ADEQ
Arizona Department
of Environmental Quality

2021 Regional Haze Four Factor Initial Control Determination

Facility: Drake Cement, Paulden Facility

Air Quality Division
November 23, 2020

Table of Contents

List of Figures

List of Tables

1 ADEQ Initial Regional Haze Four Factor Control Determination

1.1 ADEQ Initial Control Determination for Drake Cement Paulden

ADEQ's initial determination is to find that it is reasonable not to require additional controls on Drake Cement Paulden Facility during this planning period.

1.2 ADEQ Control Determination Finalization Timeline

In order to meet the State rulemaking process timeframe for proposed rule inclusion in the July 31st, 2021 Regional Haze state implementation plan (SIP) submittal, ADEQ must finalize all four factor analyses as expeditiously as possible. To provide an opportunity for interested stakeholders to review and comment on ADEQ's initial decision prior to finalization, the department intends to post initial decisions on the agency webpage along with the original source submitted four factor analyses. Once ADEQ has reviewed relevant stakeholder comments, the agency will revise its initial decisions if necessary and post final decisions (see Figure 1). ADEQ welcomes feedback on these initial decisions and invites any interested party to send their comments by **December 31st 2020** to:

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Please note that this review and feedback opportunity does not constitute an official state implementation plan or state rulemaking comment period. The agency intends to provide an official 30 day comment period on any proposed SIP or rulemaking action in accordance with Arizona Revised Statutes §§ 41-1023, 49-425, and 49-444.

Figure 1: Four Factor Control Determination Process Map

2 ADEQ Four Factor Analysis

2.1 Summary

Drake Cement had one emission source the contributed approximately 84% of the facility's total NO_X, SO_2, and PM_{10} combined emissions. This emission source was the Main Baghouse Raw Mill and Kiln. This unit was determined not to have an "Effective Control" as presented for the Regional Haze analysis[1]. Hence, this emission source was not screened out and was the only unit considered for the Regional Haze analysis. Low NOX Burners, Preheater Riser Duct Firing, and Selective Non-Catalytic Reduction (SNCR) are currently implemented at the Drake Cement Paulden facility. The only remaining potential control available for implementation at the Paulden facility is Selective Catalytic Reduction (SCR). ADEQ is proposing that SCR is not feasible as evidenced by the Drake Cement's 4-factor analysis. Therefore, ADEQ's initial determination is to find that it is reasonable not to require additional controls on Drake Cement during this planning period.

2.2 Facility Overview

2.2.1 Process Description

Limestone is quarried on United States Forest Service (USFS) lands adjacent to the Cement Plant site. Limestone quarrying consists of drilling and blasting limestone, loading limestone into haul trucks, and hauling and dumping mined limestone into a primary crusher. Crushed limestone is conveyed via three overland conveyors which transport crushed limestone into the limestone storage building at the plant site.

Various additives and fuel sources used in the manufacturing process, including coal, iron ore and other materials are brought to the site by rail cars or trucks and stored in the Additive Storage Building.

The raw materials are conveyed to the Raw Mill material silos. Raw material from each Raw Mill silo is proportioned in the proper amounts using weigh scales on the conveyor belts and variable speed conveyors.

Proportioned raw materials are dried, pulverized and size-classified in the Raw Mill circuit. The ground raw material (raw meal) is delivered to the blending silo and then to pyroprocessing. The feed is injected at either the second or third stages of the six-stage pre-heater tower. The formation of Portland cement clinker in pyroprocessing starts with the blended raw meal travelling down the six-stage pre-heater, concurrent to the kiln effluent gases. Heated raw meal

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[1] ADEQ 2021 Regional Haze State Implementation Plan Source Screening Methodology https://static.azdeq.gov/aqd/haze/4_factor_screening_approach.pdf

can be diverted at either the fourth or fifth stage to enter the pre-calciner. Thermal processing in the precalciner initiates the calcining reactions and mixes the material prior to entering the rotary kiln.

Pulverized coal fuel is pneumatically injected into the pre-calciner. The pre-calciner consumes about 50-55% of the total coal feed. The remaining coal is injected into the Kiln.

Tertiary combustion air is introduced to the pre-calciner after being pre-heated in the clinker cooler. The combustion gases carrying hot, partially reacted solids exit the pre-calciner and enter the clean-up cyclone where particulate matter is separated. Discharge solids from this cyclone are gravity fed to the upper end of the kiln. The cleaned hot gases exiting the top of the pre-heater cyclone are typically split to the Raw Mill (90%) and Coal Mill (10%). These serve as conveyance gases for the pulverized materials and a source of heat to dry these materials and improve thermal efficiency. These gases are treated by the Raw Mill and Coal Mill Baghouses and then discharged though the main stack.

