MONTEREY BAY AIR RESOURCES DISTRICT

24580 Silver Cloud Court, Monterey, CA 93940

MEETING DATE:	October 18, 2023	**REGULAR AGENDA**
TO:	Board of Directors	
FROM:	Mary Giraudo, Engineering Supervisor	
SUBJECT:	Receive a Report on Evaluation of a Best Available Retrofit Control Technology (BARCT) Rule for Lime Kiln Sources Subject to the BARCT Schedule and Adopt a Resolution Which Requires No Further Action to Implement a BARCT Rule	

RECOMMENDATION

Receive a Report on Evaluation of a Best Available Retrofit Control Technology (BARCT) Rule for Lime Kiln Sources Subject to the BARCT Schedule and Adopt a Resolution Which Requires No Further Action to Implement a BARCT Rule.

DISCUSSION

In 2018, the Board adopted an Expedited BARCT Implementation Schedule to satisfy the requirements of Health and Safety Code Section 40920.6 (c). The purpose of the BARCT schedule was to establish a timeline for further consideration of new rules or revisions to existing rules to reduce emissions from permitted equipment at industrial sources. The BARCT schedule only applies to the following sources: Aera Energy LLC, Chevron U.S.A. Inc., CALNRG Operating LLC (formerly Eagle Petroleum LLC), and Lhoist North America of Arizona, Inc.

The current and final category under review in the BARCT schedule is consideration of oxides of nitrogen (NOx) emissions from lime kilns. NOx is a precursor compound to ozone formation so reducing NOx emissions could result in limiting ozone formation. Based on monitoring data for the years 2017-2019, the California Air Resources Board (CARB) redesignated MBARD to attainment for the 8-hour ozone standard. MBARD has remained attainment for the 8-hour ozone standard since the redesignation.

Staff evaluated the need for a BARCT rule to reduce NOx emissions from fuel combustion to operate lime kilns. Only one of the BARCT sources, Lhoist North America of Arizona, Inc., would be subject to a new lime kiln rule. MBARD is proposing to not proceed with creating a new rule for lime kilns based a fuel switch in 2010 from fuel oil to natural gas along with changes in production rates which reduced NOx emissions and that further controls to reduce NOx emissions by requiring BARCT would not be feasible, achieved in practice, or cost-effective.

FINANCIAL IMPACT

CARB provided grants to air districts to implement the community air protection program aspects of AB617 which included the BARCT schedule. MBARD has been awarded several grants which will be utilized by Planning for community air protection activities and Engineering for rule development activities associated with the implementation of the expedited BARCT schedule.

There will be no financial impact to the subject industrial source because MBARD is proposing to not proceed with rule development.

ATTACHMENTS

Resolution

Staff Report: Evaluation of Best Available Retrofit Control Technology (BARCT) – Consideration of BARCT for Lime Kilns

RESOLUTION 23-XXX

BEFORE THE AIR POLLUTION CONTROL BOARD OF THE MONTEREY BAY AIR RESOURCES DISTRICT

Adopt a Resolution Requiring No Further Action to Implement a Best Available Retrofit Control Technology (BARCT) Rule for Lime Kiln Sources Subject to the BARCT Schedule ……………………)

WHEREAS, Health and Safety Code §40920.6(c)(1) requires each district that is a nonattainment area for one or more pollutants to adopt an expedited BARCT schedule on or before January 1, 2019 and implement the schedule, by the earliest date feasible, but not later than December 31, 2023; and

WHEREAS, the Monterey Bay Air Resources District (MBARD) is a state nonattainment area for the pollutant PM_{10} and was redesignated attainment for the state 8-hour ozone standard in 2020; and

WHEREAS, Health and Safety Code §40920.6(c)(2) states the schedule shall apply to each industrial source that, as of January 1, 2017, was subject to a market-based compliance mechanism adopted by the state board; and

