricity demand
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	0.0012	0.15	156,069	Waste disposal may be necessary	Additional electricity demand
Paper/Nonwoven Filters - Cartridge Collector Type	99%	0.0015	0.15	481,506	Waste disposal may be necessary	Additional electricity demand
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	0.0042	0.15	874,974	Waste disposal may be necessary	Additional electricity demand
Dry Electrostatic Precipitator - Wire Plate Type	95%	0.0077	0.15	611,468	Waste disposal may be necessary	Additional electricity demand
Wet Scrubber	20-90%	0.015	0.14	37,870	Wastewater	Additional electricity demand

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Table A.7 Ranking of Remaining $PM_{2.5}$ Control Efficiencies for Screen CP-Screen

Control Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Water Sprays	82.5%	0.027	0.13	33,076	None	Additional electricity demand
Cover (current control technology used at LNA Grantsville)	70%	0.046	0.11	No Additional Costs	None	No additional energy use

[a] Control efficiencies are for filterable emissions only.

[b] Calculated using the uncontrolled potential emission rates in Table A.2 and expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies except for a wet scrubber, where it is assumed that a high efficiency system (90% control) would be available.

[c] Calculated by subtracting the expected controlled $PM_{2.5}$ emission rate from the uncontrolled potential emission rates in Table A.2.

[d] Calculated using engineering judgement and the EPA Air Pollution Cost Control Manual (see Attachment B). Values were converted from the 1998 to 2016 cost year by applying the Gross Domestic Product: Implicit Price Deflator (GDP IPD) for 2016 available from the United States Department of Commerce Bureau of Economic Analysis.

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Table A.8 Ranking of Remaining $PM_{2.5}$ Control Efficiencies for Conveyor Process K-Belt /K-Screen to K-Elev1

Control Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Fabric Filter - Pulse Jet Type	99-99.5%	0.00049	0.065	52,601	Waste disposal may be necessary	Additional electricity demand
Fabric Filter - Mechanical Shaker Type	99-99.5%	0.00049	0.065	48,145	Waste disposal may be necessary	Additional electricity demand
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	0.00049	0.065	46,616	Waste disposal may be necessary	Additional electricity demand
Paper/Nonwoven Filters - Cartridge Collector Type	99%	0.00066	0.065	79,018	Waste disposal may be necessary	Additional electricity demand
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	0.0018	0.064	130,609	Waste disposal may be necessary	Additional electricity demand
Dry Electrostatic Precipitator - Wire Plate Type	95%	0.0033	0.063	292,848	Waste disposal may be necessary	Additional electricity demand
Wet Scrubber	20-90%	0.0066	0.059	37,538	Wastewater	Additional electricity demand

Table A.8 Ranking of Remaining $PM_{2.5}$ Control Efficiencies for Conveyor Process K-Belt /K-Screen to K-Elev1

Control Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Water Sprays (current control technology used at LNA Grantsville)	82.5%	0.012	0.054	No Additional Costs	None	No additional energy use

[a] Control efficiencies are for filterable emissions only.

[b] Calculated using the uncontrolled potential emission rates in Table A.2 and expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies except for a wet scrubber, where it is assumed that a high efficiency system (90% control) would be available.

[c] Calculated by subtracting the expected controlled $PM_{2.5}$ emission rate from the uncontrolled potential emission rates in Table A.2.

[d] Calculated using the EPA Air Pollution Cost Control Manual (see Attachment B). Values were converted from the 1998 to 2016 cost year by applying the Gross Domestic Product: Implicit Price Deflator (GDP IPD) for 2016 available from the United States Department of Commerce Bureau of Economic Analysis.

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ATTACHMENT B: COST EFFECTIVENESS EVALUATION USING THE EPA COST CONTROL MANUAL

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Table B.1 Cost Effectiveness Evaluation for Controlling $PM_{2.5}$ Emissions from Crusher CP-JCrush

Cost Item	Control Option						
	Fabric Filter - Pulse Jet Type	Fabric Filter - Mechanical Shaker Type	Fabric Filter - Reverse Air Cleaned Type	Paper/ Nonwoven Filters - Cartridge Collector Type	Wet Electrostatic Precipitator - Wire Plate Type	Dry Electrostatic Precipitator - Wire Plate Type	Wet Scrubber
Purchased Equipment Costs							
Purchased Equipment (PE)	$ 192,493	$ 122,608	$ 91,204	$ 202,820	$ 713,036	$ 950,000	$ 37,438
Instrumentation (I)	$ 19,249	$ 12,261	$ 9,120	$ 20,282	$ 71,304	$ 95,000	$ 3,744
Sales Tax	$ 16,939	$ 10,790	$ 8,026	$ 17,848	$ 62,747	$ 83,600	$ 3,295
Freight	$ 21,174	$ 13,487	$ 10,032	$ 22,310	$ 78,434	$ 104,500	$ 4,118
Total Purchased Equipment Costs (TPE)	***$ 249,855***	***$ 159,145***	***$ 118,382***	***$ 263,261***	***$ 925,521***	***$ 1,233,100***	***$ 48,595***
Direct Installation Costs							
Foundations and Supports	$ 9,994	$ 6,366	$ 4,735	$ 10,530	$ 37,021	$ 49,324	$ 2,916
Handling and Erection	$ 124,928	$ 79,573	$ 59,191	$ 131,630	$ 462,761	$ 616,550	$ 19,438
Electrical	$ 19,988	$ 12,732	$ 9,471	$ 21,061	$ 74,042	$ 98,648	$ 486
Piping	$ 2,499	$ 1,591	$ 1,184	$ 2,633	$ 9,255	$ 12,331	$ 2,430
Insulation	$ 17,490	$ 11,140	$ 8,287	$ 18,428	$ 18,510	$ 24,662	$ 1,458
Painting	$ 9,994	$ 6,366	$ 4,735	$ 10,530	$ 18,510	$ 24,662	$ 486
Total Direct Installation Costs	***$ 184,893***	***$ 117,768***	***$ 87,603***	***$ 194,813***	***$ 620,099***	***$ 826,177***	***$ 27,213***
Total Direct Capital Costs (TDC)	***$ 434,748***	***$ 276,913***	***$ 205,985***	***$ 458,074***	***$ 1,545,620***	***$ 2,059,277***	***$ 75,808***
Indirect Installation Costs							
Engineering	$ 24,986	$ 15,915	$ 11,838	$ 26,326	$ 185,104	$ 246,620	$ 4,859
Construction and Field Expense	$ 49,971	$ 31,829	$ 23,676	$ 52,652	$ 185,104	$ 246,620	$ 4,859
Contractor Fees	$ 24,986	$ 15,915	$ 11,838	$ 26,326	$ 92,552	$ 123,310	$ 4,859
Start-up	$ 2,499	$ 1,591	$ 1,184	$ 2,633	$ 9,255	$ 12,331	$ 486
Performance Test	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000
Contingencies	$ 7,496	$ 4,774	$ 3,551	$ 7,898	$ 27,766	$ 36,993	$ 1,458
Total Indirect Installation Costs (TII)	***$ 115,936***	***$ 76,024***	***$ 58,088***	***$ 121,835***	***$ 505,781***	***$ 671,874***	***$ 22,522***
Total Capital Investment (TCI)	***$ 550,685***	***$ 352,937***	***$ 264,074***	***$ 579,909***	***$ 2,051,402***	***$ 2,731,151***	***$ 98,330***
Direct Annual Costs							
Operating and Supervisory Labor	$ 20,988	$ 20,988	$ 20,988	$ 20,988	$ 31,481	$ 31,481	$ 20,988
Maintenance	$ 9,125	$ 9,125	$ 9,125	$ 9,125	$ 16,930	$ 20,006	$ 9,125
Replacement Bags/Cartridges and Labor	$ 10,792	$ 10,415	$ 14,862	$ 83,874	$ -	$ -	$ -
Water	$ -	$ -	$ -	$ -	$ 105	$ -	$ 105
Electricity	$ 6,659	$ 6,659	$ 6,659	$ 6,659	$ 113,726	$ 113,724	$ 26
Compressed Air	$ 3,899	$ -	$ -	$ 19,493	$ -	$ -	$ -
Total Direct Annual Costs	***$ 51,462***	***$ 47,187***	***$ 51,634***	***$ 140,139***	***$ 162,242***	***$ 165,211***	***$ 30,243***
Indirect Annual Costs							
Capital Recovery - TCI	$ 40,438	$ 25,655	$ 18,666	$ 37,153	$ 153,650	$ 204,563	$ 7,365
Total Indirect Annual Costs	***$ 40,438***	***$ 25,655***	***$ 18,666***	***$ 37,153***	***$ 153,650***	***$ 204,563***	***$ 7,365***
Total Annual Costs	***$ 91,900***	***$ 72,842***	***$ 70,300***	***$ 177,292***	***$ 315,892***	***$ 369,774***	***$ 37,608***

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Table B.2 Cost Effectiveness Evaluation for Controlling $PM_{2.5}$ Emissions from Screen CP-Screen

