

Final Report

HARC Project H-28

Evaluation of Potential Control Technologies for Oxides of Nitrogen
from Point Sources in Ellis County, Texas

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SUMMARY

INTRODUCTION

The objective of this project was to conduct a comprehensive review of all currently available technologies that could be employed for reducing NO_x emissions from existing major point sources in Ellis County, Texas. Ellis County had NO_x emissions in 2000 of 57 tons per day (tpd), with Point Sources contributing about 60% of those emissions. The Dallas area had 20 days over the 8-hour ozone standard in 2003, with a peak 8-hour value of 130 ppb. Because Ellis County has the potential to impact the air quality in the Dallas area, this report assesses technologies available to reduce emissions from major sources of NO_x in Ellis County. The study also includes estimates for the initial capital expenditure and annual operating costs for technologies that could be practically implemented to further reduce emissions. These costs were compared with NO_x controls being required of other industries and other sectors in the Dallas-Fort Worth (DFW) area.

GENERAL APPROACH

This evaluation includes an identification of the source categories that produce the largest quantities of oxides of Nitrogen (NO_x) emissions from stationary point sources. To determine the potential for potential new strategies, the baseline of current control and the technical feasibility of making additional emission reductions beyond current requirements were evaluated. Within the limits of available data and information, estimates of the quantity and cost-effectiveness of these reductions are provided.

The cost estimates were based on both the capital and operating costs to achieve reductions beyond those required under current regulation. For comparative purposes, cost-effectiveness (dollars per pound of NO_x reduced) was calculated. The cost-effectiveness was calculated using certification data, published data from other reports, and data from vendors and other manufacturers of emission control and process equipment. The methodologies used in this report are based on the EPA Air Pollution Control Cost Manual, Fifth Edition

The control technology and costs are compared with the level of controls and costs of NO_x controls being required of other sources and other sectors in the DFW area (to the degree that such data is published and readily available).

EMISSION SOURCES

Based on a preliminary evaluation of the major sources of NO_x in Ellis County, the following categories of point sources were reviewed:

- Cement Kilns
- Power Plants
- Fiberglass Plants
- Steel Industry
- Glass Container Industry
- Natural Gas Transmission

Due to limited resources and the need to focus on the highest priority sources, this analysis focused on the five largest facilities, which comprise most of the NO_x emissions in Ellis County. Therefore, additional sources were not addressed. The 2002 emissions inventory of the TCEQ was the primary source for determining emissions from these sources¹. Annual 2002 emissions from these five plants, based on TCEQ data², were as follows:

Table S-1. Summary of NO_x Emissions from Cement Plants and Power Plants.

Facility	2002 NO _x (tons/yr)
Ash Grove Cement	2,572
TXI Operations	4,221
Holcim Texas	4,175
Midlothian Energy	721
Ennis Tractebel Power	89

The cement plants collectively produced more than 90% of 2002 NO_x emissions from these five plants. In addition, the two power plants have advanced NO_x control systems in place. The technology used for controlling NO_x emissions is Selective Catalytic Reduction (SCR), which is in place on all the turbines at the two energy facilities. Accordingly, it was concluded that these plants have limited potential for further reductions. Given the limited resources for this analysis, it was decided to focus exclusively on the cement plants.

CEMENT PLANT OPERATIONS AND EQUIPMENT IN ELLIS COUNTY

There are seven wet process kilns operating in Ellis County. Three of these kilns are operated by Ash Grove Cement (formerly North Texas Cement Company) and four wet process kilns are operated by TXI Operations. Three dry process kilns are in operation in Ellis County, one at TXO Operations and two at Holcim Texas. In the wet process kilns, slurry is introduced into the feed end but first must undergo a simultaneous heating and drying process. The wet process kilns tend to be older kilns and less conducive to methods used to control NO_x emissions. The dry process kilns in Ellis County utilize a dry feed rather than a slurry and represent a newer technology referred to as preheater/precalciner kilns. These kilns have a larger capacity and have higher energy efficiency. These kilns are also more conducive to advance NO_x controls.

Kilns in Ellis County have employed or propose to install a variety of controls to reduce NO_x emissions. These controls include process modifications, mid-kiln firing and the installation of low-NO_x burners. Process modifications, which reduce NO_x emission without the installation of specific control equipment, include the ChemStar process. The processes and control equipment for reducing NO_x emissions at the three cement plants in Ellis County is described in full detail in this report. Table S-2 summarizes the technologies in place and the 2002 NO_x emissions from each of the kiln operations in Ellis County.