WHEREAS, MBARD has four subject industrial sources: Aera Energy LLC, Chevron USA Inc., CALNRG Operating LLC (formerly Eagle Petroleum LLC), and Lhoist North America of Arizona, Inc.; and

WHEREAS, an expedited BARCT schedule was adopted November 14, 2018 identifying review of a new rule applicable to lime kilns; and

WHEREAS, one industrial source, Lhoist North America of Arizona Inc., operates lime kilns; and

WHEREAS, oxides of nitrogen (NOx) are precursor compounds to ozone formation and lime kilns emit NOx from fuel combustion; and

WHEREAS, a review of BARCT options to reduce NOx emissions from the lime kilns operating at Lhoist North America of Arizona Inc. found BARCT is not feasible, achieved in practice, or cost-effective; and

NOW, THEREFORE, BE IT RESOLVED THAT THE BOARD OF DIRECTORS OF THE MONTEREY BAY AIR RESOURCES DISTRICT:

1. Requires no further action to implement a BARCT rule for lime kilns.

PASSED AND ADOPTED this 18th day of October 2023, upon motion of, seconded by and carried by the following vote, to wit:

AYES:
NOES:
ABSENT:

I hereby certify that the foregoing is a true and correct Resolution as duly adopted by the Board of Directors of the Monterey Bay Air Resources District on October 18, 2023.

By: ____ Approved: ____

Monterey Bay Air Resources District

Evaluation of Best Available Retrofit Control Technology (BARCT) – Consideration of BARCT for Lime Kilns

Seong Kim, Engineer II
Armando Jimenez, Engineer III
Mary Giraudo, Engineer Supervisor
Amy Clymo, Engineering and Compliance Manager