Clinker exiting the lower end of the kiln passes through a reciprocating grate clinker cooler and roller crusher. The clinker cooler reduces the temperature of the product solids exiting the Kiln and reclaims much of the heat from the product solids. Air from the first set of cooler fans contacts the hottest clinker and is then sent to the Kiln hood as secondary and tertiary combustion air for the coal. Air leaving the Clinker Cooler passes through Cooler Baghouse and then discharges via the Cooler Stack. The cooled clinker is transported to the enclosed clinker dome.

Clinker is conveyed to a finish mill feed silo. This clinker, as well as gypsum and limestone, are transferred in appropriate proportions to the finishing mill system. The finish mill system consists of a complete Roller Press installation working in series with a ball mill. The Portland cement product is then transported to a cement silo for final storage before being loaded into trucks and rail cars.

2.2.2 Baseline Emission Calculations

Drake Cement's historical facility-wide emission for 2016 through 2018 are presented in Table 1.

Table 1 Facility-Wide Historical Emissions

Year	Hours of Operation	NO_x (tpy)	SO_2 (tpy)	PM_{10} (tpy)
2016	6,912.5	282	1	36
2017	7,324.4	310	3	44
2018	7,357.6	316	10	49

2.3 ADEQ Screening Methodology

The process/emission unit screening methodology used by the ADEQ relies on the emissions inventory data from ADEQ State and Local Emissions Inventory System (SLEIS). The method used for emissions data from 2015 – 2017 and throughput data from 2016 – 2018 for the 2028 emissions projections. Quality assured 2018 emissions data were not available at the time of the analysis which is why 2015-2017 emissions datasets were utilized. The air pollutants that were analyzed per the ADEQ's screening analysis include PM_{10}, SO_2, and NO_X. Emission units, unit processes, process throughputs (inputs or outputs), and emissions for pollutants were reviewed for Drake Cement.

A scaling factor was determined for each pollutant and emission unit by dividing the annual emissions by the annual throughput. Then the average scaling factor over the three-year period (2015-2017) was calculated. In addition, the average process throughput for the three-year period (2016-2018) was calculated. The projected annual emissions for each unit process was determined by multiplying the average scaling factor (2015-2017) by the average process throughput (2016-2018).

Then the ADEQ applied a screening process to determine which emission units would undergo the four factor analysis. Any processes that were identified as being effectively controlled were deferred from consideration for the current round. Four factor analyses would be conducted on the remaining processes that make up the top 80% of summed NOx, SO2, and PM10 emissions at the source. For the purposes of this round and per the screening methodology, the only process/emission unit that comprised at least 80% of the remaining processes is the main baghouse for the raw mill and kiln.

NO_X from the emission unit, Main Baghouse for Raw Mill and Kiln, comprised 84% of the cumulative NO_X, SO_2, and PM_{10} combined emissions. This emission unit is not considered to have an "Effective Control" to exempt it from Regional Haze Analysis. Thus, this is the only emission unit evaluated.

2.4 Proposed Control Methodology

2.4.1 Baseline Control Scenario (Projected 2028 Emissions Profile)

The ADEQ relied upon guidance from the Western Regional Air Partnership (WRAP) regarding the use of a "Q/d > 10" threshold to screen out sources from the four-factor analysis. To accomplish this, the ADEQ reviewed calendar year 2014 emission inventory data for sources of PM_{10}, NO_X, and SO_2.

To determine the "Q" value, the facility-wide PM_{10} primary, nitrogen oxide, and sulfur dioxide annual emissions were totaled. Since Drake Cement station had a "Q" value greater than 10, it determined that the facility would be subject to a four factor analysis.

To determine the distance (“d”) value, the ADEQ used GIS to plot the location of Drake Cement and the boundary of all Class I areas within Arizona and surrounding States. Then, the distance from Drake Cement to the nearest Class I area boundary (in kilometers) was determined.

Once “Q” and “d” had been established, “Q/d” for Drake Cement was determined to be 17. These results are summarized in Table *2* below.

Table 2: Q/d for Drake Cement

Facility	Q (tpy)	d (km)	Q/D	Nearest CIA
Drake Cement LLC	375	22	17	Sycamore Canyon WA

2.4.2 Evaluated Controls and Emission Estimates

Drake Cement identified the following controls below.

2.4.2.1 Low-NOX Burners (LNBs):

These burners have already been installed on the kiln and as a result are not discussed in detail. Baseline emissions are based on the operation of these LNBs. All alternative methods of NOx control in this analysis will assume that the kiln continues to operate this burner.

2.4.2.2 Preheater Riser Duct Firing:

Drake currently utilizes riser duct firing in the preheater. This means that a portion of the fuel is fired in the riser duct to increase the degree of calcinations in the preheater. Baseline emissions are based on the operation of the riser-duct firing. All alternative methods of NOx control in this analysis will assume that the kiln continues to operate the riser-duct firing.