Cost Item	Control Option							
	Fabric Filter - Pulse Jet Type	Fabric Filter - Mechanical Shaker Type	Fabric Filter - Reverse Air Cleaned Type	Paper/ Nonwoven Filters - Cartridge Collector Type	Wet Electrostatic Precipitator - Wire Plate Type	Dry Electrostatic Precipitator - Wire Plate Type	Wet Scrubber	Water Spray System
Purchased Equipment Costs								
Purchased Equipment (PE)	$ 530,962	$ 298,432	$ 215,129	$ 589,742	$ 2,105,155	$ 950,000	$ 37,438	$ 15,000
Instrumentation (I)	$ 53,096	$ 29,843	$ 21,513	$ 58,974	$ 210,515	$ 95,000	$ 3,744	$ 1,500
Sales Tax	$ 46,725	$ 26,262	$ 18,931	$ 51,897	$ 185,254	$ 83,600	$ 3,295	$ 1,320
Freight	$ 58,406	$ 32,827	$ 23,664	$ 64,872	$ 231,567	$ 104,500	$ 4,118	$ 1,650
Total Purchased Equipment Costs (TPE)	***$ 689,189***	***$ 387,364***	***$ 279,237***	***$ 765,485***	***$ 2,732,491***	***$ 1,233,100***	***$ 48,595***	***$ 19,470***
Direct Installation Costs								
Foundations and Supports	$ 27,568	$ 15,495	$ 11,169	$ 30,619	$ 109,300	$ 49,324	$ 2,916	$ -
Handling and Erection	$ 344,595	$ 193,682	$ 139,619	$ 382,742	$ 1,366,246	$ 616,550	$ 19,438	$ -
Electrical	$ 55,135	$ 30,989	$ 22,339	$ 61,239	$ 218,599	$ 98,648	$ 486	$ 195
Piping	$ 6,892	$ 3,874	$ 2,792	$ 7,655	$ 27,325	$ 12,331	$ 2,430	$ 974
Insulation	$ 48,243	$ 27,116	$ 19,547	$ 53,584	$ 54,650	$ 24,662	$ 1,458	$ 584
Painting	$ 27,568	$ 15,495	$ 11,169	$ 30,619	$ 54,650	$ 24,662	$ 486	$ -
Total Direct Installation Costs	***$ 510,000***	***$ 286,650***	***$ 206,635***	***$ 566,459***	***$ 1,830,769***	***$ 826,177***	***$ 27,213***	***$ 1,752***
Total Direct Capital Costs (TDC)	***$ 1,199,189***	***$ 674,014***	***$ 485,872***	***$ 1,331,943***	***$ 4,563,260***	***$ 2,059,277***	***$ 75,808***	***$ 21,222***
Indirect Installation Costs								
Engineering	$ 68,919	$ 38,736	$ 27,924	$ 76,548	$ 546,498	$ 246,620	$ 4,859	$ 1,947
Construction and Field Expense	$ 137,838	$ 77,473	$ 55,847	$ 153,097	$ 546,498	$ 246,620	$ 4,859	$ 3,894
Contractor Fees	$ 68,919	$ 38,736	$ 27,924	$ 76,548	$ 273,249	$ 123,310	$ 4,859	$ 1,947
Start-up	$ 6,892	$ 3,874	$ 2,792	$ 7,655	$ 27,325	$ 12,331	$ 486	$ 195
Performance Test	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ -
Contingencies	$ 20,676	$ 11,621	$ 8,377	$ 22,965	$ 81,975	$ 36,993	$ 1,458	$ 584
Total Indirect Installation Costs (TII)	***$ 309,243***	***$ 176,440***	***$ 128,864***	***$ 342,813***	***$ 1,481,545***	***$ 671,874***	***$ 22,522***	***$ 8,567***
Total Capital Investment (TCI)	***$ 1,508,433***	***$ 850,454***	***$ 614,737***	***$ 1,674,757***	***$ 6,044,805***	***$ 2,731,151***	***$ 98,330***	***$ 29,789***
Direct Annual Costs								
Operating and Supervisory Labor	$ 20,988	$ 20,988	$ 20,988	$ 20,988	$ 31,481	$ 31,481	$ 20,988	$ 20,988
Maintenance	$ 9,125	$ 9,125	$ 9,125	$ 9,125	$ 34,999	$ 20,006	$ 9,125	$ 9,125
Replacement Bags/Cartridges and Labor	$ 31,861	$ 30,750	$ 43,877	$ 247,629	$ -	$ -	$ -	$ -
Water	$ -	$ -	$ -	$ -	$ 315	$ -	$ 315	$ 526
Electricity	$ 39,322	$ 39,322	$ 39,322	$ 39,322	$ 355,422	$ 355,418	$ 77	$ 206
Compressed Air	$ 11,510	$ -	$ -	$ 57,551	$ -	$ -	$ -	$ -
Total Direct Annual Costs	***$ 112,806***	***$ 100,185***	***$ 113,312***	***$ 374,614***	***$ 422,218***	***$ 406,905***	***$ 30,505***	***$ 30,844***
Indirect Annual Costs								
Capital Recovery - TCI	$ 110,595	$ 61,396	$ 42,757	$ 106,892	$ 452,756	$ 204,563	$ 7,365	$ 2,231
Total Indirect Annual Costs	***$ 110,595***	***$ 61,396***	***$ 42,757***	***$ 106,892***	***$ 452,756***	***$ 204,563***	***$ 7,365***	***$ 2,231***
Total Annual Costs	***$ 223,401***	***$ 161,581***	***$ 156,069***	***$ 481,506***	***$ 874,974***	***$ 611,468***	***$ 37,870***	***$ 33,076***

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Table B.3 Cost Effectiveness Evaluation for Controlling $PM_{2.5}$ Emissions from Conveyor Process K-Belt/K-Screen to K-Elev1

Cost Item	Control Option						
	Fabric Filter - Pulse Jet Type	Fabric Filter - Mechanical Shaker Type	Fabric Filter - Reverse Air Cleaned Type	Paper/ Nonwoven Filters - Cartridge Collector Type	Wet Electrostatic Precipitator - Wire Plate Type	Dry Electrostatic Precipitator - Wire Plate Type	Wet Scrubber
Purchased Equipment Costs							
Purchased Equipment (PE)	$ 76,918	$ 62,571	$ 48,888	$ 70,701	$ 237,679	$ 950,000	$ 37,438
Instrumentation (I)	$ 7,692	$ 6,257	$ 4,889	$ 7,070	$ 23,768	$ 95,000	$ 3,744
Sales Tax	$ 6,769	$ 5,506	$ 4,302	$ 6,222	$ 20,916	$ 83,600	$ 3,295
Freight	$ 8,461	$ 6,883	$ 5,378	$ 7,777	$ 26,145	$ 104,500	$ 4,118
Total Purchased Equipment Costs (TPE)	***$ 99,839***	***$ 81,217***	***$ 63,457***	***$ 91,770***	***$ 308,507***	***$ 1,233,100***	***$ 48,595***
Direct Installation Costs							
Foundations and Supports	$ 3,994	$ 3,249	$ 2,538	$ 3,671	$ 12,340	$ 49,324	$ 2,916
Handling and Erection	$ 49,919	$ 40,608	$ 31,728	$ 45,885	$ 154,254	$ 616,550	$ 19,438
Electrical	$ 7,987	$ 6,497	$ 5,077	$ 7,342	$ 24,681	$ 98,648	$ 486
Piping	$ 998	$ 812	$ 635	$ 918	$ 3,085	$ 12,331	$ 2,430
Insulation	$ 6,989	$ 5,685	$ 4,442	$ 6,424	$ 6,170	$ 24,662	$ 1,458
Painting	$ 3,994	$ 3,249	$ 2,538	$ 3,671	$ 6,170	$ 24,662	$ 486
Total Direct Installation Costs	***$ 73,881***	***$ 60,100***	***$ 46,958***	***$ 67,910***	***$ 206,700***	***$ 826,177***	***$ 27,213***
Total Direct Capital Costs (TDC)	***$ 173,720***	***$ 141,317***	***$ 110,414***	***$ 159,679***	***$ 515,207***	***$ 2,059,277***	***$ 75,808***
Indirect Installation Costs							
Engineering	$ 9,984	$ 8,122	$ 6,346	$ 9,177	$ 61,701	$ 246,620	$ 4,859
Construction and Field Expense	$ 19,968	$ 16,243	$ 12,691	$ 18,354	$ 61,701	$ 246,620	$ 4,859
Contractor Fees	$ 9,984	$ 8,122	$ 6,346	$ 9,177	$ 30,851	$ 123,310	$ 4,859
Start-up	$ 998	$ 812	$ 635	$ 918	$ 3,085	$ 12,331	$ 486
Performance Test	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000
Contingencies	$ 2,995	$ 2,437	$ 1,904	$ 2,753	$ 9,255	$ 36,993	$ 1,458
Total Indirect Installation Costs (TII)	***$ 49,929***	***$ 41,735***	***$ 33,921***	***$ 46,379***	***$ 172,594***	***$ 671,874***	***$ 22,522***
Total Capital Investment (TCI)	***$ 223,649***	***$ 183,053***	***$ 144,335***	***$ 206,058***	***$ 687,801***	***$ 2,731,151***	***$ 98,330***
Direct Annual Costs							
Operating and Supervisory Labor	$ 20,988	$ 20,988	$ 20,988	$ 20,988	$ 31,481	$ 31,481	$ 20,988
Maintenance	$ 9,125	$ 9,125	$ 9,125	$ 9,125	$ 10,760	$ 20,006	$ 9,125
Replacement Bags/Cartridges and Labor	$ 3,597	$ 3,472	$ 4,954	$ 27,958	$ -	$ -	$ -
Water	$ -	$ -	$ -	$ -	$ 53	$ -	$ 53
Electricity	$ 1,110	$ 1,110	$ 1,110	$ 1,110	$ 36,799	$ 36,798	$ 8
Compressed Air	$ 1,300	$ -	$ -	$ 6,498	$ -	$ -	$ -
Total Direct Annual Costs	***$ 36,119***	***$ 34,694***	***$ 36,176***	***$ 65,678***	***$ 79,092***	***$ 88,285***	***$ 30,173***
Indirect Annual Costs							
Capital Recovery - TCI	$ 16,482	$ 13,451	$ 10,440	$ 13,340	$ 51,516	$ 204,563	$ 7,365
Total Indirect Annual Costs	***$ 16,482***	***$ 13,451***	***$ 10,440***	***$ 13,340***	***$ 51,516***	***$ 204,563***	***$ 7,365***
Total Annual Costs	***$ 52,601***	***$ 48,145***	***$ 46,616***	***$ 79,018***	***$ 130,609***	***$ 292,848***	***$ 37,538***