¹ Information provided by Russell Nettles of the TCEQ Emissions Inventory group included 2002 Contaminant Summary Reports, and other detailed reports on each of the five facilities

² See Sections 2 and 3 for additional background on emissions estimates.

The Ash Grove Cement and TXI plants predominantly use wet process kilns. In 2002 wet process kilns, for which control options are more limited, produced about 45% of all cement plant NO_x emissions.

Table S-2. Control technology used in Ellis County cement plants.

Company Name	Unit	Process	Current NO _x Control Technology ⁴	2002 NO _x Emissions (tons/yr)
Ash Grove Cement ¹	Kiln 1	Wet Process	ChemStar, MKF (tires) ³	823.9
Ash Grove Cement	Kiln 2	Wet Process	ChemStar, MKF (tires) ³	829.2
Ash Grove Cement	Kiln 3	Wet Process	ChemStar, MKF (tires) ³	918.6
Plant Total				2,571.7
TXI Operations, L.P.	Kiln 1	Wet Process	ChemStar, LNB	1,010.2
TXI Operations, L.P.	Kiln 2	Wet Process	ChemStar, LNB	24.3
TXI Operations, L.P.	Kiln 3	Wet Process	ChemStar, LNB	375.6
TXI Operations, L.P.	Kiln 4	Wet Process	ChemStar, LNB	988.4
TXI Operations, L.P.	Kiln 5	Dry Process ²	LNB	1,822.7
Plant Total				4,221.2
Holcim Texas L.P.	Kiln 1	Dry Process ²	LNB	1,909.7
Holcim Texas L.P.	Kiln 2	Dry Process ²	LNB	2,265.1
Plant Total				4,174.8

¹ Formerly North Texas Cement Company.

² Precalciner Kiln.

³ TNRCC confirmed that North Texas Cement (Ash Grove) meets the criteria of having mid-kiln firing and low NO_x-burners. Letter from Richard L. Hughes, September 20, 2000.

⁴ MKF is Mid-Kiln Firing, LNB is Low-NO_x Burners

AVAILABLE CONTROL TECHNOLOGY AND COSTS

The evaluation of potential controls for the cement plants in Ellis County is based on the experience of other plants in the U.S. and Europe as reported in the literature. For the purposes of this report, the term "technically feasible" applies to a control method or technology has been applied to other cement kilns, has been demonstrated to be successful in reducing NO_x emissions, and appears to be feasible for similar equipment and processes in use in Ellis County.

Several technologies are available to control NO_x emissions from cement kilns. A full discussion of each technology is included in this analysis. Again, the purpose of this study is to guide the reader in making a "first cut" assessment of the potential for emissions reductions through the use of the technologies discussed herein, and provide some insight on next steps that may be considered.

The capital and operating costs were estimated for each of the control technologies that were deemed technically feasible in Task 3 and repeated here in Section 3. In addition, we have performed a rough estimate of the cost and cost-effectiveness of Selective Catalytic Reduction (SCR), even though it was classified as "potentially feasible". Because the ChemStar process is used on each of the wet kilns in Ellis County, this cost of this process was not estimated. Furthermore, because low-NO_x burners are used in the wet kilns at TXI Operations, the cost for this technology was also not estimated.

In order to make the analysis more relevant to the Portland Cement facilities in Ellis County, we applied various technologies to specific kilns and did so with consideration of the equipment and NO_x control methods that are already in place at each kiln. Although estimates are not provided for all technologies at each kiln, the general cost and cost-effectiveness ranges would generally apply to all kilns. The exception is where a particular technology is not applicable to a particular kiln, i.e., the application of SNCR to wet kilns. All assumptions and costs identified with this analysis are included in the cost evaluation sheets contained in Section 4 of this report.

Because this report relied on TCEQ permitting information for the facilities, some information on the costs of controls was based on assumptions that were necessary because certain information was not available from the TCEQ for the specific kilns in operation in Ellis County. For example, we were able to obtain, from TCEQ, material throughput in tons of clinker processed per year for the Ash Grove kilns and the Holcim kilns but not the kilns at TXI Operations. We were also not able to obtain information on the amount and types of fuel used for the kilns at each of the three plants. Assumptions for these parameters as well as assumptions on specific equipment such as the use of direct-fired burners at the wet kilns were also made. Further assessments should be made with facility participation, and TCEQ documented information.

Table S-3 summarizes the discussion of available control technologies as well as the costs associated with each technology.

Table S-3. Available control technologies and Costs for Cement Plants in Ellis County.