September 25, 2023

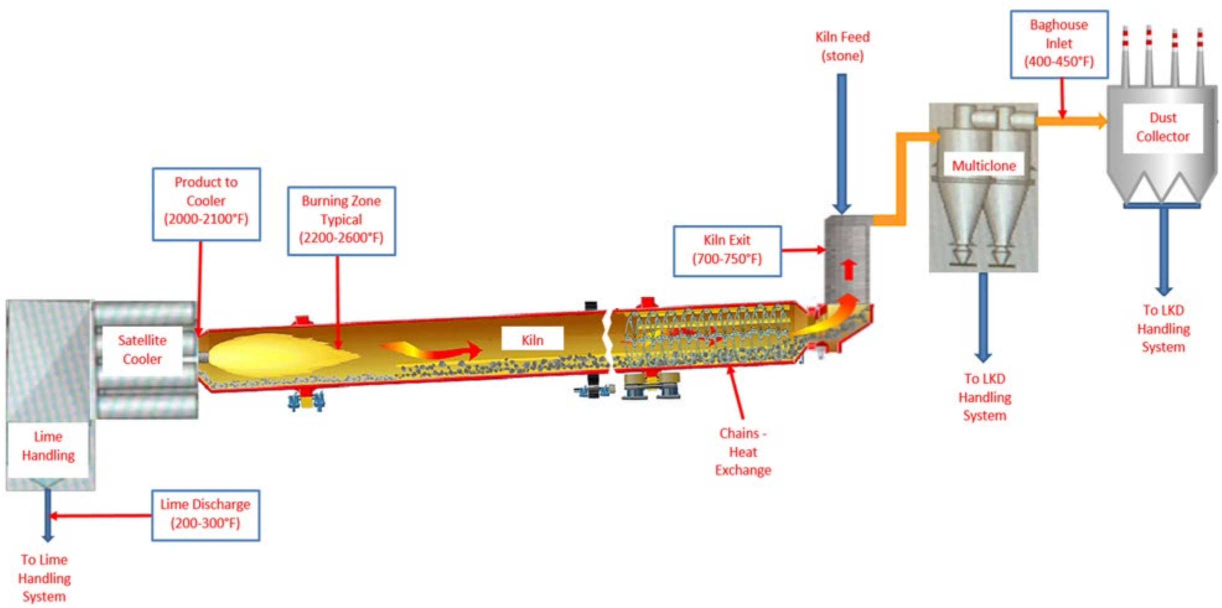
Background

Assembly Bill 617 (AB 617), which was approved on July 26, 2017, amended California Health and Safety Code Division 26, Part 3, Chapter 10, Section 40920.6., and required each air district that is a nonattainment area for one or more air pollutants to adopt, by January 1, 2019, an expedited schedule for implementation of best available retrofit control technology (BARCT) by the earliest feasible date, but no later than December 31, 2023. This requirement applies to each industrial source subject to California Greenhouse Gas (GHG) Cap-and-Trade requirements. At the time AB 617 was approved, the Monterey Bay Air Resources District (MBARD) was designated nonattainment for the state 8-hour ozone standard and state 24-hour particulate matter less than 10 microns (PM_{10}) standard and was therefore required to adopt an expedited BARCT schedule. Based on monitoring data for the years 2017-2019, the California Air Resources Board (CARB) redesignated MBARD to attainment for the 8-hour ozone standard. MBARD has remained attainment for the 8-hour ozone standard since the redesignation.

In 2018, the Board adopted an Expedited BARCT Implementation Schedule to satisfy the requirements of Health and Safety Code Section 40920.6 (c). The purpose of the BARCT schedule was to establish a timeline for further consideration of new rules or revisions to existing rules to reduce emissions from permitted equipment at industrial sources. In February 2020, the first BARCT rule, Rule 441, was adopted to address Boilers, Steam Generators, and Process Heaters. In November 2020, the Board approved staff's recommendation to not move forward with an internal combustion engine rule. In February 2022, the Board approved staff's recommendation to not move forward with revisions to Rule 427, Steam Drive Crude Oil Production Wells. The current and final category under review in the BARCT schedule is consideration of oxides of nitrogen (NOx) emissions from lime kilns. NOx is a precursor compound to ozone formation so reducing NOx emissions can result in limiting ozone formation. A step in processing limestone involves using a kiln which generates NOx emissions from the combustion of fuel.

Within the jurisdiction of MBARD, there are four industrial sources subject to the BARCT schedule: Aera Energy LLC, Chevron U.S.A. Inc., CALNRG Operating LLC (formerly Eagle Petroleum LLC), and Lhoist North America of Arizona, Inc. Lhoist North America of Arizona, Inc. operates the only lime plant in California, the Natividad plant is located in the North-East area of Salinas, California. This facility was originally constructed in 1942 and is a mining and non-metallic mineral processing plant. Dolomite is mined, crushed, and screened to produce raw dolomite mineral products for sale, or to be further processed to produce calcined dolomite for sale. The facility operates three straight rotary kilns and one multiple hearth kiln. Kilns 1, 2, and 3 are straight rotary kilns and Kiln 4 is a vertical kiln. Figure 1 below shows an example of a straight rotary kiln like the ones used within the process at the Natividad plant.

Figure 1. Rotary Kiln



The new rule under consideration would address potential NOx emission reductions from the combustion to operate the lime kilns at the Natividad plant. The Natividad plant currently operates with control devices, such as baghouses, to minimize particulate emissions (see Figure 1 above). It is not necessary to address control technology for particulate emissions from combustion in the kilns because they are fueled by natural gas. The focus of this document is on NOx emissions. Based on the following discussion, MBARD staff are proposing not to move forward with a new rule.

Rule Review

Other air districts have not established BARCT levels for lime kilns because there is only one operating lime plant in California. However, there is one existing Lime Kiln rule from San

Joaquin Valley Air Pollution Control District (Rule 4313) which applied to NOx emissions from lime kilns used for sugar beet processing. This rule applies to lime kilns processing lime mud which is part of sugar beet processing. This process is very different from the Natividad plant for several reasons; (1) the lime mud is wet; (2) the process drives water out of the product; and (3) the Natividad lime plant processes mined dry, pure limestone. Therefore, this rule was not considered applicable to establishing emission limits for the lime kilns used at the Natividad plant.