ATTACHMENT C: REVISED BACT EVALUATION TABLES FOR THE ROTARY KILN SYSTEM, PRESSURE HYDRATOR, AND BAGHOUSE DC-3HB

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Revised Table 3.2 $PM_{2.5}$ Control Technologies for the Rotary Kiln System

Control Practice/Technology	Control Efficiency [a]		Average Cost Effectiveness	
	Percent Controlled	Reference	\$/Ton $PM_{2.5}$ Reduced	Reference
Fabric Filter - Pulse Jet Type	99-99.5%	EPA CoST [b] System	283.95 [d]	EPA CoST System [c]
Fabric Filter - Mechanical Shaker Type	99-99.5%	EPA CoST System	306.55 [d]	EPA CoST System [c]
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	EPA CoST System	360.23 [d]	EPA CoST System [c]
Paper/Nonwoven Filters - Cartridge Collector Type	99%	EPA CoST System	344.68	EPA CoST System [c]
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	EPA CoST System	588.61	EPA CoST System [c]
Dry Electrostatic Precipitator - Wire Plate Type	95%	EPA CoST System	291.35	EPA CoST System [c]
Electro Dry Scrubber (current control technology used at LNA Grantsville)	70%	Estimated from AP-42, Table B.2-3 for Low Efficiency Electrostatic Precipitator	Not included in the EPA CoST System	
Wet Scrubber	20-90%	AP-42, Table B.2-3 for Wet Scrubber	Not included in the EPA CoST System [d]	
Cyclone Separator	10-80%	AP-42, Table B.2-3 for Centrifugal Collector	Not included in the EPA CoST System	

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Revised Table 3.2 $PM_{2.5}$ Control Technologies for the Rotary Kiln System

Control Practice/Technology	Control Efficiency [a]		Average Cost Effectiveness	
	Percent Controlled	Reference	$/Ton $PM_{2.5}$ Reduced	Reference
Gravel Bed Filter	0%	AP-42, Table B.2-3 for Gravel Bed Filter	Not included in the EPA CoST System	
Good Combustion Practices and Burner/Process Optimization	0%	Assumed	No Additional Costs	Assumed

[a] Control efficiencies are for filterable emissions only.

[b] CoST: The Control Strategy Tool

[c] Average cost effectiveness provided by CoST is for Reference Year 2013. The cost effectiveness value was converted to the 2016 cost year by applying the same methodology used in CoST and the Gross Domestic Product: Implicit Price Deflator (GDP IPD) for 2016 available from the United States Department of Commerce Bureau of Economic Analysis.

[d] The cost effectiveness values presented in the EPA CoST system are average values. Site-specific cost effectiveness values for fabric filter baghouses and wet scrubbers are discussed in Section 2.1.3 of LNA Grantsville's previous RACT Analysis dated August 2013. A fabric filter baghouse was determined to have a site-specific cost effectiveness value of $91,642/ton of $PM_{2.5}$ reduced. A wet scrubber was determined to have a site-specific cost effectiveness value of $71,617/ton of $PM_{2.5}$ reduced. Site-specific cost effectiveness values for the remaining $PM_{2.5}$ control practices/technologies are also expected to be similarly greater than the average values in EPA's CoST System.

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Revised Table 3.3 Ranking of Remaining $PM_{2.5}$ Control Efficiencies

Control Practice/Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Fabric Filter - Pulse Jet Type	99-99.5%	0.81	107.72	30,587.25 [e]	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)
Fabric Filter - Mechanical Shaker Type	99-99.5%	0.81	107.72	33,021.79 [e]		
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	0.81	107.72	38,804.54 [e]		
Paper/Nonwoven Filters - Cartridge Collector Type	99%	1.09	107.45	37,036.35		
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	2.98	105.55	62,129.28		
Dry Electrostatic Precipitator - Wire Plate Type	95%	5.43	103.11	30,041.34		
Electro Dry Scrubber (current control technology used at LNA Grantsville)	70%	32.56	75.98	Not Determined		
Wet Scrubber	20-90%	48.84	59.70	Not Determined [e]		

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Revised Table 3.3 Ranking of Remaining $PM_{2.5}$ Control Efficiencies

Control Practice/Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Cyclone Separator	10-80%	59.70	48.84	Not Determined	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)
Gravel Bed Filter	0%	108.54	0	Not Determined		
Good Combustion Practices and Burner/Process Optimization	0%	108.54	0	No Additional Costs		

[a] Control efficiencies are for filterable emissions only.

[b] Calculated using the uncontrolled potential $PM_{2.5}$ emission rate in Table 3.1 and the expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies. The uncontrolled potential $PM_{2.5}$ emission rate in Table 3.1 includes only filterable emissions.

[c] Calculated by subtracting the expected controlled $PM_{2.5}$ emission rates from the uncontrolled potential $PM_{2.5}$ emission rate in Table 3.1.

[d] Calculated by multiplying the average cost effectiveness presented in Revised Table 3.2 by the amount of $PM_{2.5}$ reduced per year.

[e] The economic impacts are based on cost effectiveness values presented in the EPA CoST system, which are average values. Site-specific economic impacts for fabric filter baghouses and wet scrubbers are discussed in Section 2.1.3 of LNA Grantsville's previous RACT Analysis dated August 2013. A fabric filter baghouse was determined to have a site-specific economic impact of $996,145/year. A wet scrubber was determined to have a site-specific economic impact of $534,627/year. Site-specific economic impacts for the remaining $PM_{2.5}$ control practices/technologies are also expected to be similarly greater than the average values in EPA's CoST System.

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Revised Table 3.4 SO_2 Control Technologies for the Rotary Kiln System

Control Practice/Technology	Control Efficiency		Average Cost Effectiveness	
	Percent Controlled	Reference	\$/Ton SO_2 Reduced	Reference
Flue Gas Desulfurization [a]	50-90%	EPA CoST System	665-6,651	EPA Air Pollution Control Fact Sheet for Flue Gas Desulfurization [b]
Good Combustion Practices, Burner/Process Optimization, Inherent Control (current control practice used at LNA Grantsville)	0%	Assumed	No Additional Costs	Assumed

[a] LNA conducted a cost effectiveness analysis for dry sorbent injection (i.e., a type of flue gas desulfurization) for kilns located at one of their other facilities that are fired by coal and petroleum coke. The cost effectiveness of dry sorbent injection on the coal/coke kilns was determined to be approximately \$5,000-\$5,500/tons of SO_2 reduced. Assuming the same equipment, installation, and operational costs (adjusted for sorbent usage), a dry sorbent injection system installed on the LNA Grantsville Rotary Kiln System would have a cost effectiveness of approximately \$80,000/tons of SO_2 reduced (see Appendix A). The higher cost effectiveness value is due to the minimal amount of SO_2 emitted by the LNA Grantsville Rotary Kiln System and, therefore, the limited available reduction in SO_2 emissions. Furthermore, because dry sorbent injection systems are known to have significantly lower capital and annual costs compared to wet systems, the cost effectiveness values for wet systems installed on the LNA Grantsville Rotary Kiln System are expected to be greater than the \$80,000/ton of SO_2 determined for dry sorbent injection.

[b] Average cost effectiveness value presented in the EPA Air Pollution Control Fact Sheet for Flue Gas Desulfurization is for Reference Year 2001. The cost effectiveness value was converted to the 2016 cost year by applying the Gross Domestic Product: Implicit Price Deflator (GDP IPD) for 2016 available from the United States Department of Commerce Bureau of Economic Analysis. Because the EPA Air Pollution Control Fact Sheet for Flue Gas Desulfurization is primarily applicable to stationary coal and oil-fired combustion units, the average cost effectiveness values are lower than what would be expected for LNA Grantsville's Rotary Kiln System, which has an uncontrolled potential to emit of only 8.85 tons/year.

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Revised Table 3.5 Ranking of Remaining SO_2 Control Efficiencies

Control Practice/Technology	Control Efficiency	Expected Controlled SO_2 Emission Rate (tons/year) [a]	Expected SO_2 Emission Reduction (tons/year) [b]	Economic Impacts ($/year) [c]	Environmental Impacts	Energy Impacts
Flue Gas Desulfurization [d]	50-90%	2.65	6.19	22,655.16	Waste disposal would be necessary	Additional electricity demand
Good Combustion Practices, Burner/Process Optimization, Inherent Control (current control practice used at LNA Grantsville)	0%	8.85	0	No Additional Costs	None	No additional energy use

[a] Calculated using the uncontrolled potential SO_2 emission rate in Table 3.1 and the expected SO_2 control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies.

[b] Calculated by subtracting the expected controlled SO_2 emission rates from the uncontrolled potential SO_2 emission rate in Table 3.1.

[c] Calculated by multiplying the average cost effectiveness presented in Revised Table 3.4 by the amount of SO_2 reduced per year. When there is a range of cost effectiveness, economic impacts are calculated using the median of the cost effectiveness.