Control Technology	Kiln Type	NO _x Reduction (Percent)	Capital Cost	Operating Cost	Cost-EFF (\$/ton)
Mid-Kiln Firing ¹	Wet Process	28 -59	\$3,228,000	(758,000) ¹	(\$650 - \$3,685)
Bio Solids Injection ¹	Dry Process ²	15 - 30	\$947,000 - \$1,246,000	(\$483,000) ¹ - (\$493,000)	(\$568) - (\$1,325)
SNCR	Dry Process ²	10 - 50	\$3,651,000 - \$3,949,000	\$872,000 - \$1,770,000	\$1,022 - \$12,197
SCR	Dry Process ²	80 - 95	\$27,685,000 - \$29,773,000	\$5,108,000 - \$7,023,000	\$3,849 - \$6,696

Notes:

¹ Operating costs show a savings from tipping fees and/or fuel savings.

² Dry process kilns in Ellis County are all preheater/precalciner kilns.

SUMMARY

Technology for controlling NO_x emissions in Ellis County is available and has the potential to significantly reduce emissions. With the exception of SCR, all the technologies identified in Table S-3 have been applied to cement plants in the U.S. It is important to note that specific technologies may not apply to a particular installation such as an older wet process kiln. Further, depending on the configuration and age of the unit, retrofit costs can increase above the costs identified in this report. With respect to SCR, this technology has been successfully applied to a specific application in Germany. A full discussion of this technology is included in this report. We have performed a rough estimate of the cost and cost-effectiveness of Selective Catalytic Reduction (SCR), even though it was classified as “potentially feasible”. A technology referred to as LoTO_x shows some promise, but has not been applied in a cement kiln operation. We recommend that this technology be further investigated.

This report addresses nearly all of the comments received from reviewers on the interim reports prepared for this study. However, we could not respond substantively to three specific comments because they were beyond the scope of this present project. First, comments received on the Task 2 report (Section 2 of this Report) suggested that we include the date of construction and initial startup dates for each of the cement kilns because several of the wet kilns are older configurations and less conducive to the installation of retrofit control equipment. However, that information was not available at the time of this report from the TCEQ. Second, the point was made that we should include the emission rates per ton of clinker for comparison purposes with the other clean plants in Europe. As discussed in the report, the annual clinker production was not available for all the wet kilns so we were not able to provide a comparison of the rates per ton of clinker produced. Lastly, although briefly discussed in this report, we did not investigate the issue raised by manufacturers regarding the iron ore content of the limestone, or the sulfur content of the limestone or some other aspect of the limestone which may prevent them from operating SNCR/SCR systems efficiently. Again, we did not have fuel use or fuel specification information to provide this type of analysis. We suggest that all three of these areas be further investigated. In addition, we highly recommend that any follow-on work on this project include actual site visits. This would allow onsite investigation of the operations and equipment in place as well as provide detailed information on configuration of the kilns. All of this information would provide further analyses for the TCEQ and assist in dealing with issues associated with the installation of further emission control equipment.

While this report identified potential technologies and the associated costs, it should be viewed as a preliminary evaluation to be used for further evaluation at specific sites. At this level of analysis, where detailed information on plant design, equipment and operations is not available, conclusions on technical feasibility are necessarily preliminary and have significant uncertainty. Therefore, the analysis and conclusions must be considered preliminary, since they are based on general information about the facilities in Ellis County and do not involve a detailed engineering analysis of specific plant equipment or operations. Detailed assessment of the actual emissions reductions likely from these facilities would require substantial equipment vendor interaction and plant engineering design. While we have done a preliminary engineering “scoping” assessment, including some very limited vendor discussions, this cannot replace the much more complex and costly process of actual engineering design.

Since cost-effectiveness calculations apply cost estimates to the range of emission reductions estimated in this report, all the uncertainties and limitations with emission reduction estimates that were described in the report apply equally to the cost-effectiveness numbers in this report.

At these levels of analysis, the capital cost estimates do not address specific retrofit considerations for the Ellis County plants. There was not enough information available to uncover potential hidden costs of a specific installation on a specific unit. EPA guidance notes that a retrofit factor of up to 50% of the capital cost of the control system can be justified on a case-by-case basis, but that it is also important to avoid over-estimates (Control Cost Manual, p. 2-28). Since this study has no means of developing a retrofit factor for each technology-unit combination, we have chosen to apply an across the board contingency factor of 20%. Specific considerations for retrofit requirements are identified in the discussion for each control technology. The contingency factor may or may not be adequate to cover plant and unit specific issues.

In summary, these estimates should be considered rough estimates of the actual cost-effectiveness of control should these control methods be applied to Ellis County cement plants.