The Natividad plant lime kilns are not subject to 40 CFR Part 60, Subpart HH – Standards of Performance for Lime Manufacturing Plants. Per Section §60.340(c) because any facility under paragraph (a) of this section that commences construction or modification after May 3, 1977, is subject to the requirements of this subpart. Each of the Natividad plant lime kilns pre-date the requirements of this part and have not undergone modification (as defined in 40 CFR §60.2) after May 3, 1977, and therefore are not subject to the requirements of this part.

In the 1990s, the Natividad plant began to use natural gas as well as recycled light No. 6 fuel oil as a fuel source to Kilns 1-3. Kiln 4 was never permitted to operate on recycled light No. 6 fuel oil. February 2010 was the last time fuel oil was used in any of the kilns, and the infrastructure supporting the use of recycled light No. 6 fuel oil has been idled. This change in fuel type reduced NOx emissions from over 300 tons per year down to a range of 20-30 tons per year depending on annual process rates. This represents approximately an 80-90% reduction in NOx emissions, depending on the annual process rates.

In 2012, the final Best Available Retrofit Technology (BART) NOx emission limits were promulgated by the United States Environmental Protection Agency (EPA) for Lhoist's Nelson plant located in Arizona (Federal Register Vol. 80, No. 74). The two kilns operating at this plant operate with coal, petroleum coke or a mixture of coal and petroleum coke. However, as discussed above, the Natividad plant operates using natural gas which results in much lower emissions than solid fuels such as coal or petroleum coke. Table 1 compares EPA's BART levels established for the Nelson lime plant to the calculated levels for the Natividad plant.

Table 1. Emission Factor Comparison

Pollutant	Emission factor (lb/ton product)	
	Nelson Plant in AZ	Natividad Plant in CA
NO_x	Kiln 1: 3.80 lb/ton Kiln 2: 2.61 lb/ton	Kiln 1: 0.65 lb/ton Kiln 2: 0.65 lb/ton Kiln 3: 0.63 lb/ton Kiln 4: 1.10 lb/ton [a]

[a] Kiln 4 has not operated in over 35 years, maximum theoretical value reported.

As shown in Table 1, the emission factors used for the Natividad plant are lower than the Nelson plant BART levels because of the different fuels; coal and petroleum coke versus natural gas. The Nelson plant was required to install emission controls to comply with the emission limits in Table 1. The Natividad plant emissions are much lower without additional controls due to using natural gas as the kiln fuel.

NOx Emission Control Options

Similar to boilers and engines, post-combustion control technologies such as Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR) could be considered to reduce emissions from lime kilns. The following will briefly discuss both technologies and the potential issues when applied to a lime kiln along with the cost-effectiveness. However, the lime kilns at the Lhoist Natividad plant are not equipped with preheaters and the control technologies have only been applied to preheater rotary kilns. This information is based upon documents from the EPA docket materials for the Arizona Regional Haze Federal Implementation Plan which included a Best Available Retrofit Technology (BART) determination for the Lhoist Nelson lime kilns 1 and 2 located in Arizona. Finally, as discussed above, the Nelson plant in Arizona is fueled by coal, petroleum coke or a mixture of coal and petroleum coke which results in much higher NOx emissions than the natural gas fueled kilns operated at the Natividad plant.

Selective Catalytic Reduction (SCR)

Selective catalytic reduction (SCR) is an exhaust gas treatment process in which ammonia (NH_3) is injected into the exhaust gas upstream of a catalyst bed. On the catalyst surface, NH_3 and nitric oxide (NO) or nitrogen dioxide (NO_2) react to form nitrogen and water. Although SCR is being used in the utility industry on equipment such as boilers, there are differences between the exhaust streams generated by the two industries that account for the difference in the application of the technology. A utility boiler's exhaust gas stream does not vary over time. The boiler gas stream characteristics do not change greatly, whereas the lime kiln exhaust gas stream temperature has a high degree of fluctuation. The temperature variability of the exhaust gas stream makes the technology technically difficult to implement.