[d] As previously described, LNA conducted a cost effectiveness analysis for dry sorbent injection (i.e., a type of flue gas desulfurization) for coal/coke kilns located at one of their other facilities. The corresponding economic impacts of dry sorbent injection on the coal/coke kilns was determined to be approximately $3,350,000-$5,076,000/year. Assuming the same equipment, installation, and operational costs (adjusted for sorbent usage), a dry sorbent injection system installed on the LNA Grantsville Rotary Kiln System would have an economic impact of approximately $495,000/year (see Appendix A). The lower economic impact is due to the lower amount of sorbent needed to reduce the minimal amount of SO_2 emitted by the LNA Grantsville Rotary Kiln System. Because dry sorbent injection systems are known to have significantly lower capital and annual costs compared to wet systems, the economic impacts of wet systems installed on the LNA Grantsville Rotary Kiln System are expected to be greater than the $495,000/year determined for dry sorbent injection.

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Revised Table 3.6 NOx Control Technologies for the Rotary Kiln System

Control Practice/Technology	Control Efficiency		Average Cost Effectiveness	
	Percent Controlled	Reference	\$/Ton NO_x Reduced	Reference
Low NO_x Burner Systems [c]	30%	EPA CoST System	934.27	EPA CoST System [a]
Selective Catalytic Reduction [c]	90%	EPA CoST System	2,948.30	EPA CoST System [a]
Selective Non-Catalytic Reduction	25-50%	EPA CoST System and Data from a Different LNA Facility	1,284.61 [b]	EPA CoST System [a]
Good Combustion Practices and Burner/Process Optimization (current control practice used at LNA Grantsville)	0%	Assumed	No Additional Costs	Assumed

[a] Average cost effectiveness provided by CoST is for Reference Year 2013. The cost effectiveness value was converted to the 2016 cost year by applying the same methodology used in CoST and the Gross Domestic Product: Implicit Price Deflator (GDP IPD) for 2016 available from the United States Department of Commerce Bureau of Economic Analysis.

[b] The cost effectiveness value presented in the EPA CoST system is an average value. A site-specific cost effectiveness value for selective non-catalytic reduction is discussed in Section 3.1.3 of LNA Grantsville's previous RACT Analysis dated August 2013. Selective non-catalytic reduction was determined to have a site-specific cost effectiveness value of \$3,977/ton of NO_x reduced. Site-specific cost effectiveness values for low NO_x burner systems and selective catalytic reduction (although determined to be infeasible for the LNA Grantsville facility) are also expected to be similarly greater than the average values in EPA's CoST System.

[c] Determined in the original BACT Analysis to be technically infeasible.

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Revised Table 3.7 Ranking of Remaining NO_x Control Efficiencies

Control Practice/Technology	Control Efficiency	Expected Controlled NO_x Emission Rate (tons/year) [a]	Expected NO_x Emission Reduction (tons/year) [b]	Economic Impacts ($/year) [c]	Environmental Impacts	Energy Impacts
Selective Non-Catalytic Reduction	25-50%	205.31	123.19	158,248.47 [d]	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)
Good Combustion Practices and Burner/Process Optimization (current control practice used at LNA Grantsville)	0%	328.50	0	No Additional Costs		

[a] Calculated using the uncontrolled potential NO_x emission rate in Table 3.1 and the expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies.

[b] Calculated by subtracting the expected controlled NO_x emission rates from the uncontrolled potential NO_x emission rate in Table 3.1.

[c] Calculated by multiplying the average cost effectiveness presented in Revised Table 3.6 by the amount of NO_x reduced per year.

[d] The economic impact is based on a cost effectiveness value presented in the EPA CoST system, which is an average value. A site-specific economic impact for selective non-catalytic reduction is discussed in Section 3.1.3 of LNA Grantsville's previous RACT Analysis dated August 2013. Selective non-catalytic reduction was determined to have a site-specific economic impact of $163,324/year. Site-specific economic impacts for low NO_x burner systems and selective catalytic reduction (although determined to be infeasible for the LNA Grantsville facility) are also expected to be similarly greater than the average values in EPA's CoST System.

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Revised Table 4.2 PM$_{2.5}$ Control Technologies for the Pressure Hydrator

Control Practice/Technology	Control Efficiency [a]		Average Cost Effectiveness	
	Percent Controlled	Reference	\$/Ton PM$_{2.5}$ Reduced	Reference
Fabric Filter - Pulse Jet Type (current control technology used at LNA Grantsville)	99-99.5%	EPA CoST System	283.95	EPA CoST System [b]
Fabric Filter - Mechanical Shaker Type	99-99.5%	EPA CoST System	306.55	EPA CoST System [b]
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	EPA CoST System	360.23	EPA CoST System [b]
Paper/Nonwoven Filters - Cartridge Collector Type	99%	EPA CoST System	344.68	EPA CoST System [b]
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	EPA CoST System	588.61	EPA CoST System [b]
Dry Electrostatic Precipitator - Wire Plate Type	95%	EPA CoST System	291.35	EPA CoST System [b]
Best Combustion/ Management Practices	0%	Assumed	No Additional Costs	Assumed

[a] Control efficiencies are for filterable emissions only.

[b] Average cost effectiveness provided by CoST is for Reference Year 2013. The cost effectiveness value was converted to the 2016 cost year by applying the same methodology used in CoST and the Gross Domestic Product: Implicit Price Deflator (GDP IPD) for 2016 available from the United States Department of Commerce Bureau of Economic Analysis.

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Revised Table 4.3 Ranking of Remaining $PM_{2.5}$ Control Efficiencies

Control Practice/Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Fabric Filter - Pulse Jet Type (current control technology used at LNA Grantsville)	99-99.5%	1.74	229.83	65,259.64	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)
Fabric Filter - Mechanical Shaker Type	99-99.5%	1.74	229.83	70,453.88		
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	1.74	229.83	82,791.69		
Paper/Nonwoven Filters - Cartridge Collector Type	99%	2.32	229.25	79,019.16		
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	6.37	225.20	132,556.37		
Dry Electrostatic Precipitator - Wire Plate Type	95%	11.58	219.99	64,094.91		
Best Combustion/ Management Practices	0%	231.57	0	No Additional Costs		

[a] Control efficiencies are for filterable emissions only.

[b] Calculated using the uncontrolled potential $PM_{2.5}$ emission rate in Table 4.1 and the expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies. The uncontrolled potential $PM_{2.5}$ emission rate in Table 4.1 includes only filterable emissions.

[c] Calculated by subtracting the expected controlled $PM_{2.5}$ emission rates from the uncontrolled potential $PM_{2.5}$ emission rate in Table 4.1.

[d] Calculated by multiplying the average cost effectiveness presented in Revised Table 4.2 by the amount of $PM_{2.5}$ reduced per year.

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Revised Table 5.2 PM$_{2.5}$ Control Technologies for Baghouse DC-3HB

Control Practice/Technology	Control Efficiency [a]		Average Cost Effectiveness	
	Percent Controlled	Reference	$/Ton PM$_{2.5}$ Reduced	Reference
Fabric Filter - Pulse Jet Type (current control technology used at LNA Grantsville)	99-99.5%	EPA CoST System	283.95	EPA CoST System [b]
Fabric Filter - Mechanical Shaker Type	99-99.5%	EPA CoST System	306.55	EPA CoST System [b]
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	EPA CoST System	360.23	EPA CoST System [b]
Paper/Nonwoven Filters - Cartridge Collector Type	99%	EPA CoST System	344.68	EPA CoST System [b]
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	EPA CoST System	588.61	EPA CoST System [b]
Dry Electrostatic Precipitator - Wire Plate Type	95%	EPA CoST System	291.35	EPA CoST System [b]
Best Combustion/ Management Practices	0%	Assumed	No Additional Costs	Assumed

[a] Control efficiencies are for filterable emissions only.

[b] Average cost effectiveness provided by CoST is for Reference Year 2013. The cost effectiveness value was converted to the 2016 cost year by applying the same methodology used in CoST and the Gross Domestic Product: Implicit Price Deflator (GDP IPD) for 2016 available from the United States Department of Commerce Bureau of Economic Analysis.

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Revised Table 5.3 Ranking of Remaining $PM_{2.5}$ Control Efficiencies

Control Practice/Technology	Control Efficiency [a]	Expected Controlled $PM_{2.5}$ Emission Rate (tons/year) [b]	Expected $PM_{2.5}$ Emission Reduction (tons/year) [c]	Economic Impacts ($/year) [d]	Environmental Impacts	Energy Impacts
Fabric Filter - Pulse Jet Type (current control technology used at LNA Grantsville)	99-99.5%	1.10	145.28	41,251.52	Not Applicable (top option is chosen)	Not Applicable (top option is chosen)
Fabric Filter - Mechanical Shaker Type	99-99.5%	1.10	145.28	44,534.87		
Fabric Filter - Reverse Air Cleaned Type	99-99.5%	1.10	145.28	52,333.78		
Paper/Nonwoven Filters - Cartridge Collector Type	99%	1.46	144.91	49,949.11		
Wet Electrostatic Precipitator - Wire Plate Type	95-99.5%	4.03	142.35	83,790.72		
Dry Electrostatic Precipitator - Wire Plate Type	95%	7.32	139.06	40,515.28		
Best Combustion/ Management Practices	0%	146.38	0	No Additional Costs		

[a] Control efficiencies are for filterable emissions only.

[b] Calculated using the uncontrolled potential $PM_{2.5}$ emission rate in Table 5.1 and the expected control efficiencies. When there is a range of control efficiencies, emissions are calculated using the median of the control efficiencies. The uncontrolled potential $PM_{2.5}$ emission rate in Table 5.1 includes only filterable emissions.

[c] Calculated by subtracting the expected controlled $PM_{2.5}$ emission rates from the uncontrolled potential $PM_{2.5}$ emission rates in Table 5.1.