2.4.2.3 Selective Non-Catalytic Reduction:

In an SNCR system, a reagent is injected into the flue gas within an appropriate temperature window. The NO_X and reagent (ammonia or urea) react to form nitrogen and water. A typical SNCR system consists of reagent storage, multi-level reagent-injection equipment, and associated control instrumentation. Drake cement has already installed a SNCR system on the kiln and has demonstrated compliance with federally enforceable NO_X emission rates of 95 pounds/hr and 1.95 pounds/ton clinker.

2.4.2.4 Selective Catalytic Reduction:

SCR is an exhaust gas treatment process in which ammonia (NH_3) is injected into the exhaust gas upstream of a catalyst bed. On the catalyst surface, NH_3 and nitric oxide (NO) or nitrogen dioxide (NO_2) react to form diatomic nitrogen and water.

When operated within the optimum temperature range of 500°F to 800°F, the reaction can result in removal efficiencies between 70 and 90 percent. The rate of NO_X removal increases with temperature up to a maximum removal rate at a temperature between 700°F and 750°F. As the temperature increases above the optimum temperature, the NO_X removal efficiency begins to decrease. SCR use in the cement industry is incredibly limited, with only a handful of uses in Europe and one instance, i.e. the Joppa Cement Plant operated by LaFarge Holcim in the United States.

Low NO_X Burners, Preheater Riser Duct Firing, and Selective Non-Catalytic Reduction are currently implemented at the Paulden facility. Therefore, these control technologies are not evaluated. Only Selective Catalytic Reduction was evaluated for Regional Haze in the next section.

Table 3 Evaluated Controls

Control Option	Technically Feasible (Y/N)	Pollutant Impacted	Control Effectiveness (%)
Selective Catalytic Reduction	N	NO_X	90

2.5 Four Factor Analysis Review

ADEQ is proposing that SCR is not feasible due to review of Drake Cement's analysis as described below. Additionally, Drake Cement provided the cost of compliance of the SCR.

2.5.1 Technical Feasibility

2.5.1.1 Availability of SCR

SCR is not widely available for use with cement kilns, in large part because the site-specificity limits the commercial availability of systems. Therefore, for this analysis, SCR is considered as a technically infeasible control technology for additional NOx reductions at the Paulden Facility.

2.5.1.2 Operating Temperature Limitation

In their design report, Joppa specifies that for SCR application, the kiln must operate at a temperature range of approximately 500-800 °F. If the temperature is too low, it will directly and negatively impact SCR effectiveness for NO_x reduction and result in the formation of byproducts such as, ammonium sulfate and ammonium bisulfate. It also causes increased ammonia slip. If the temperature is too high, oxidation of the NH_3 to NO can occur and run the risk of damaging the catalysts. The Drake Cement kiln operates at approximately 2000°F which is outside the acceptable temperature range for proper operation of the SCR. Due to the high temperature of the kiln exhaust gases, it is not feasible to install an SCR upstream of the kiln baghouse and downstream of the kiln. Based on the above discussion, the SCR could potentially to be installed downstream of the kiln baghouse. However, the outlet baghouse exhaust temperature for Drake plant ranges from 260 °F to 450 °F which is much lower than the desired reaction temperature range of between 500 °F to 800 °F. To make this feasible, additional burners would be required to reach optimal gas temperatures. This would require additional fuel usage. Additionally, the Illinois Environmental Protection Agency (Illinois EPA) has also shown concerns for temperature fluctuations that can occur during kiln operation which result in additional NO_x or ammonia slip when these variations occur at the SCR. Overall, the temperature of the kiln exhaust stream at the Paulden Facility is not amenable to installation of an SCR.

2.5.2 Cost of Compliance

The currently installed and operating NOx controls are the most efficient cost-effective option for NOx emissions reduction and control at this facility. However, the cost of compliance and incremental control efficiency was estimated using the U.S. EPA Cost Control Manual and Design Reports from the Joppa Facility.

Based on the cost manual, direct capital costs were conservatively estimated to be approximately 12.9 million for SCR design and installation. In addition, potential costs for any additional controls or downtime associated with installation that may be required were conservatively not included in this cost analysis.

The cost of design and installation of a hypothetical SCR system based on the above-mentioned conservative approach is approximately $28,641/ton with a total capital cost of $12.9 million and annual direct and indirect operating cost of $2.39 million.

2.5.3 Time Necessary for Compliance

Since the retrofit of the SCR system is deemed technically infeasible for the Paulden Facility, the time required for the re-design and re-configuration of the Paulden Facility to accommodate the SCR System installation is unknown at this time. Note that it took almost 6 years for Joppa to design and test the SCR system in order to achieve compliance with the consent decree.

2.5.4 Energy and Non-Air Quality Impacts

As noted above, since the SCR system is technically infeasible, the associated energy and non-air quality impacts are unknown. However, any SCR system has the following potential impacts:

- Generation of Used Catalyst Waste
- Increased energy demands to operate the SCR System

2.5.5 Remaining Useful Life of Source

It is conservatively estimated that the SCR system would remain in service for a 20-year period before it needs any significant modification or reconstruction.