Another potential issue with this technology comes from particulate fouling and masking of the catalyst, particularly with calcium-based particulates from kilns. The irregularly-shaped particulates from kilns are more likely to create fouling and plugging problems than spherical particulates from utility boilers. Also, to achieve about an 80% removal rate, an SCR would need to be operated at a temperature between 700 and 750 degrees Fahrenheit (^{o}F). To avoid fouling the catalyst bed with the PM in the exhaust stream, an SCR unit would need to be located downstream of the particulate matter control device. However, due to the low exhaust gas temperature exiting air pollution control devices at lime plants (in most cases, a baghouse, which is the case for the Natividad plant), a heat exchanger system would be required to reheat the exhaust stream to the desired reaction temperature. Thus adding more costs to the system. Based upon the information available, this technology would not be feasible to implement.

Selective Non-Catalytic Reduction (SNCR)

SNCR is infeasible in straight rotary lime kilns because it requires a high but very specific temperature range (between 1,600 and 2,100 ^oF) to be effective. At lower temperatures, the NOx reduction reaction is incomplete, and at higher temperatures NOx emissions can actually be increased. There are three possible locations where this temperature profile could be achieved in lime kilns: in the preheater (if equipped), after the air pollution control device (a baghouse), or within the kiln.

For lime kilns, feed particle size makes injection of reactants infeasible in preheaters, because large stone would either damage spray nozzles, or the sprays would impinge on the stone, wetting the stone but not entraining the reagent in the gas stream.

Flue gas exhaust temperatures from lime kilns' baghouses and wet scrubbers (generally below 450 ^oF and 212 ^oF, respectively) are substantially below the SNCR operating range. Consequently, the exhaust gases would need to be reheated. Reheating exhaust gases would also result in additional pollutants being formed from the combustion products from the fuel used to reheat the exhaust gases.

Another potential problem with SNCR is the formation of unreacted ammonia or urea that will react with sulfur oxides in the flue gas in the presence of water to form ammonium bisulfite, a sticky compound that can cause corrosion, fouling, and blockages downstream of the injection point. This would create serious problems with the preheater, ductwork, baghouses, and fans; reduce kiln draft; and cause excessive outages. Finally, ammonia absorption into the lime kiln dust collected in the baghouse could impact the ability to sell this byproduct.

Kilns 1, 2, and 3 at Natividad are straight rotary kilns and Kiln 4 is a vertical kiln. These kilns are not classified as preheater kilns and SNCR is not a proven technology for these kilns. Therefore, SNCR is not a feasible control option for kilns at the Natividad plant.

Cost-Effectiveness

A general estimate of the total annual capital and operating costs for SNCR is approximately $263,000 per kiln for a potential total cost of $789,000 to retrofit the three straight rotary kilns at the Natividad plant (see Attachment 1). This cost estimate does not include the capital or operating cost for the installation of a preheater system. With baseline emissions at 18 tons per year, an estimated control efficiency of 50% and retrofitting two kilns at $263,000 per kiln, the cost-effectiveness would be $58,000 per ton. There is limited information available regarding BARCT cost-effectiveness thresholds for NOx established by other air districts, however, a CARB document presents a range of $9,700 - $18,000 per ton reduced as the thresholds used by other air districts in 2002 (CARB 2002). Accounting for inflation, this is equivalent to $16,490 - $30,600 in 2023 dollars. When compared to this range of cost-effectiveness values, it can be concluded an SNCR retrofit at $58,000 per ton would not be cost-effective if it were technically feasible.

Conclusion

Based on the information reviewed by MBARD staff, a BARCT rule for the Lhoist Natividad lime plant kilns is not needed. When the kilns were switched to operate using natural gas, this resulted in NOx emission reductions of approximately 80-90%, depending on the annual process rates. MBARD considers the fuel switch to natural gas as a control alternative for the lime kilns since the control technologies reviewed in this document would not be feasible or cost-effective.