[d] Calculated by multiplying the average cost effectiveness presented in Revised Table 5.2 by the amount of $PM_{2.5}$ reduced per year.

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ATTACHMENT D: QUOTE FOR TWO DRY SORBENT INJECTION SYSTEMS FOR THE LNA NELSON FACILITY

NOL-TEC SYSTEMS

SORB-N-JECT® Technology

www.nol-tec.com

May 22, 2013

LHOIST NORTH AMERICA
Hulen Street 3700
PO Box 985004
Fort Worth, TX 76185

Attention: Mr. Gideon Siringi
Email: Gideon.Siringi@Lhoist.com
Phone: 817-732-8164

Subject: Hydrated Lime Injection System at Nelson Plant
NOL-TEC SYSTEMS®, INC. Proposal 13767

Mr. Siringi,

We are pleased to submit for your review our ***budgetary (±20%)*** proposal for a Nol-Tec Sorb-N-Ject® Technology system in accordance with the following:

SYSTEM CONCEPT:

Hydrated Lime will be delivered on site in PD Blower trucks. Trucks will unload to one (1) of four (4) storage silos. Each kiln will have two (2) dedicated silos. Silo will discharge to a Loss-In-Weight Feeder, which consists of a hopper on load cells and a drop thru rotary airlock with a VFD. Material will be conveyed via PD Blower to an injection point with two injection lances per kiln. Injection location on kiln duct work TBD.

TRUCK UNLOAD DESIGN CRITERIA:

(Note that the following design criteria are based upon information that is either assumed or known to us at the time of quoting. Customer verification of this data is required to ensure proper system and equipment sizing.)

Product:	Lhoist Sorbacal Hydrated Lime
Bulk Density:	22 Lbs./Cu. Ft.
Particle Size:	Fine
Moisture:	Dry
Temperature:	Ambient
Abrasiveness:	Slight
System Capacity:	Expected 20 TPH ~ Due to the amount of manual adjustments on PD Blower Trucks, NTS can not guarantee this rate.

Conveyed Distance;	
Horizontal:	100 Ft.
Vertical:	10 Ft.
No 90° Bends:	1

EQUIPMENT:

Truck Unload Blowers:

1. Two (2) Blower packages, positive displacement rotary blower, driven by a 75 HP, TEFC, 1750 RPM, 230/460/3/60 motor, mounted on a structural base with motor slide rails and the following accessories:
   - Belt drive and guard
   - Intake cartridge air filter
   - Intake and discharge silencers
   - Check valve.
   - Relief valve.
   - Pressure gauge.
   - Pressure switch.
   - Sound enclosure with integral exhaust.

2. Two (2) Air-to-Air heat exchangers, designed to cool conveying air to within 10 °F of ambient temperature.

Clean Air Line:

3. Two (2) Lots of clean air line. Each includes:
   - Forty (40) Ft. 4" sch. 40 mild steel pipe, shipped with a standard mill finish in 20-foot random lengths.
   - Two (2) Elbows, 4" sch. 40, mild steel, 90° with 12" radius and 8" tangents.
   - One (1) Material handling hose, 4" diameter, 240" long.
   - One (1) 4" Pipe adapter.
   - One (1) 4" Bracket limit switch.
   - Seven (7) 4" compression couplings with black gasket.

Silo Fill Line:

4. Four (4) Lots of silo fill lines. Each includes:
   - One (1) 4" Pipe adapter.
   - One (1) 4" Bracket limit switch
   - One (1) Material handling hose, 4" diameter, 240" long.
   - One hundred (100) Ft. 4" sch. 40 mild steel pipe, shipped with a standard mill finish in 20-foot random lengths.
   - One (1) 4" Inline screener.
   - One (1) Silo receiver, Model 232, 4" sch. 40, mild steel welded construction with internal wear shield.
   - Seven (7) 4" compression couplings with black gasket.

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Storage Silos:

5. Two (2) Storage silos, welded mild steel construction, having a usable capacity of 9165 cu. ft., for the storage of Hydrated Lime with a bulk density of 22 lbs/cu.ft. Silos are sized for 8 days of storage of sorbent for kiln one. Silo is constructed with the following features:
   - 14'-0" diameter.
   - 66'-0" cylinder height.
   - 85'-0" overall height.
   - 60° cone to a 24" discharge diameter at a height of 15'-0" above grade.
   - Full enclosed skirt support with 3'-6" wide door.
   - 20" top deck manway with pressure/vacuum relief valve.
   - Vent filter mounting flange on top deck.
   - Four (4) level control mounts.
   - Fill line support brackets.
   - Top perimeter guard rail.
   - Ladder with safety cage and step-off platform (as required).
   - 80 MPH wind load design.
   - 30 PSF roof load.
   - Seismic II design.
   - Interior is unpainted.
   - Exterior painted finish is enamel (white).
   - Silo is shipped F.O.B. shipping point. (Freight and erection not included.)

6. Two (2) Storage silos, welded mild steel construction, having a usable capacity of 7000 cu. ft., for the storage of Hydrated Lime with a bulk density of 22 lbs/cu.ft. Silos are sized for 8 days of storage of sorbent for kiln two. Silo is constructed with the following features:
   - 14'-0" diameter.
   - 53'-0" cylinder height.
   - 60'-0" overall height.
   - 60° cone to a 24" discharge diameter at a height of 15'-0" above grade.
   - Full enclosed skirt support with 3'-6" wide door.
   - 20" top deck manway with pressure/vacuum relief valve.
   - Vent filter mounting flange on top deck.
   - Four (4) level control mounts.
   - Fill line support brackets.
   - Top perimeter guard rail.
   - Ladder with safety cage and step-off platform (as required).
   - 80 MPH wind load design.
   - 30 PSF roof load.
   - Seismic II design.
   - Interior is unpainted.
   - Exterior painted finish is enamel (white).
   - Silo is shipped F.O.B. shipping point. (Freight and erection not included.)

425 Apollo Drive • Lino Lakes, MN 55014 • P(651) 780-8600 F(651) 780-4400

NOTE: Ladders, safety cages, platforms, and handrails are shipped loose, in sections, to be field assembled and installed by installation contractor.

Silo Accessories:

7. Four (4) Lots of HVAC for the silo skirts. Each includes:
   - One (1) Wall mounted exhaust fan, with thermostat and guard.
   - One (1) Rain hood.
   - One (1) Aluminum louver.
   - One (1) Heating unit, 10 kW, with thermostat.

8. Four (4) Lots of lighting for the silo skirt. Each includes:
   - Eight (8) Wall mounted lights, 100 W.
   - Two (2) Light switches.
   - Two (2) 120V Receptacles.
   - Two (2) Emergency exit LEDs.
   - One (1) Light control enclosure.

9. Two (2) Jib cranes with electric hoist.

10. Four (4) Lots of silo level control. Each includes:
    - Four (4) Proximity level controls. Low level, mid level, high level, and emergency high level control.
    - One (1) Continuous guided radar level control.

Silo Dust Collection:

11. Four (4) Dust collectors Model 238, 60NT25, fabricated of 12 ga. mild steel, capable of 17" w.g. pressure, with access door, air manifold and valves for reverse pulse cleaning. Each includes:
    - One (1) Weather hood, 10" dia., mild steel.
    - One (1) Control enclosure, dust collector, 5 bank, NEMA 4, mild steel junction box with timer board, 110V.
    - One (1) Magnehelic differential gauge, indoor/outdoor.
    - Twenty-five (25) Cartridges, spun bond polyester, 5.75" dia. x 43" long, 30 sq. ft. each.
    - Twenty-five (25) Clamps, ½" wide, 301 stainless steel with quick release.

Silo Discharge:

12. Four (4) Fluidizing bin bottoms, Model 328, fabricated of mild steel, 24" diameter flanged inlet, 70° cone to a 12" diameter flanged discharge, complete with three individual air injection valve assemblies, having ceramic seats and abrasion resistant clear urethane cone seals. Also included is a single coil solenoid valve for aeration valve sequencing, with hoses and fittings. Each also includes:
    - One (1) Butterfly valve, 12" with carbon steel disc and 416 stainless steel shaft, has a manual handwheel.
    - One (1) 12" Spool section, mild steel.

- One (1) Butterfly valve, 12" with carbon steel disc and 416 stainless steel shaft, has rack and pinion double-acting air operator, solenoid valve and limit switches. Valve is factory assembled, pre-piped, and pre-wired to a NEMA 4 limit switch housing.
- One (1) Flex connection.
- Four (4) Clamps, ½" wide, 301 stainless steel with quick release.

Weigh Hoppers:

13. Four (4) Weigh Hoppers, 45 cu. ft. capacity fabricated of mild steel with a 12" dia. inlet, a 60° cone to a 10" dia. discharge, and six (6) tangential aeration jets, with controls. Each also includes:
    - Two (2) Single cartridge dust filters, Model 279, 9" dia., mild steel fabricated for mounting direct to hopper top. Complete with 30 square feet of cartridge filter media, 36" long top removal mild steel cartridge, ½" dia. air hose. (Plumbing shipped loose for field assembly.)
    - One (1) Load cell, mild steel, 3 module kit, 5,000 lb. per cell. Includes stainless steel summing box, mounts, load cells and cable.

Airlock Packages:

14. Four (4) Airlock packages, Model 257, 10 X 10, with 0.18 CFR displacement. Cast iron, housing construction with 8-vane welded steel rotor with fixed blade tips. Driven by a 1 HP, 1750 RPM, TEFC motor and gear drive which is side-mounted from the valve housing. Package includes:
    - Roller chain & sprocket drive with enclosed guard.
    - Outboard bearings.
    - Packing gland seal with air purge connection. Requires compressed air service (by customer).
    - Zero speed switch.
    - One (1) Butterfly valve, 10" with carbon steel disc and 416 stainless steel shaft, has rack and pinion double-acting air operator, solenoid valve and limit switches. Valve is factory assembled, pre-piped, and pre-wired to a NEMA 4 limit switch housing. For automatic isolation of rotary valve.
    - One (1) Spool section, 10" mild steel.
    - 3" convey line adapter.

DESIGN CRITERIA-HYDRATED LIME INJECTION:

(Note that the following design criteria are based upon information that is either assumed or known to us at the time of quoting. Customer verification of this data is required to ensure proper system and equipment sizing.)

Product:	Hydrated Lime
Bulk Density:	22 Lbs./Cu. Ft.
Particle Size:	Fine
Moisture:	Dry
Temperature:	Ambient
Abrasiveness:	Slight
System Capacity:	2100 PPH Kiln One, 1600 PPH Kiln Two
Conveyed Distance;	
Horizontal:	150 Ft.
Vertical:	50 Ft.
No 90° Bends:	6
Convey Line Dia:	3" Sch 40

ESTIMATED SYSTEM OPERATING CONDITIONS:

Air Flow:	200 CFM

EQUIPMENT:

Convey Line Blowers:

15. Four (4) Blower packages, positive displacement rotary blower, driven by a 15 HP, TEFC, 1750 RPM, 230/460/3/60 motor, mounted on a structural base with motor slide rails and the following accessories:
    - Belt drive and guard
    - Intake cartridge air filter
    - Intake and discharge silencers
    - Check valve.
    - Relief valve.
    - Pressure gauge.
    - Pressure switch.
    - Sound Enclosure with integral exhaust.

16. Four (4) Air-to-Air heat exchangers, designed to cool conveying air to within 10 °F of ambient temperature.

Clean Air Line:

17. Two (2) Lots of clean air line. Each includes:
    - Sixty (60) Ft. 3" sch. 40 mild steel pipe, shipped with a standard mill finish in 20-foot random lengths.
    - One (1) Tee bend, 3" sch 40 mild steel.
    - Four (4) Flanged adapter, 3" mild steel construction.

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- Two (2) Butterfly valves, 3" with carbon steel disc and 416 stainless steel shaft, has rack and pinion double-acting air operator, solenoid valve and limit switches. Valve is factory assembled, pre-piped, and pre-wired to a NEMA 4 limit switch housing.
- Four (4) Elbows, 3" sch. 40, mild steel, 90° with 6" radius and 6" tangents.
- Thirteen (13) 3" Compression couplings with black gasket.

Convey Line:

18. Two (2) Lots of convey line. Each includes:
    - Two hundred (200) Ft. 3" sch. 40 mild steel pipe, shipped with a standard mill finish in 20-foot random lengths.
    - Six (6) Bends, Model 207, 4" sch. 40, wear back, 90°, 40" centerline radius and 12" tangents.
    - Twenty-four (24) 3" Compression couplings with black gasket.

Splitters and Injection Lances:

19. Two (2) Lots of convey line splitters and injection lances. Each includes:
    - One (1) Flanged adapter, 3" mild steel construction.
    - One (1) Convey line splitter, 3" sch 40 inlet to two (2) 2 ½" sch 40 outlets. Splitter is designed to create back pressure to ensure an even split of material to each injection point.
    - Forty (40) Ft. 2 ½" sch. 40 mild steel pipe, shipped with a standard mill finish in 20-foot random lengths.
    - Four (4) Tee bends, 2 ½" sch 40 mild steel. End capped.
    - Two (2) Full port air operated ball valves.
    - Two (2) Full port manual ball valves.
    - Two (2) 2 ½" Spool sections.
    - Four (4) Flanged adapters, 2 ½" mild steel construction.
    - Two (2) 2 ½" Lance injectors, 304 stainless steel construction.
    - Two (2) Blow port assemblies, with Chicago fitting. For manual compressed air cleaning of lances.
    - Two (2) Pressure transmitters, -250 to 250 in.w.c.
    - Two (2) Pressure transmitter air manifolds.

Electrical Equipment:

20. One (1) Motor control panel with PLC.

21. Two (2) Remote I/O Panels.

22. Four (4) Silo scale panels.

BUDGETARY SYSTEM PRICE, (Items 1-22)..$2,045,000.00

UTILITIES: Please note, it is required the customer provide clean, dry, compressed air at 80 PSIG minimum to 100 PSIG maximum for the above Nol-Tec system to insure optimum operation. Through the pressure controller, the system will be regulated to the proper conveying pressure. Electrical power is to be furnished as specified in the item descriptions.

TEST CLAUSE: Please note that certain assumptions have been made with regard to material characteristics in the design of this system. Nol-Tec reserves the right to test a representative sample of the material to verify these assumptions. If the outcome of the testing results in changes to the design of the system, we will adjust our proposal accordingly. Any resultant pricing changes will be submitted to the customer for approval prior to implementation. Tests will be performed at Nol-Tec's facility in Lino Lakes, MN. Charges for testing (if applicable) are to be determined on an individual case basis. Test material freight costs (to and from Nol-Tec) are the responsibility of the customer. Any additional costs for testing are to be based upon specific testing requirements. We require an MSDS for all materials prior to testing. Tested materials must be returned to the customer after trials. Nol-Tec **cannot** dispose of tested materials.

FREIGHT: All prices are FCA Lino Lakes, Minnesota (and shipping points), freight pre-paid and added. Fuel surcharges may apply. Export crating is not included.

DELIVERY: To be determined at time of order. Current schedule is ten to twelve (10-12) weeks after drawing approval. Drawings will be issued for approval approximately six to eight (6-8) weeks after receipt of purchase order and all necessary engineering information.

TERMS:

20% invoiced upon receipt of purchase order (verbal or written).
70% progressive payments monthly (based on timeline of job).
10% invoiced upon acceptance of equipment, not to exceed 90 days after shipment.
All invoices are due net 30 days.

PRICING VALIDITY AND RISING STEEL COSTS:
Due to current volatility in the steel market, material escalation (if any) will be based on current market costs. Pricing in this proposal is based on today's market cost. Any increase in steel cost, between the purchase order placement date and material procurement date (above this benchmark) will be to the customer's account.

If awarded a contract, Nol-Tec reserves the right to revise and resubmit our proposal (based on current market conditions) for final customer acceptance. All pricing will be based on maintaining a predetermined delivery schedule. Any delays, related to the agreed upon delivery time line, could delay equipment procurement and may result in an overall system and/or component price increase.

ENGINEERING: Two (2) sets of engineered drawings and a maintenance manual provided in digital format are included in the above prices. The documentation provides sufficient detail to insure the proper installation of the components proposed. Additional sets of drawings or hard copies of manuals are available at an additional cost. Approval drawings will be submitted via e-mail or U.S. Postal Service. Manuals are delivered to one location via UPS ground service. Alternate or express delivery services can be provided upon request and will be charged to the customer.

SPARE PARTS: Spare parts pricing is not included. A detailed spare parts list is provided after approval of engineered drawings.

START-UP: Start-up service is at an additional cost, and as stated in the enclosed Terms and Conditions.

EXCEPTIONS: Unless stated above, we do not include state and local taxes, freight, installation labor and materials, motor controls, explosion relief devices, foundations and footings, pits and pit steel, tubing supports, structural steel work, fasteners, compressed air source, compressed air piping, air assist pilot line piping, or anything not specified in the item descriptions. Drilling and welding of air assist fittings to conveying line is by others. Above system and piping component quantities are estimated based on information in our possession at time of quoting. Nol-Tec reserves the right to adjust design, quantities, and pricing if actual layout necessitates. To ensure proper operation, it is the responsibility of the customer to provide uninterrupted material flow out of feed vessels that are not supplied by Nol-Tec such as silos, hoppers, railcars and trucks. Due to the varying condition of pressure differential railcars/trucks and the number of manual adjustments possible on these vessels, Nol-Tec cannot guarantee an unloading rate.

EQUIPMENT TAGGING: Major equipment components provided by Nol-Tec are identified with laminated or sticker tags that include the line item of the shipping schedule, job number, customer name, quantity ordered and customer P.O. number. Special equipment tags or additional information can be provided at an additional cost.

PAINT: The above proposed equipment is provided with one coat of Nol-Tec standard silicone modified alkyd paint with a gloss finish on external (non-product contact) steel surfaces, unless noted otherwise. Equipment is not prepared to prevent overspray onto interior (product contact) surfaces. If interior overspray is not acceptable, there will be an additional charge. Stainless steel, aluminum, and non-ferrous surfaces are unpainted. Pipe, tubing and bends are supplied with a standard mill finish, unpainted. Purchased components from Nol-Tec suppliers are to be painted manufacturer's standard paint. If other than the standard paint is required, it can be furnished at an extra cost.

This proposal, including the specifications, drawings, manuals, and any other information submitted, are considered proprietary and are disclosed in confidence upon condition they are not to be reproduced or disclosed to anyone, other than personnel in the company to whom the proposal is addressed, without written permission of Nol-Tec Systems, Inc.

Thank you for your interest in Nol-Tec Systems, Inc. Should you have any questions on this proposal, please contact us.