References

California Air Resources Board. 2002. Implications of Future Oxides of Nitrogen Controls From Seasonal Sources in the San Joaquin Valley. Table 9. Comparison of BARCT Cost Effectiveness Thresholds.

United States Environmental Protection Agency (EPA). 2012. Federal Register Vol. 80, No. 74.

Attachment 1

Cost-Effectiveness Calculations

SELECTIVE NON-CATALYTIC REDUCTION - COST EFFECTIVENESS ANALYSIS

Cost Item	Units	Kiln #1	Kiln #2	Kiln #3	Kiln #4	Notes
CAPITAL COSTS[1,2]						
Total Capital Investment	$	337,500	337,500			Per Table 5-4, Nelson BACT Five Factor Analysis 09-27-13 - Public.pdf
Excludes Cost of Preheater						See Footnote 1 below
Capital Recovery Factor		0.094	0.094			See Footnote 2 below
ANNUAL COSTS						See Footnote 3 below
Variable Operating Costs (VOC)[3]						
Reagent Usage	lbs/hr	26	39			See Footnote 3 below
Reagent Usage	lb/yr	304,984	307,476			Based on anhydrous ammonia usage, 90% annual CF, normal stoichiometric ratio of 0.70
Reagent Usage	tons/yr	152	154			
Reagent Cost	$/ton	1,000	1,000			See Footnote 4 below; Based on use of anhydrous ammonia
Reagent Cost	$/yr	152,000	154,000			
Aux Power	kW/hr	1.8	2.75			Based on 90% annual capacity factor. See Footnote 3 below
Aux Power	kWh/yr	14,191	21,681			
Aux Power	$/kWh	0.05	0.05			
Aux Power	$/yr	709.55	1,084.05			
Total VOC		$152,709.55	$155,084.05			Auxilary Power Cost + Reagent Cost
Fixed Operating Costs (FOC)						
Additional Labor	$/yr	59,200	59,200			
Admin, Taxes, Insurance	$/yr	18,000	18,000			
Total FOC		$77,200	$77,200			
Annualized Capital Costs	$/yr	31,725.00	31,725.00			
TOTAL ANNUAL COSTS	**$/yr**	**$261,634.55**	**$264,009.05**			Total VOC +Total FOC + Annualized Capital Cost

1. Nelson Kilns rated at 850 and 1100 tons per day. Kilns 1 and 2 at Nativadad rated at 39 and 59 tons per hour, respectively. Assuming 8 hrs per day = 312 and 472 tons per day, respectively.
   Because Kilns 1 and 2 production rates are approximaley 1/3 (36%) and 1/4 (55%) the output of the Nelson Kiln 1, the total capital cost will be assumed to be 75% of the unit presented in L'hoist's Table 5-4.

2.

Interest Rate	7%
Equipment Lifetime (years)	20
Capital Recovery Factor	0.094

3. Actual usage rates from Nelson Plant Kiln #1, as provided by L'hoist, multiplied by factor of 0.36 for Kiln #1, and 55% for Kiln #2.

4. Anhydrous ammonia price established at approximately double historical urea price range (excluding 2008 high)
https://www.indexmundi.com/commodities/?commodity=urea$months=360

Natividad Historical Operations

Kilns Operated	Year	Total NOx Emissions (tons/yr)	Annual Emission Reductions (tons/yr)	Average 3-year emission reductions (tons/yr)	Average 5-year emission reductions (tons/yr)
Kilns 1 & 2	2018	22.7	11.35		
Kilns 1 & 2	2019	21.44	10.72		
Kilns 1 & 2	2020	17.4	8.70	7.67	9.01
Kilns 1 & 2	2021	16.33	8.17		
Kilns 1 & 2	2022	12.27	6.14		

Total Cost	$525,643.60
Cost effectiveness; 3-year baseline	**$68,562.21**
Cost effectiveness; 5-year baseline	**$58,314.13**