Respectfully,

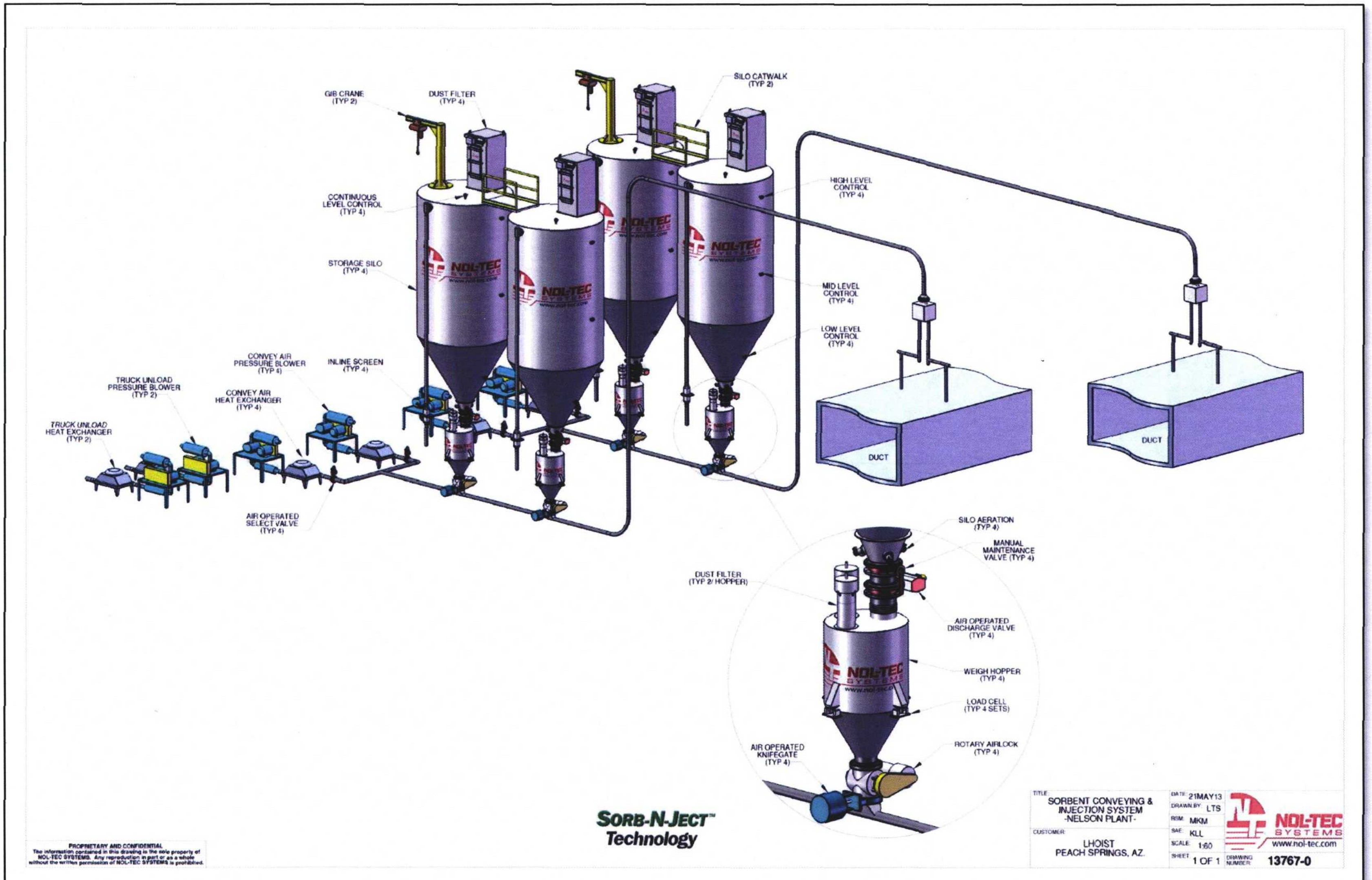
NOL-TEC SYSTEMS®, INC.

Mike Manning
Regional Sales Manager
mikemanning@nol-tec.com
Ph: 651-203-2561
Cell: 651-308-9209

MM:kl

Enclosure: Terms & Conditions 042407-Q
Drawing: 13767-0

Copy to: Dave Luzan – Luzan & Company


GIB CRANE (TYP 2)
DUST FILTER (TYP 4)
SILO CATWALK (TYP 2)
CONTINUOUS LEVEL CONTROL (TYP 4)
STORAGE SILO (TYP 4)
HIGH LEVEL CONTROL (TYP 4)
MID LEVEL CONTROL (TYP 4)
LOW LEVEL CONTROL (TYP 4)
NOL-TEC SYSTEMS
CONVEY AIR PRESSURE BLOWER (TYP 4)
INLINE SCREEN (TYP 4)
TRUCK UNLOAD PRESSURE BLOWER (TYP 2)
CONVEY AIR HEAT EXCHANGER (TYP 4)
TRUCK UNLOAD HEAT EXCHANGER (TYP 2)
AIR OPERATED SELECT VALVE (TYP 4)
DUCT
DUCT
SILO AERATION (TYP 4)
MANUAL MAINTENANCE VALVE (TYP 4)
DUST FILTER (TYP 2/ HOPPER)
AIR OPERATED DISCHARGE VALVE (TYP 4)
WEIGH HOPPER (TYP 4)
LOAD CELL (TYP 4 SETS)
ROTARY AIRLOCK (TYP 4)
AIR OPERATED KNIFEGATE (TYP 4)
SORB-N-JECT™ Technology
PROPRIETARY AND CONFIDENTIAL
The information contained in this drawing is the sole property of NOL-TEC SYSTEMS. Any reproduction in part or as a whole without the written permission of NOL-TEC SYSTEMS is prohibited.
TITLE: SORBENT CONVEYING & INJECTION SYSTEM -NELSON PLANT-
CUSTOMER: LHOIST PEACH SPRINGS, AZ.
DATE: 21MAY13
DRAWN BY: LTS
RSM: MKM
SAE: KLL
SCALE: 1:60
SHEET: 1 OF 1
NOL-TEC SYSTEMS
www.nol-tec.com
DRAWING NUMBER: 13767-0

NOL-TEC SYSTEMS, INC.
GENERAL TERMS AND CONDITIONS OF SALE

This Quotation is subject to all instructions, terms and conditions on the face hereof and also the following terms and conditions:

1. Warranty. Nol-Tec Systems, Inc. (hereinafter called "Nol-Tec") makes the following limited warranty:

Nol-Tec warrants to the original purchaser only (hereinafter referred to as "Buyer") that the parts manufactured by Nol-Tec of each new and unused system purchased from or through Nol-Tec under these Terms and Conditions, which parts have not been altered, changed or repaired in any manner, will be free from defects in material and workmanship for a period of one (1) year from the date of delivery. If any such part is not as warranted and if the Buyer notifies Nol-Tec of such defects in writing within one year of delivery, Nol-Tec will repair or replace, at its option, such defective part, provided that full information is furnished to Nol-Tec of the nature of the defect. Labor in removing and replacing parts at the installation site under this warranty, and return of defective parts to Nol-Tec's factory, shall be paid for by Buyer. This warranty by Nol-Tec does not cover any part of the system manufactured by third persons whether or not such third persons are subcontractors to Nol-Tec for this system.

If after inspection of the returned products, Nol-Tec determines that the defect is a result of misuse, mishandling, installation, abnormal conditions of operation, unauthorized repair or modification, or due to the Buyer's failure to install, maintain or operate the product in compliance with written instructions, all expenses incurred by Nol-Tec in connection with the replacement or repair of the product shall be for the account of the Buyer. Any product returned to Nol-Tec for replacement shall become the property of Nol-Tec.

EXCEPT AS EXPRESSLY PROVIDED IN THIS SECTION 1, ALL PRODUCTS AND SERVICES PROVIDED UNDER THESE TERMS AND CONDITIONS ARE PROVIDED "AS IS". ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, ARE HEREBY DISCLAIMED AND EXCLUDED BY NOL-TEC, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR USE, OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS, AND ALL OBLIGATIONS OR LIABILITIES ON THE PART OF NOL-TEC FOR DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE USE, MAINTENANCE OR PERFORMANCE OF THE PRODUCTS AND SERVICES PROVIDED HEREUNDER (INCLUDING LIABILITY FOR NEGLIGENCE), OTHER THAN LIABILITY BASED UPON THE GROSS NEGLIGENCE OR INTENTIONAL MISCONDUCT OF NOL-TEC

REPLACEMENT OR REPAIR OF THE NOL-TEC PRODUCTS AS PROVIDED ABOVE IS THE BUYER'S EXCLUSIVE REMEDY AND NOL-TEC'S SOLE OBLIGATION FOR ANY BREACH OF THE FOREGOING WARRANTY.

2. **LIMITATIONS OF LIABILITY. NOL-TEC WILL NOT BE LIABLE FOR ANY LOSS OR DAMAGE CAUSED BY DELAY IN FURNISHING PRODUCTS, OR BY DELAY IN ANY OTHER PERFORMANCE UNDER OR PURSUANT TO THIS AGREEMENT.**

IN NO EVENT WILL NOL-TEC'S LIABILITY OF ANY KIND INCLUDE ANY LOST PROFITS, LOST REVENUE, SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL LOSSES OR DAMAGES, EVEN IF NOL-TEC HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH POTENTIAL LOSS OR DAMAGE.

Nol-Tec shall not be liable to the Buyer for any claims, demands, injuries, damages, actions, or causes of action whatsoever based on negligence or strict liability.

No claim or cause of action arising from, or related to the products and services provided under these Terms and Conditions, whether based in tort, contract or otherwise, may be asserted (i) by any party but the original purchaser, or (ii) any time later than the date one year after the claim cause of action has accrued.

3. Acceptance/Agreement. Any acceptance of this Quotation is subject to acceptance of these Terms and Conditions. These Terms and Conditions (i) constitute the entire agreement between the parties with respect to the subject matter hereof, (ii) supersede any and all other agreements between the parties related thereto, as well as all proposals, oral or written, and all negotiations, conversations or discussions between the parties related to this Agreement, (iii) may not be altered, amended or otherwise modified without the written agreement signed by the parties hereto, and (iv) may be executed in two or more counterparts, each of which will be deemed an original hereof. No product or service specifications, or terms and conditions that are additional or contrary to the terms of this Agreement, whether contained in any purchase order or other communication from Buyer or any third party, will be construed as, or constitute a waiver of these terms and conditions, or acceptance of any such additional terms, conditions or specifications. Nol-Tec hereby rejects and objects to such additional or contrary terms, conditions or specifications

4. Orders. All orders are subject to acceptance by Nol-Tec, in its sole discretion, at its general offices in Lino Lakes, Minnesota, USA, even if such order are taken elsewhere by any sales representative or other agent of Nol-Tec.

5. Terms and Payment. The written price quotation listed herein shall be payable in current funds of the United States, at par, at 425 Apollo Drive, Lino Lakes, Minnesota 55014, according to the "Terms" as quoted herein. No other understanding or agreements, verbal or otherwise, with respect to the price and terms of payment shall be binding on either party, except as expressly stated herein. The foregoing terms of payment apply whether or not Nol-Tec has agreed to erect said system and whether or not there is delay in erection by any person, regardless of cause of delay.

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Prices on the goods covered by this Quotation are firm for 30 days from the date of this Quotation. If there is a delay in the completion of shipment of the order due to any change requested by the Buyer, or as the result of any delay on the Buyer's part in furnishing information required for completion of the order, the price agreed upon at the time of acceptance of the order is subject to change. Prices are F.O.B. carrier's equipment at Nol-Tec's factory and are exclusive of all federal, state or local taxes, and any present or future sales, use or other tax or duty that Nol-Tec may be required to collect or pay shall be added to the sales prices and paid by the Buyer.

6. Increase to Price. In the event changes by Buyer in concept to the proposed system should require additional, or modification to existing mechanical equipment hardware or software, the price to Purchaser shall be revised accordingly.

7. Installation/Start-Up/Field Service. The above price does not include installation of the system, system start-up, or any field service, unless otherwise specifically provided elsewhere herein or in our contract.

8. Installation Supervision Upon written request by Buyer to Nol-Tec, at any reasonable time prior to installation of the system provided by Nol-Tec, Nol-Tec agrees to supply to the installation site one installation supervisor qualified to instruct as to the proper installation of the system. The Buyer cost for this service is charged in accordance with current published rate schedule.

8A. Start-Up/Field Service and Training. Upon written request by Buyer to Nol-Tec, Nol-Tec agrees to supply to the job site, one start-up/field service technician qualified to instruct as to the proper troubleshooting and start-up of the system. The Buyer cost for this service is charged in accordance with current published rate schedule.

9. Drawings. Nol-Tec will deliver drawings to Buyer for approval of system prior to ordering materials and supplies, and prior to fabrication of system by Nol-Tec. Buyer agrees to either approve or correct such drawings, in writing, within 10 days after receipt thereof and return same to Nol-Tec for further processing. Nol-Tec reserves the right to give Buyer notice of delay caused Nol-Tec by Buyer's failure to promptly sign and return said drawings as aforesaid.

10. Cancellations, Countermand, and Return of Goods. Orders accepted by Nol-Tec cannot be cancelled or countermanded, or shipments deferred or goods returned except with the prior written consent from Nol-Tec's office in Lino Lakes, Minnesota, and upon terms that will indemnify Nol-Tec against all losses resulting there from, including the profit on any part of the order that is cancelled. When Nol-Tec authorizes the return of goods, Buyer shall prepay the shipping charges on such returned goods unless otherwise expressly stated by Nol-Tec in its written return authorization.

11. Patents. Nol-Tec shall indemnify and save the Buyer harmless from any judgments for damages and costs which may be rendered against the Buyer in any suit brought against the Buyer on account of the infringement of any United States patent by any goods supplied by Nol-Tec hereunder (as such and not incorporated into any other device), provided that the Buyer promptly notifies Nol-Tec of the commencement of any such suit and authorizes Nol-Tec to settle or defend such suit as Nol-Tec may see fit, and provided further that the Buyer renders every reasonable assistance which Nol-Tec may require in defending any such suit. This provision shall not apply if Buyer has furnished Nol-Tec with the specifications for such goods, and in that event, the Buyer shall indemnify and hold Nol-Tec harmless from any claim of patent infringement. If the goods supplied by Nol-Tec are found to be infringing, Nol-Tec's liability to the Buyer shall be limited to any one of the following, at Nol-Tec's election:

a. Procuring for the Buyer the right to use the goods; or
b. Modifying the goods so that such goods become non-infringing; or
c. Replacing the goods with non-infringing goods; or
d. Removing the goods and refunding the purchased price to the Buyer.

In consideration of Nol-Tec's covenants hereunder, Buyer waives all other claims or potential claims for damages against Nol-Tec for any alleged or established patent infringement, and agrees to indemnify and save Nol-Tec harmless there from.

12. Delivery. Shipping dates are approximate and are based upon current and anticipated manufacturing capabilities and upon prompt receipt of all necessary information from Buyer. Delivery shall also be contingent upon receipt of materials from subcontractors. Unless otherwise agreed in writing by Nol-Tec, delivery shall occur and risk of loss shall pass to the Buyer upon delivery of the goods to the carrier at Nol-Tec's factory. Transportation shall be at the Buyer's sole risk and expense, and any claim for loss of damage in transit shall be against the carrier only. Buyer agrees to accurately check shipment upon arrival and file claim with the common carrier for any damage or loss. Risk of damage or loss to the system from any cause shall pass from Nol-Tec to Buyer upon delivery to the common carrier, notwithstanding the fact that Nol-Tec reserves the right of possession and title in the property until the above price is paid in full, all as provided elsewhere herein.

13. Force Majeure. Fulfillment of this order is contingent upon the availability of materials. Nol-Tec shall not be liable for any delays in delivery, or for nondelivery or nonperformance, in whole or in part, caused by the occurrence of any contingency beyond the control of either Nol-Tec or suppliers to Nol-Tec, including but not limited to war, sabotage, acts of civil disobedience, failure or delay in transportation, acts of any government or agency or subdivision thereof, judicial actions, labor disputes, fires, accidents, explosions, epidemics, guaranties, restrictions, storms, floods, earthquakes or acts of God, shortage of labor, fuel, raw material or machinery or technical failure where Nol-Tec has exercised ordinary care in the prevention thereof. If any contingency occurs, Nol-Tec may allocate production and deliveries among its customers.

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14. Titles and Possession. Title and right of possession of the property furnished to Buyer pursuant to the terms of the contract shall remain in Nol-Tec until full payment of the price according to the above terms has been made, notwithstanding the delivery of the property to Nol-Tec or to a common carrier or to other bailee for the purpose of transmission to the Buyer.

The property furnished under this contract shall not become a part of any real estate by reason of being attached thereto or installed therein or thereon. If Buyer shall default in payment, Nol-Tec shall elect to exercise its lien upon said property as provided by this paragraph and the Minnesota Uniform Commercial Code and Buyer shall be responsible for all costs and expenses associated therewith. Buyer hereby grants unto Nol-Tec a license irrevocable to enter upon any real estate owned or leased by Buyer for the purpose of removing said property, and Buyer shall be responsible for the resulting damage, if any, to real and personal property to which it is affixed.

15. Inspection. Buyer shall inspect and test the goods shipped hereunder immediately upon installation thereof and shall, within 15 days of the substantial completion of installation, give notice in writing to Nol-Tec of any matter or thing by reason whereof he may allege that the system is not in accordance with this contract.

If Buyer fails to give such written notice, said system shall be deemed accepted by Buyer. Notwithstanding this right of inspection by Buyer, Buyer agrees to pay the above price according to the above terms whether or not a right of inspection and testing exists pursuant to the terms of this paragraph.

16. Applicability of United Nations Convention. With regard to international sales, the United Nations Convention on Contracts for the International Sale of Goods shall not apply to the purchase and sale of products hereunder.

17. General Provisions. The Buyer may not assign any rights to, or delegate any performance owed under this Agreement without the consent of Nol-Tec. Nol-Tec shall have the right to credit toward the payment of any monies that may become due Nol-Tec hereunder and any sums which may now or hereafter be owed to the Buyer by Nol-Tec. **THE VALIDITY AND PERFORMANCE IN ALL MATTERS RELATING TO THE INTERPRETATION AND EFFECT OF THIS AGREEMENT, ANY PROVISION HEREIN AND ANY AMENDMENT HERETO SHALL BE GOVERNED BY AND CONSTRUED IN ACCORDANCE WITH THE INTERNAL LAWS (AND NOT THE LAWS OF CONFLICT) OF THE STATE OF MINNESOTA. ALL DISPUTES ARISING IN CONNECTION WITH THIS AGREEMENT SHALL BE RESOLVED, IF NOT SOONER SETTLED, BY A COURT OF COMPETENT JURISDICTION LOCATED IN THE STATE OF MINNESOTA.** The Buyer shall pay Nol-Tec all fees, costs and expenses of Nol-Tec reasonably incurred in the enforcement of Nol-Tec's right under or with respect to this Agreement, including, without limitation, reasonable attorneys' fees.

18. Acceptance. The foregoing offer is accepted and the undersigned acknowledges receipt of a true and complete copy.

By:

____

(Name and Title)

For:

____

Buyer Name/Contract Number

Seller:
NOL-TEC SYSTEMS, INC.
A Minnesota Corporation

By:

____

(Name and Title)

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